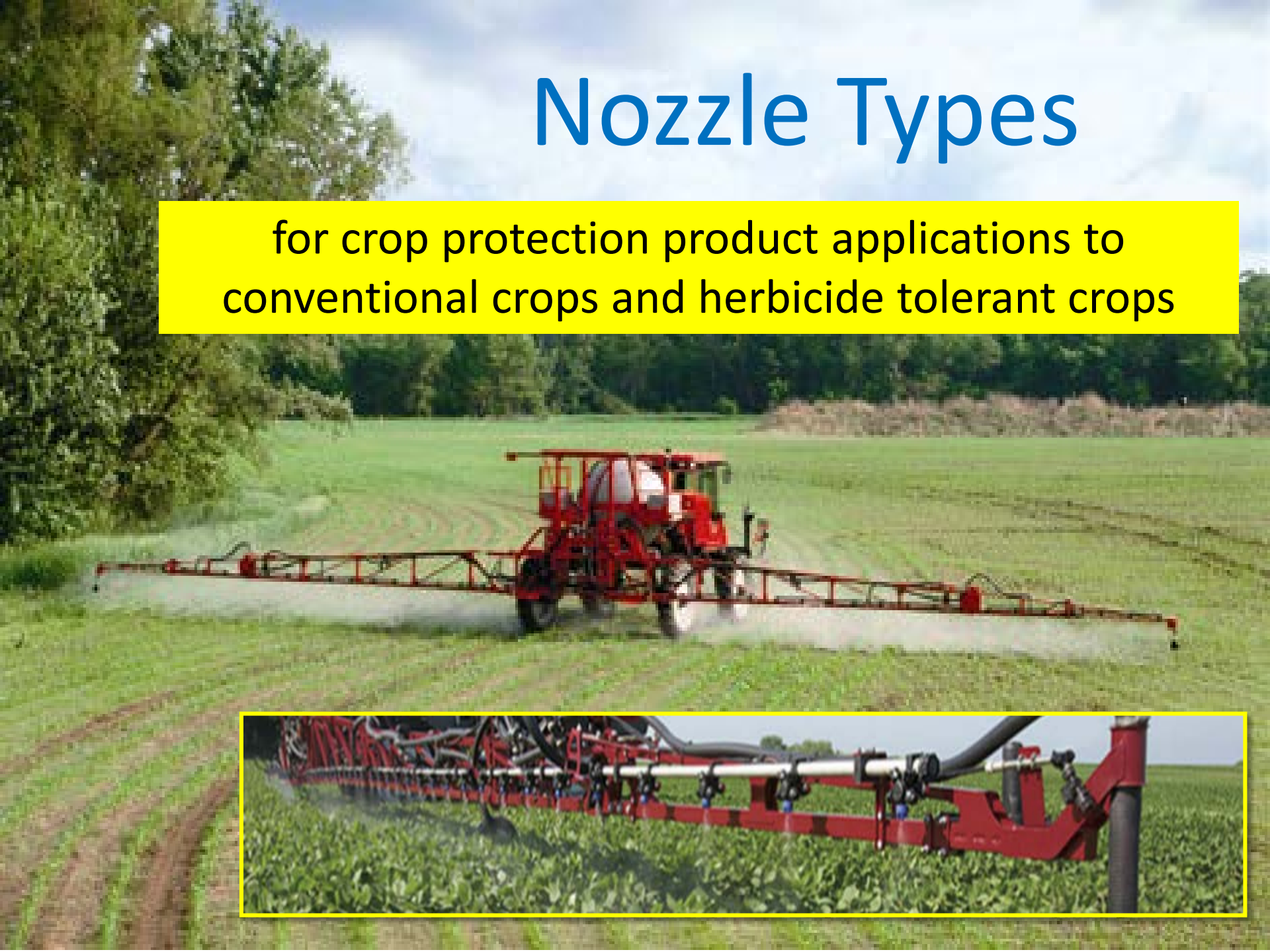
# Effective Pest Control: Nozzle and Technology Options for Improved Efficacy and Drift Mitigation

# Nozzle Types

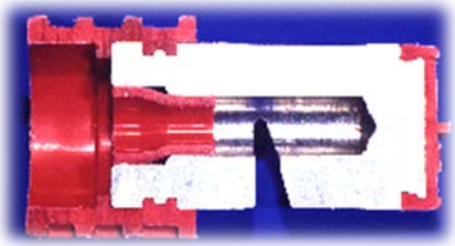
for crop protection product applications to conventional crops and herbicide tolerant crops



# Nozzle Technology

- Nozzles designed to reduce drift
- Improved drop size control
- Emphasis on ‘spray quality’



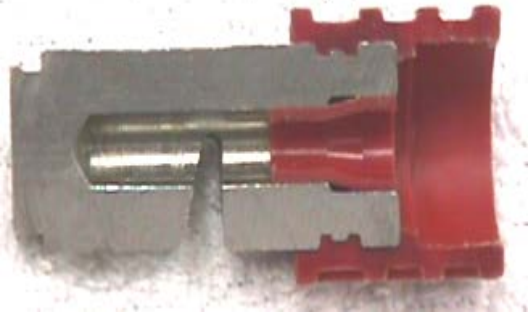








# Nozzles Types

Flat Spray Patterns

**flat-fan**

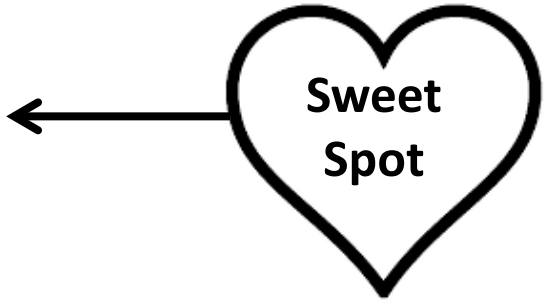
**chamber**

**venturi**



# Extended Range Flat-Fan

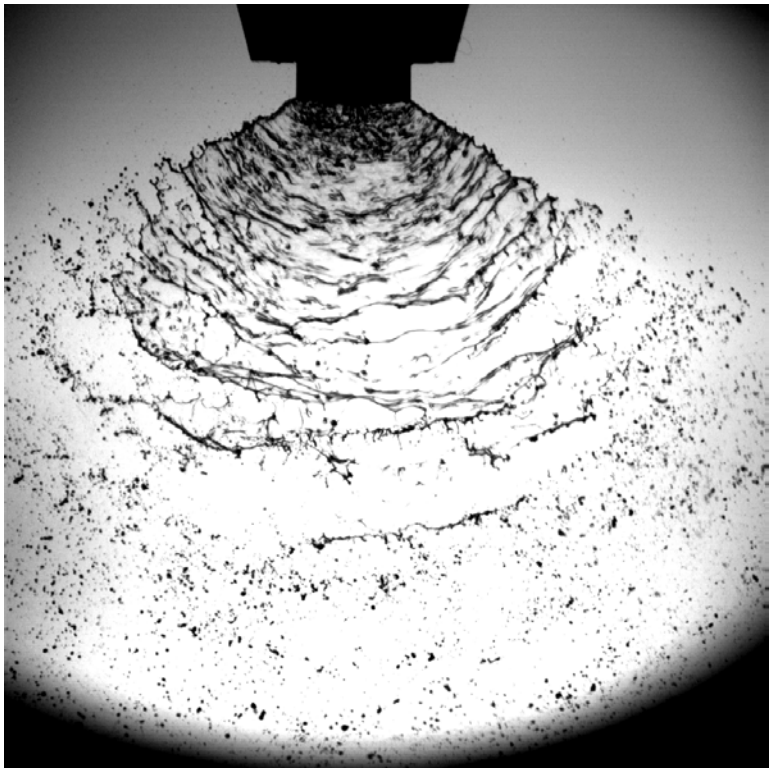
- Spray Pattern width: 80° and 110°
- Operating PSI: 15-60 PSI
- Tapered edge flat spray pattern
- Overlap required: 50-60% for uniform application (20-30% each edge)
- Nozzle Spacing: Typically 20 inches
- Optimum spray height:  80° - 30" above target, or 110° - 20" above target
- Recommended PSI: 20-25 PSI

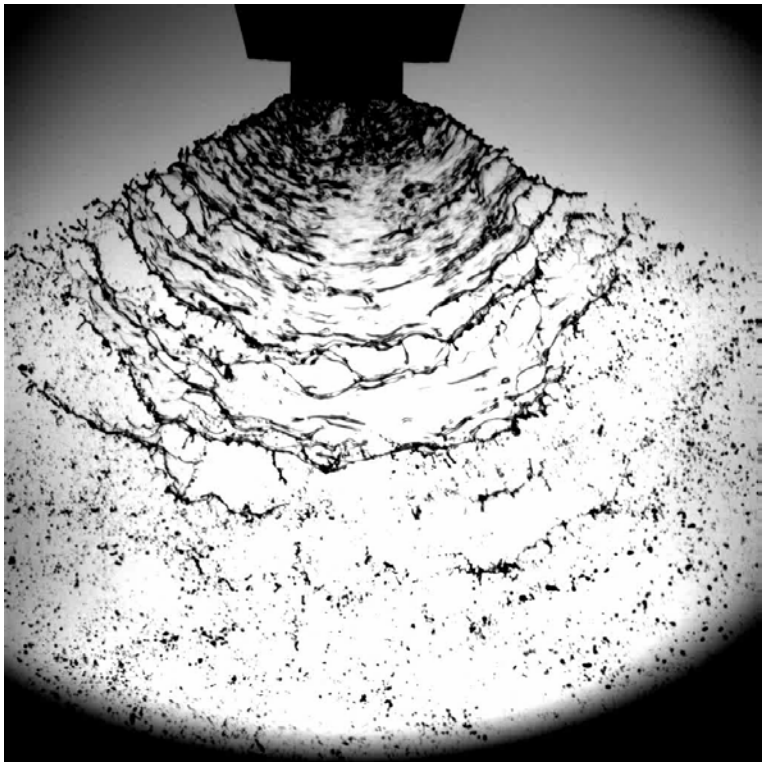

TeeJet catalog #51A
pages 12-13

# XR Nozzle Demonstration

XR11004-35 psi



XR11005-40 psi



# Extended Range Flat-Fan

- Spray Pattern width: 80° and 110°
- Operating PSI: 15-60 PSI
- Nozzle Spacing: Typically 20 inches
- Optimum spray height: 80° - 30" above target or 110° - 20" above target
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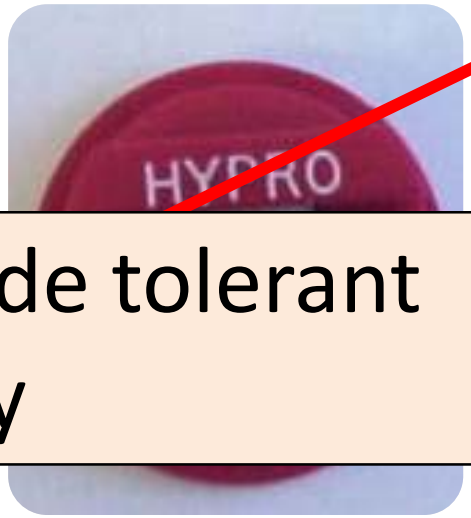
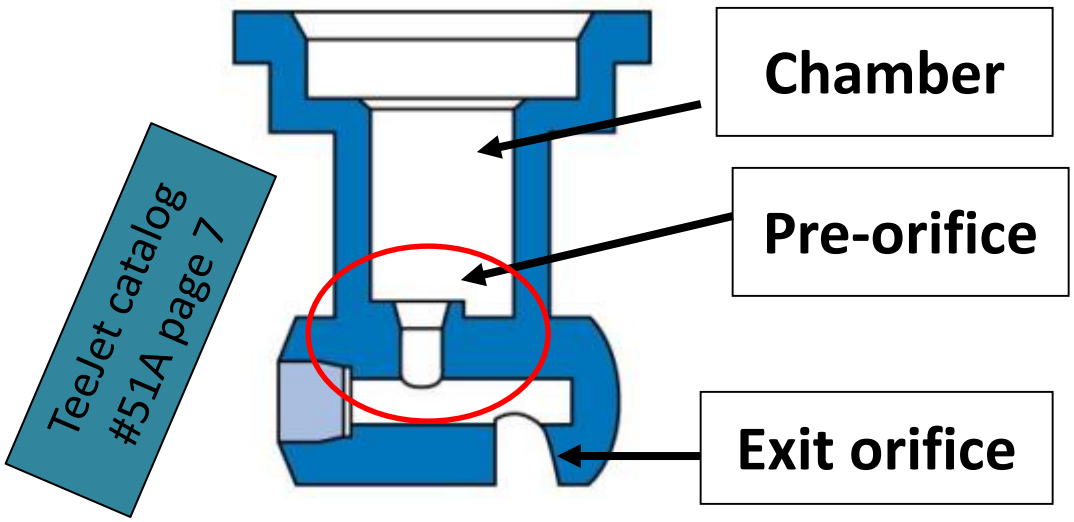



Will not be a part of a herbicide tolerant crop nozzle strategy

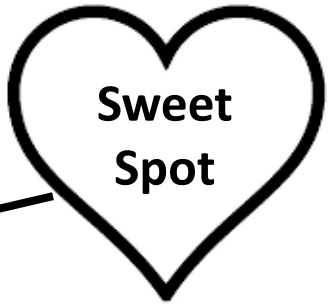
Drift Potential to high compared to other nozzle options

# Turbulation Chamber Flat-fan

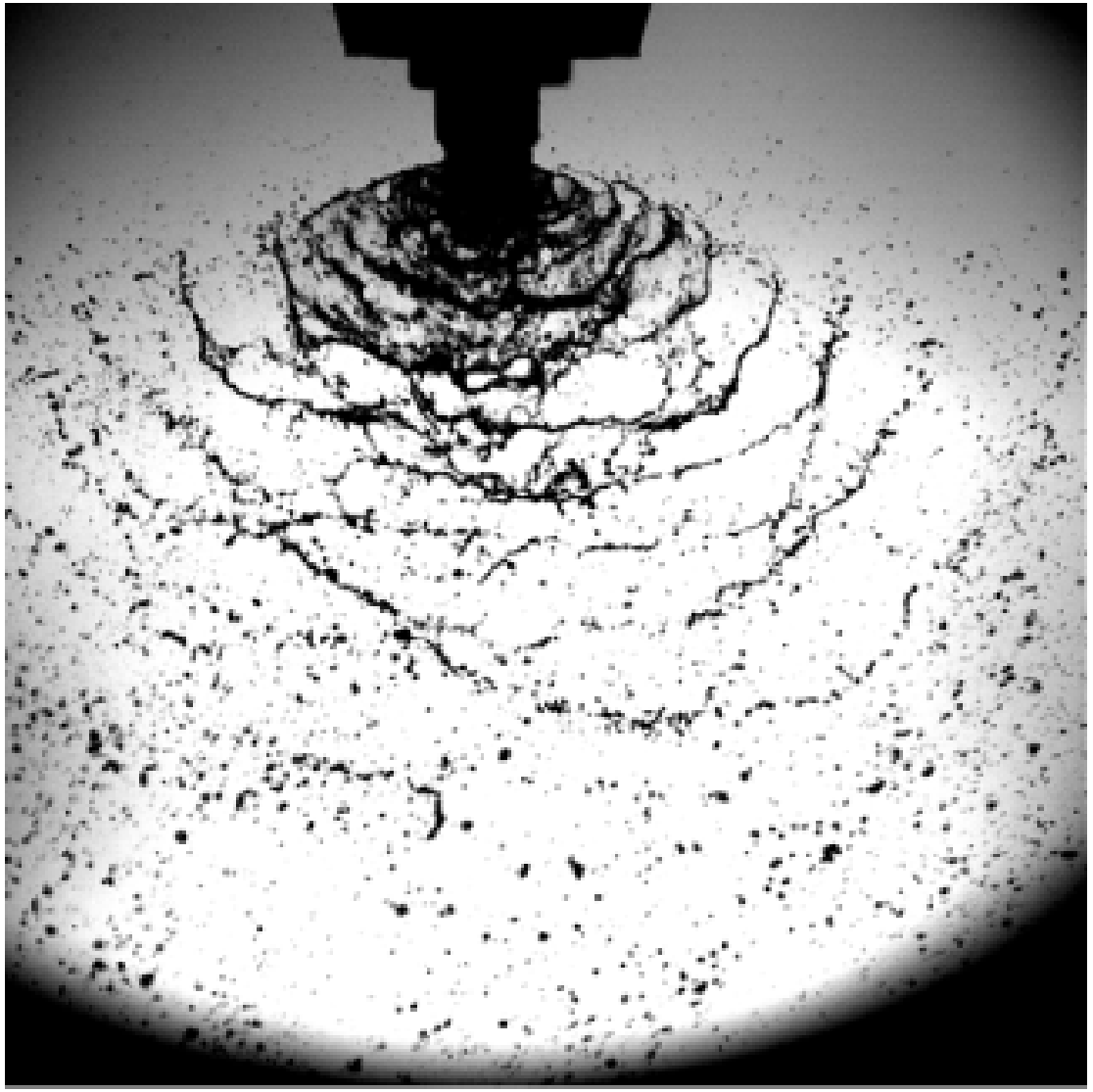




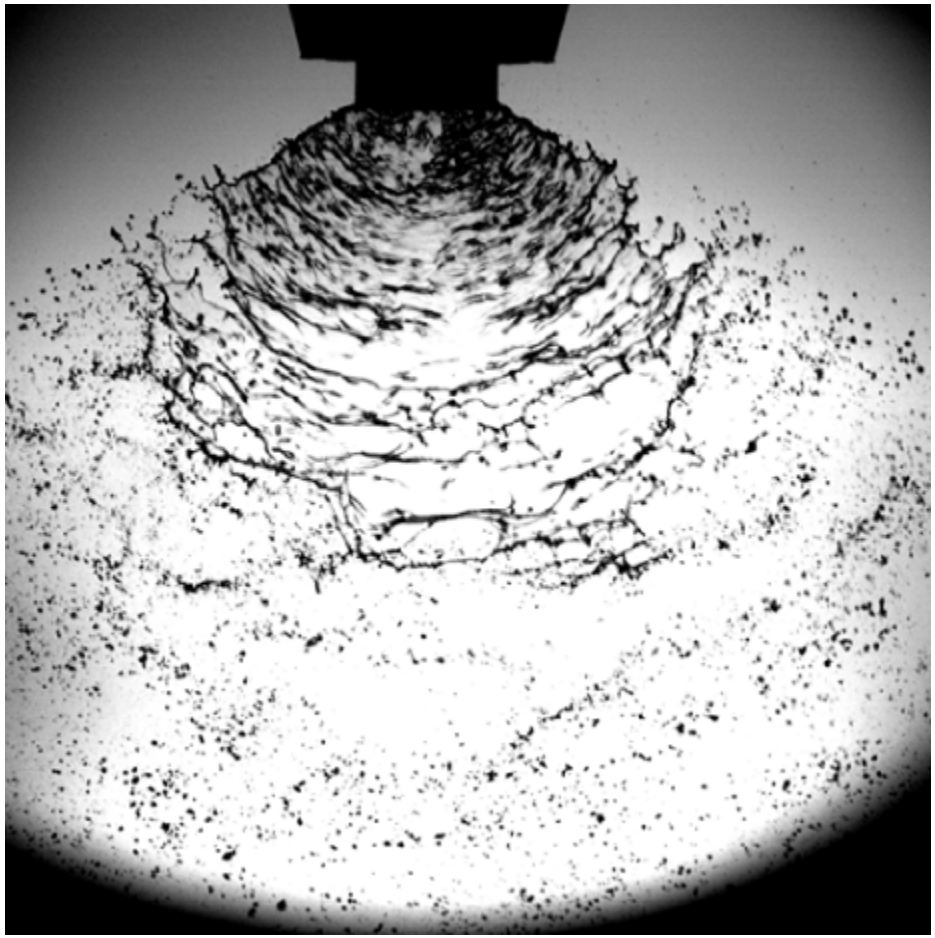
- Spray Pattern width: 110° but more like 125° – 130°
- Operating PSI: 15-90 PSI
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Optimum spray height: 20” above target
- Recommended PSI: 30-40 PSI



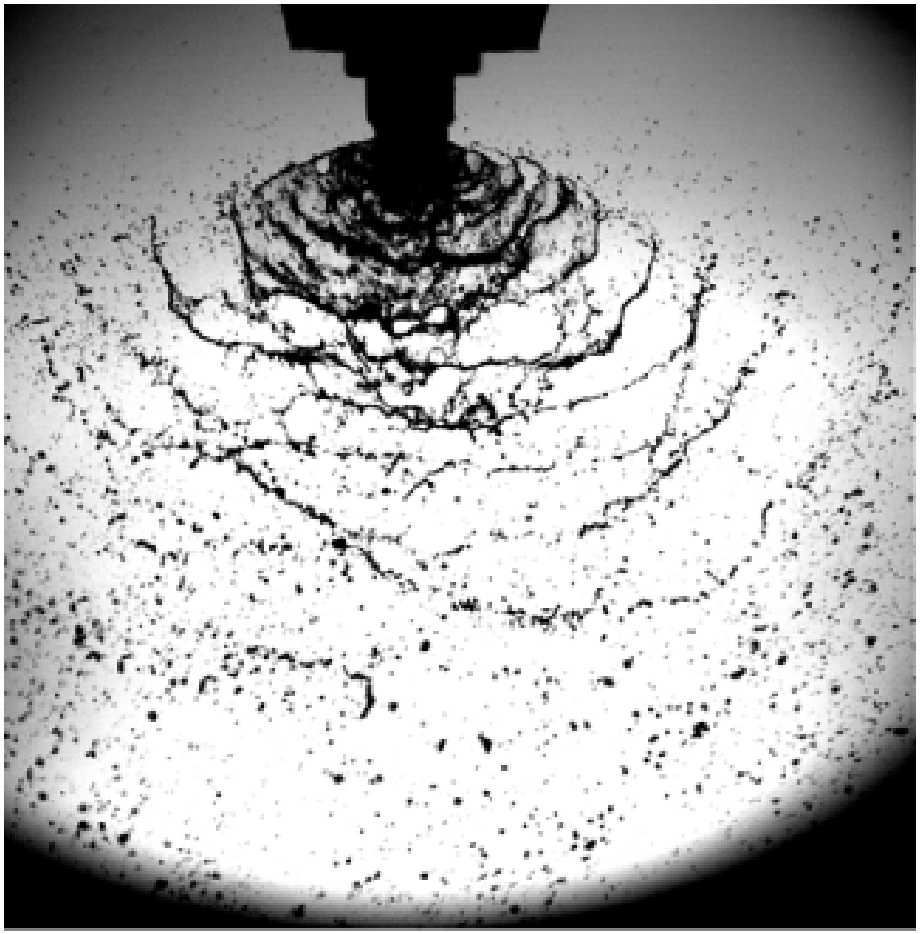
# TT11004-40 psi



XR11004-30 psi

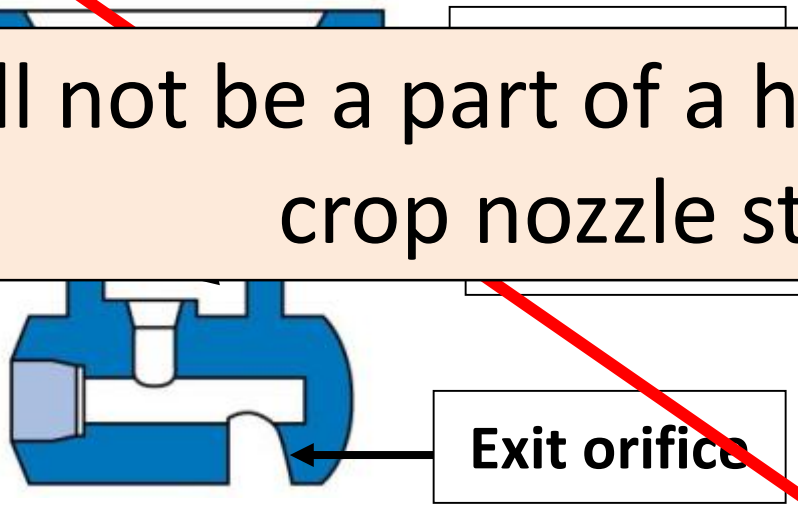


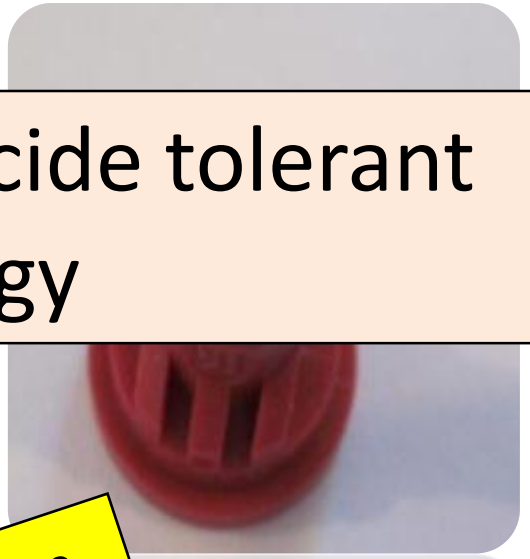
TT11004-40 psi



# Turbulation Chamber Flat-fan

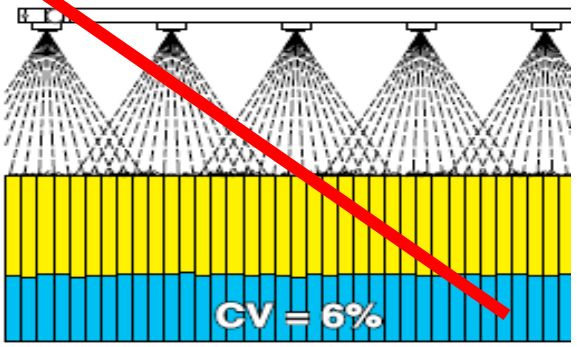
Will not be a part of a herbicide tolerant crop nozzle strategy



- Spray Pattern width: 110° but m
- Operating PSI: 15-90 PS
- Tapered Edge f
- Overlap req (20-30% each edge)
- Nozzle Spaci pically 20”
- Optimum spray height: 20” above target
- Recommended PSI: 30-40 PSI

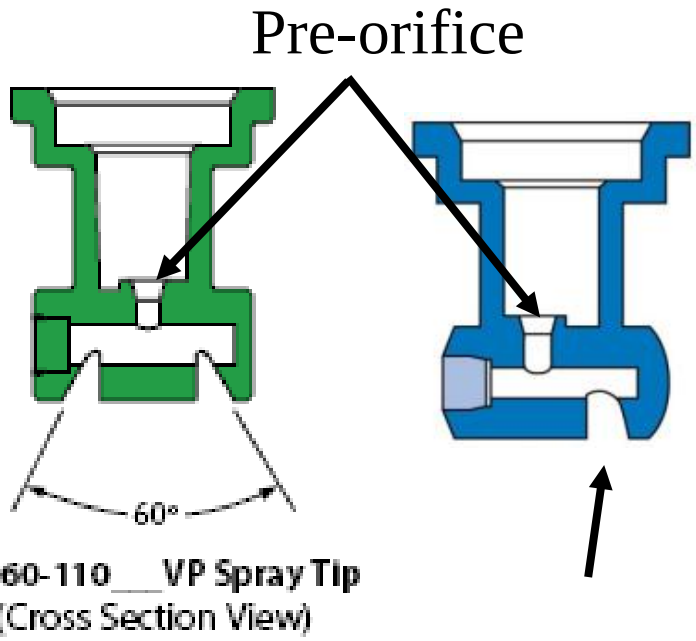
But, will still be an option when coverage is required!



# Turbo Flat-fan Twin

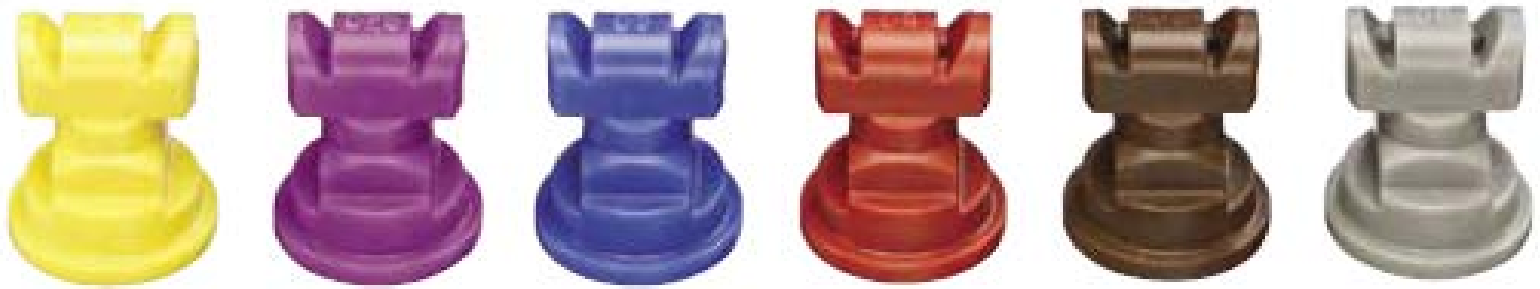
TeeJet catalog
#51A page 16

- Dual outlet
- Superior leaf coverage
- Droplet range slightly larger that comparable TT flat-fan



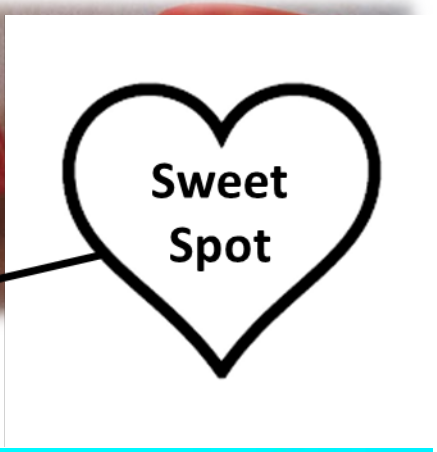

TTJ60-110__VP Spray Tip
(Cross Section View)

**Turbo TwinJet – TTJ60**



# Wilger Chambered Flat-Fan

- Spray Pattern width: 80 - 110°
- Operating PSI: 20-80 PSI
- Tapered Edge flat spray pattern
- Overlap required: 50%-60%
  (20-30% each edge)
- Nozzle Spacing: Typically 20"
- Optimum spray height: 20" above target
- Recommended use PSI: 30-40 PSI

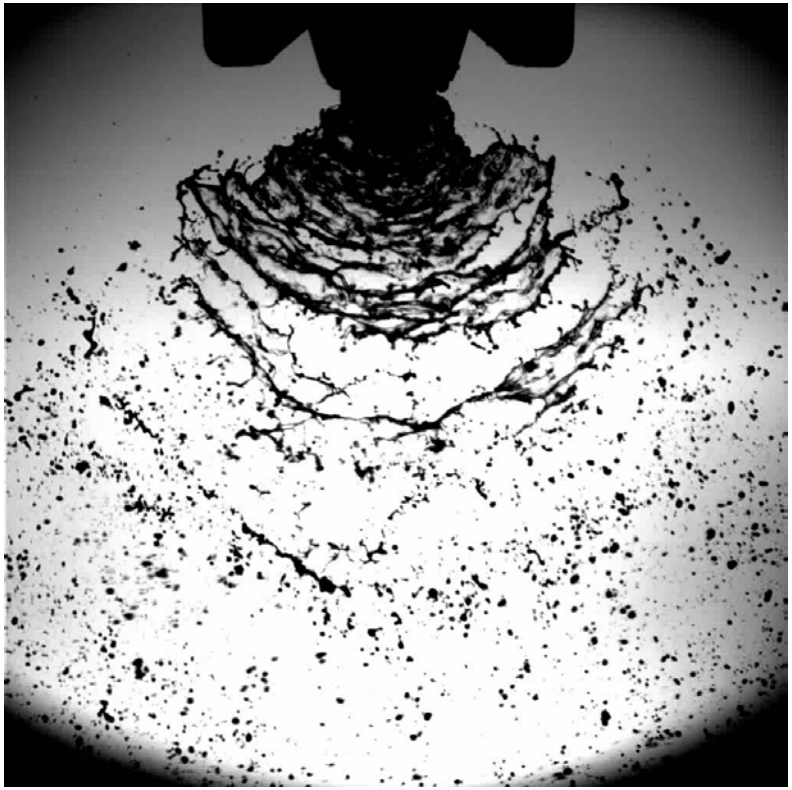


Adapter required

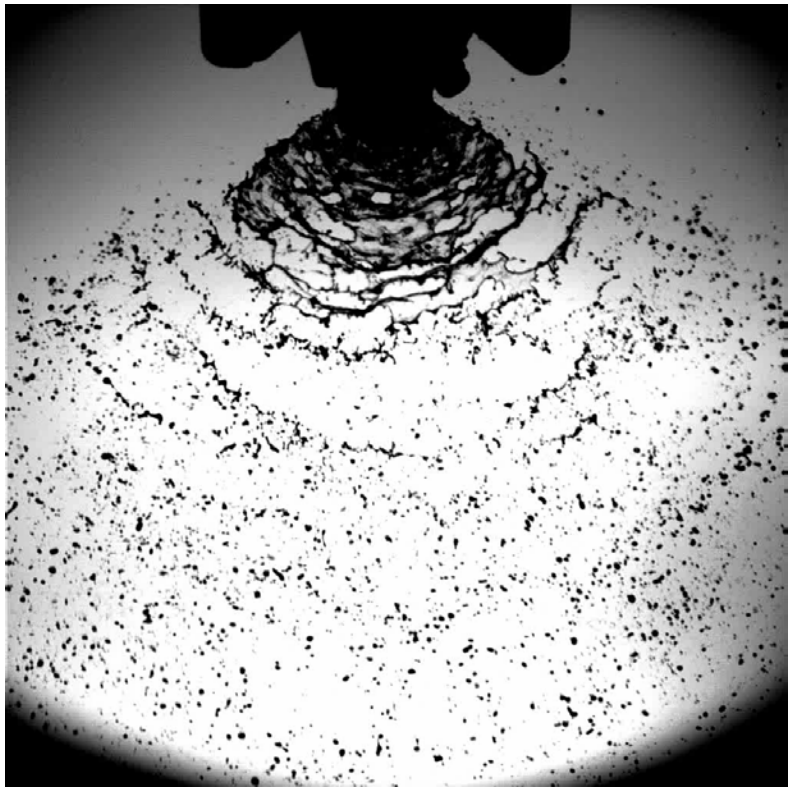

Commonly found on CASE IH Aim Command Sprayers

# Wilger Nozzle Demonstration

DR110-04-40 psi



MR110-04-40 psi



# Pulse Width Modulation - PWM

- Blended Pulse Technology – Pulse Width Modulation
- Solenoid valve flow control (1-8X) “Tip Cha
- Control PSI indepen
- Ulti

**Technology Update!!!**

Deve oped by Ag Engineers at the U of CA - Davis


CAPSTAN Ag Systems Inc
Since 1893

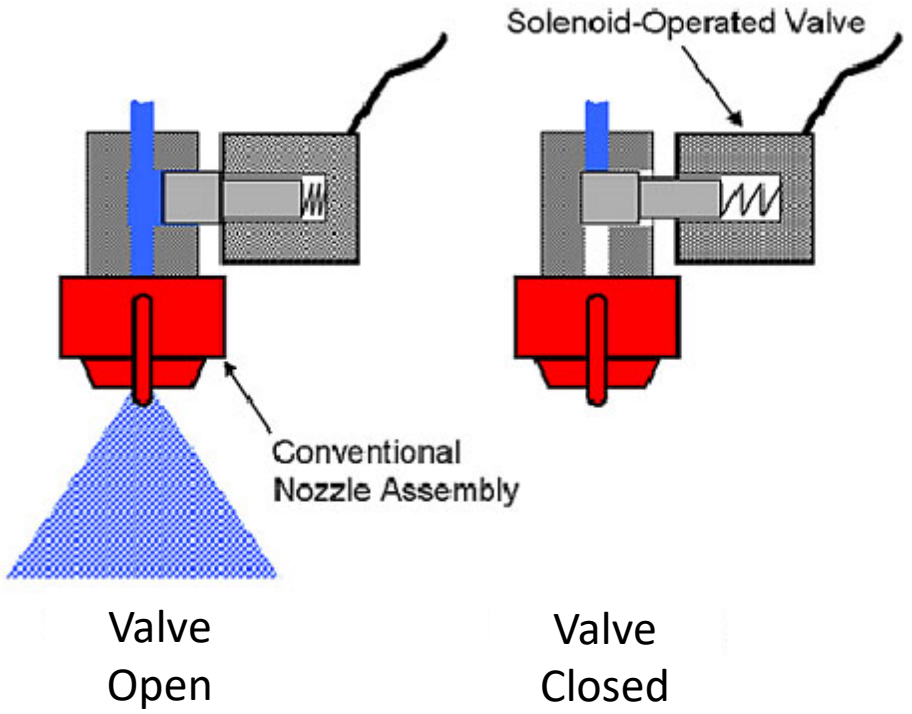
Excellent drift mitigation tool; ideal for precision applications

# OEM install on the Tyler Patriot in mid 90's

# Tyler sold to CaseIH two years later

# How It Works

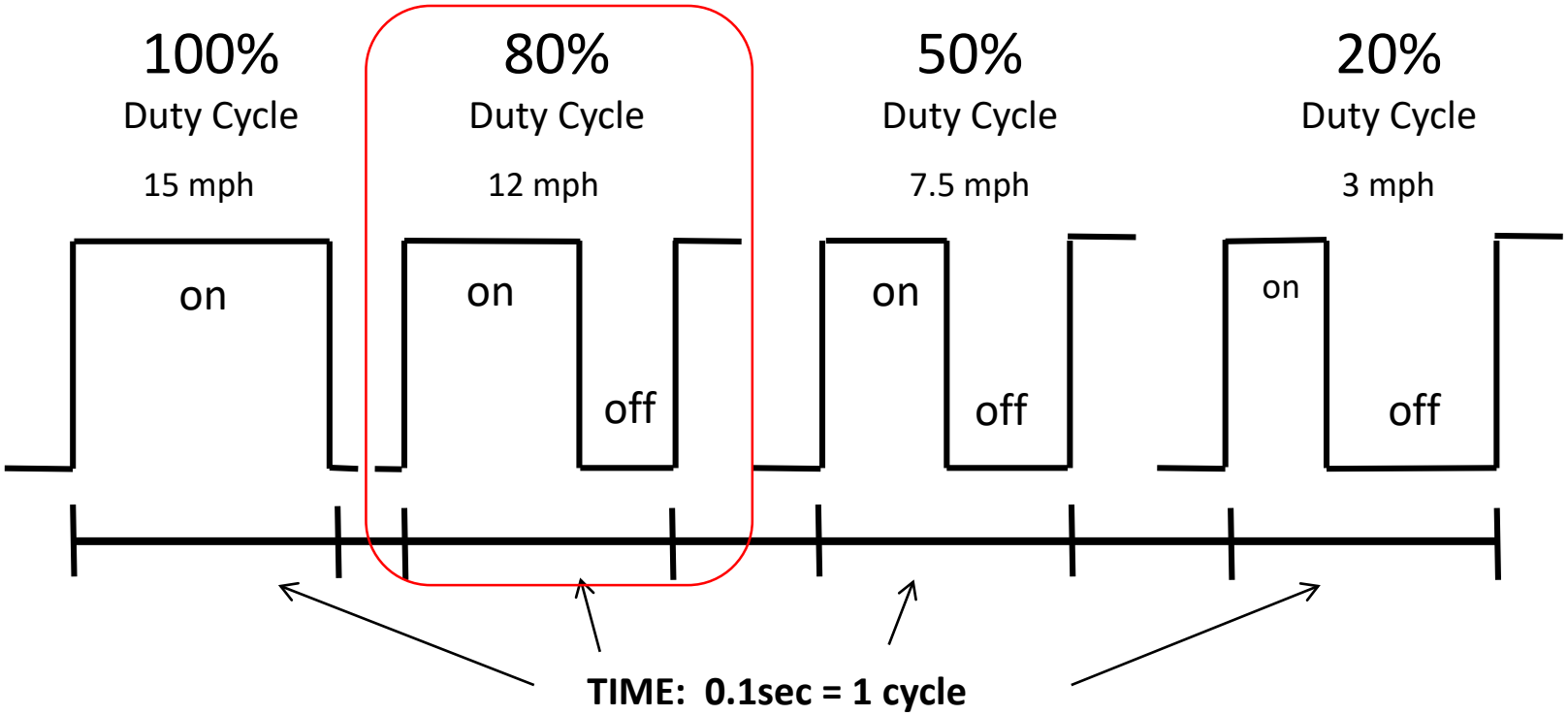
- Uses high speed solenoid valves to regulate flow
- Varies application rate with duty cycle: independently of pressure
- Cycles 10X per second




Venturi nozzles can't be used with pulse width modulation

# What is Pulse Width Modulation?

- Type of control system
- Modulates a DC square wave signal



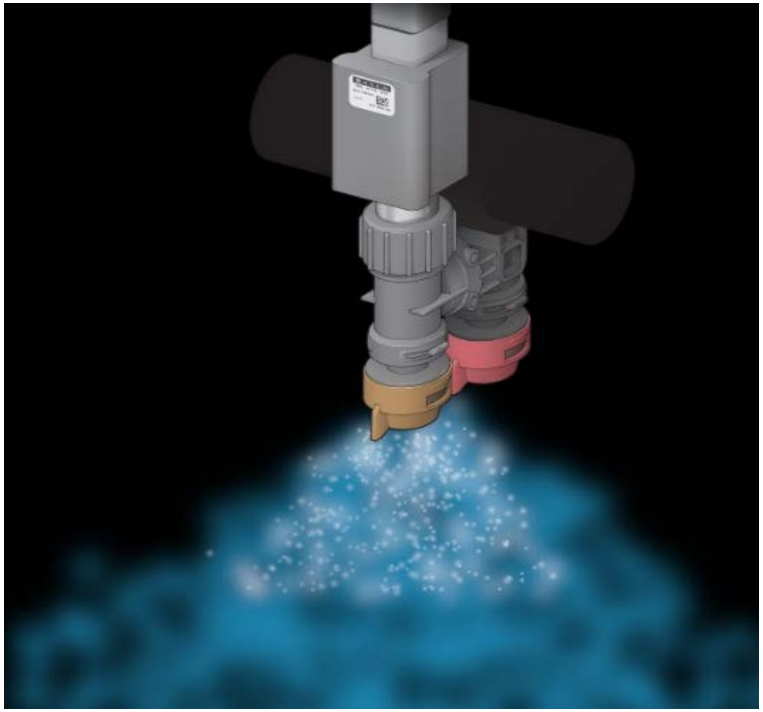

Speed affects a change in duty cycle which affects the amount of flow

# PWM Summary Points:

- Wilger nozzle system is a good option
- Will not work with venturi nozzles
- Other PWM technology:
  - Boom flow compensation
    - adjusts flow on radius turns
  - PINPOINT – Individual nozzle control - on/off per nozzle
- Available as retrofit on any spray system as ‘SharpShooter’-Capstan
- Also retrofit via Raven?


# New Sources of Pulse Width Modulation

Raven Hawkeye Nozzle Control System



# Press Release

**August 2, 2016**

## CapstanAG Systems Files Patent Infringement Suit Against Raven Industries And CNH Industrial America

TOPEKA, Kan., August 2, 2016 – Capstan AG Systems, Inc., a privately-owned Kansas company and the nation's leading manufacturer of pulse-width-modulated agricultural spray control systems, announced today that it has filed a patent infringement lawsuit against Raven Industries, Inc. (RAVN) and CNH Industrial America, LLC, a subsidiary of Netherlands-based CNH Industrial NV (CNHI). The lawsuit was filed in the U.S. District Court for the District of Kansas.

In its complaint, Capstan AG Systems alleges that Raven's "Hawkeye" agricultural sprayer system infringes two of Capstan's patents: U.S. Patent Nos. 8,191,795 and 8,523,085. Capstan's patents relate to agricultural sprayer systems and methods that incorporate individual valve control, yielding more efficient and precise application of liquid agricultural products.

The complaint also alleges that CNH has entered a partnership with Raven to offer the infringing Hawkeye sprayer system on CNH equipment, under the name AIM Command FLEX. Until recently, CNH had offered Capstan's products on its sprayers, under the names AIM Command and AIM Command PRO.

# Cost $$$$:

JD quoting $38K ordered w/machine and factory install.

Raven Hawkeye priced for a JD sprayer 120’ boom at $40K installed.


# HYPRO® Duo React

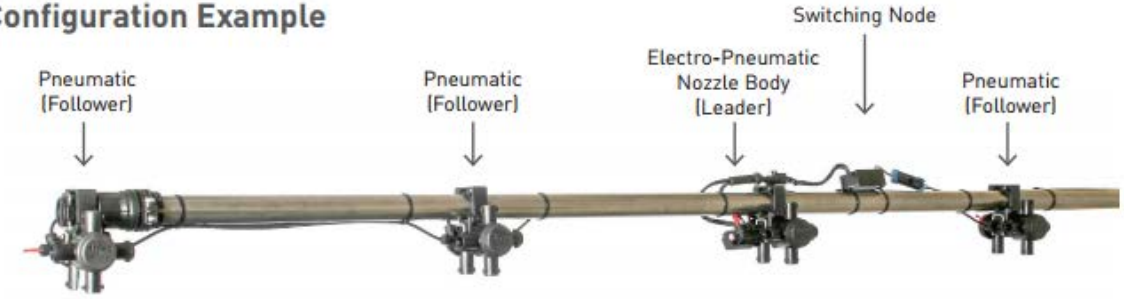
## Compact and Economical Twin Pneumatic Valve Nozzle Body and Control System

Duo React Console

Electro-Pneumatic (Leader)

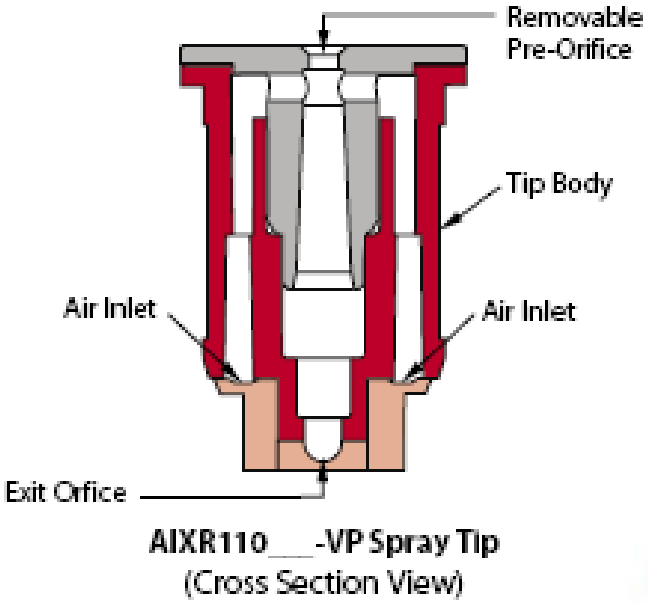
Pneumatic (Follower)

**Boom Configuration Example**



# Venturi Designs - Low Pressure

AIXR TeeJet



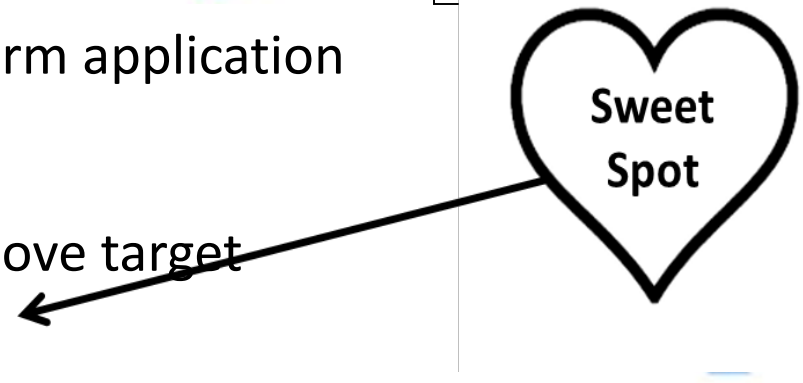

AIXR110___-VP Spray Tip
(Cross Section View)

TeeJet catalog
#51A page 8

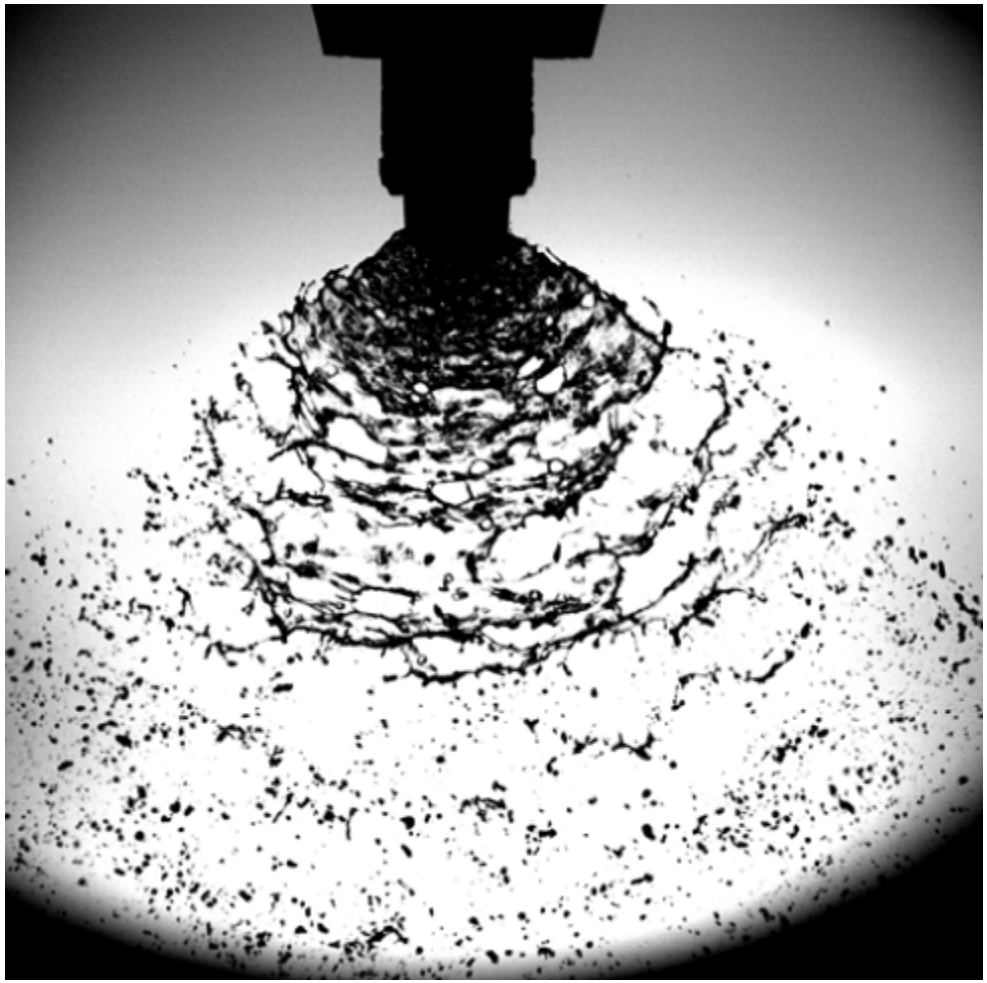
Air Mix



- Spray Pattern: 110°
- Operating PSI: 15-90 psi
- Tapered Edge flat spray pattern
- Overlap required: 50%-60% for uniform application (20-30% each edge)
- Nozzle Spacing: Typically 20”
- Optimum spray height: 110° - 20” above target
- Recommended PSI: 40-50 PSI



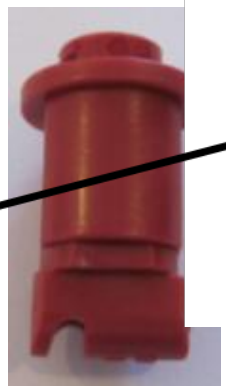
# AIXR11004-50 psi

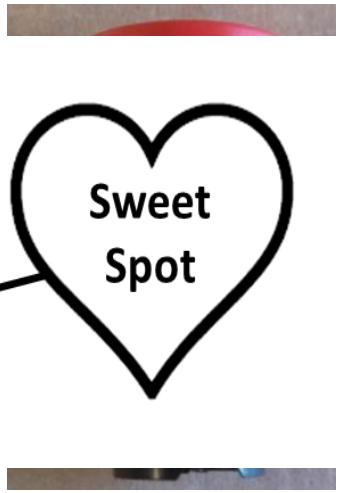


# Venturi Designs - High/Medium Pressure

TeeJet catalog #51A page 9-10

- Contains venturi - air aspirator
- Promotes an internal pressure drop – 4:1
- Spray Pattern: 80° and 120°
- Operating PSI: 30 - 100 psi
- Tapered Edge Flat Spray Pattern
- Overlap Required: 50%-60% for Uniform Application (20-30% each edge)
- Nozzle Spacing: Typically 20“
- Recommended PSI: 50-80 PSI




**Air Induction – Air Inclusion – Air Injection**

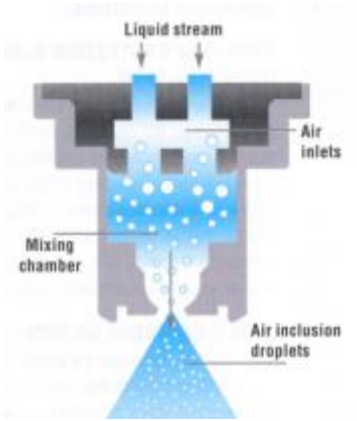
**Designed so air is drawn into the nozzle cavity and exits with the fluid**

# Pre-Orifice VENTURI Nozzles

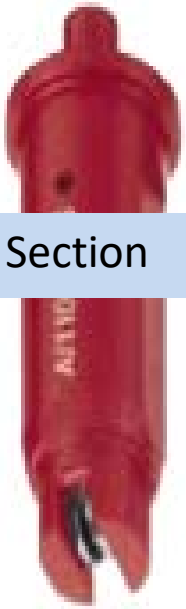
## High and Medium Pressure

Pressure drop ratio = 4:1

Greenleaf TurboDrop XL

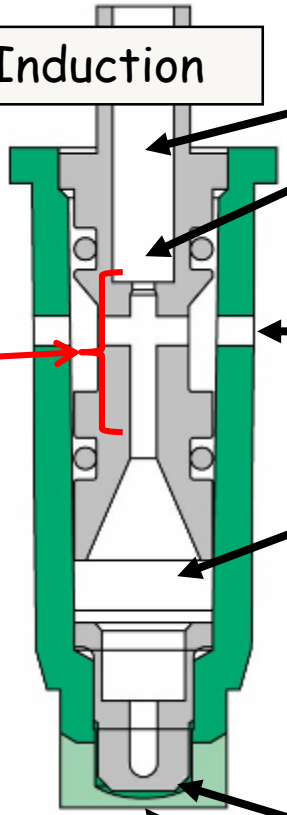



TeeJet Air Induction



Venturi Section

Hypro Ultra LowDrift



Chamber

Pre-orifice

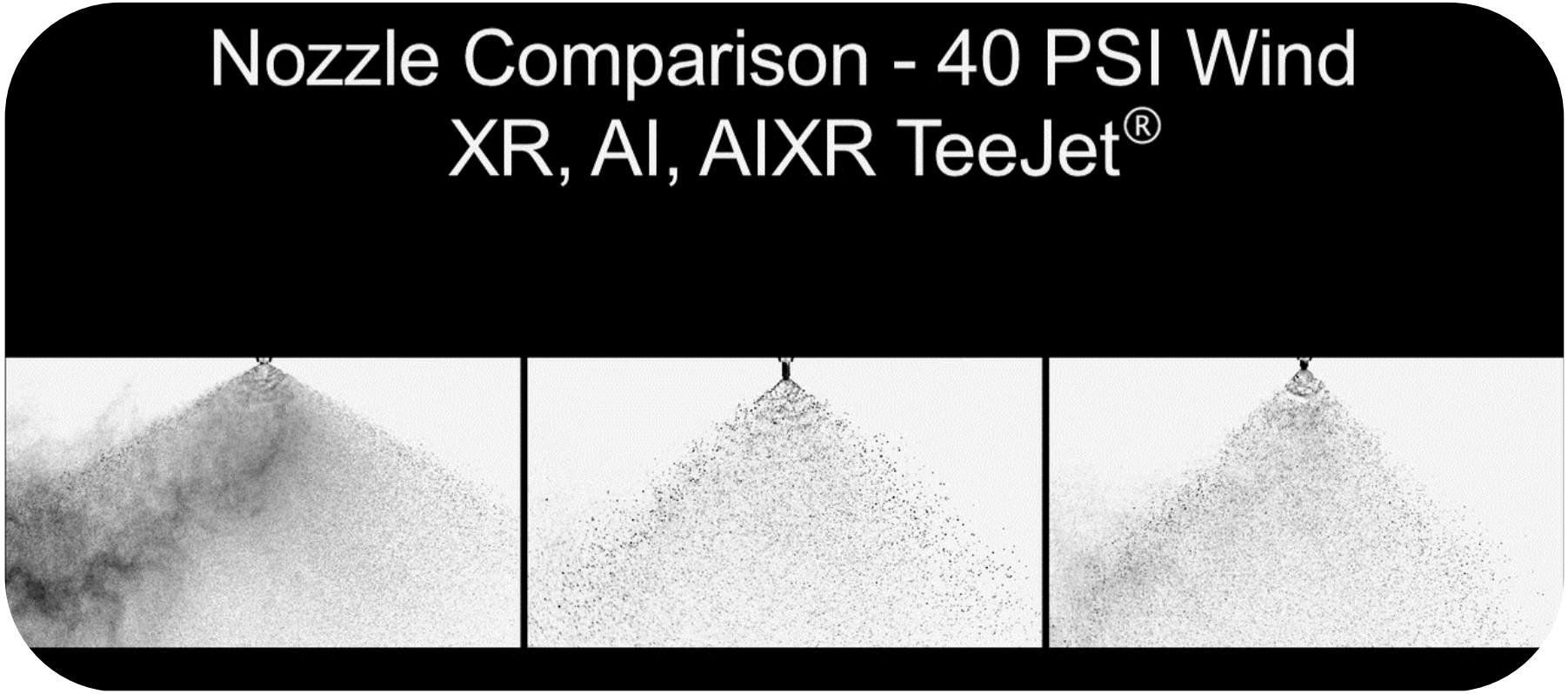
Air Inlets

Mixing Chamber

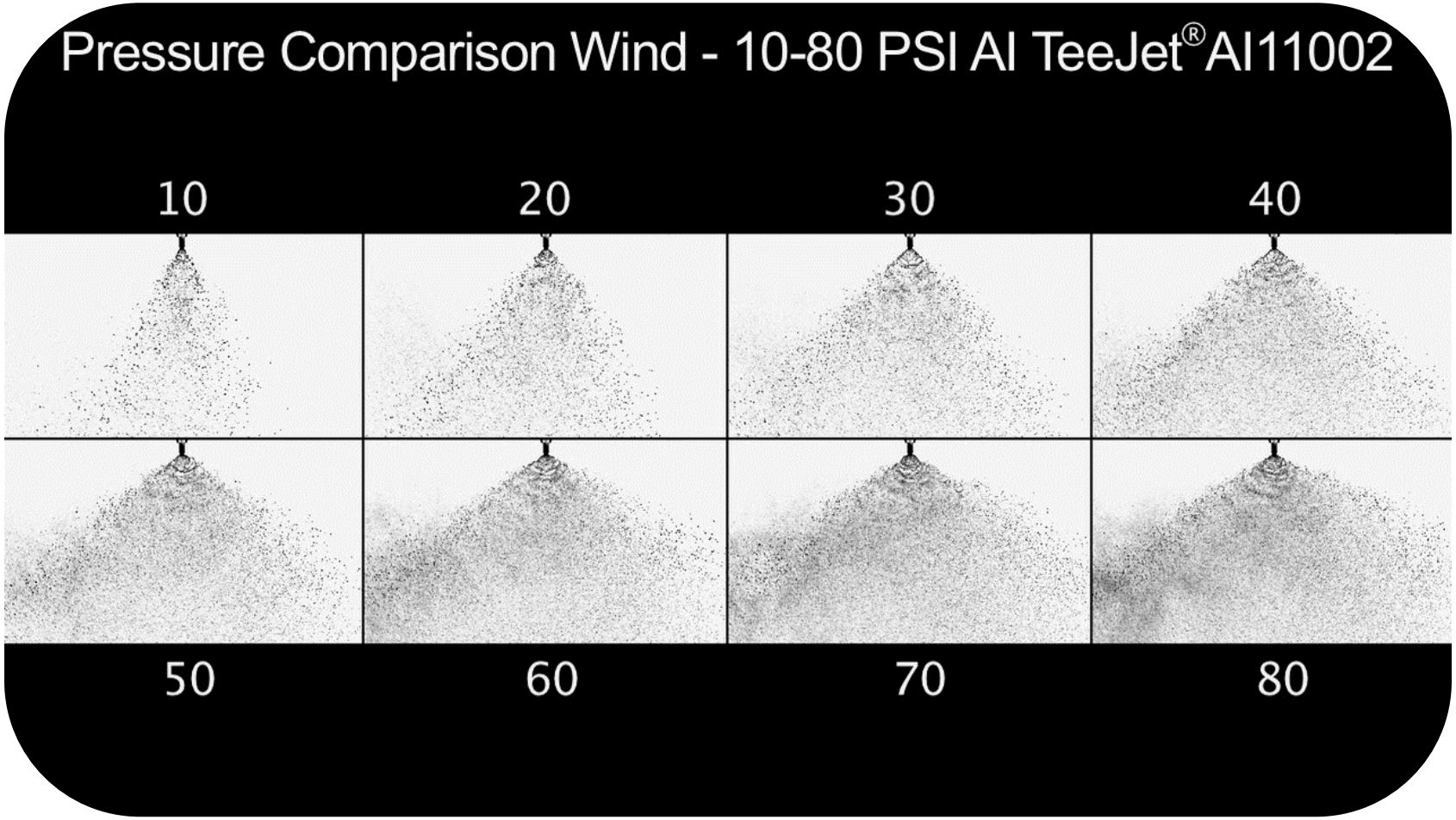
Exit orifice

Exit orifice = 2X Pre-orifice

# Influencing Droplet Size - Nozzles



# Influencing Droplet Size - Pressure




Water

# Turbulation Chamber w/Venturi

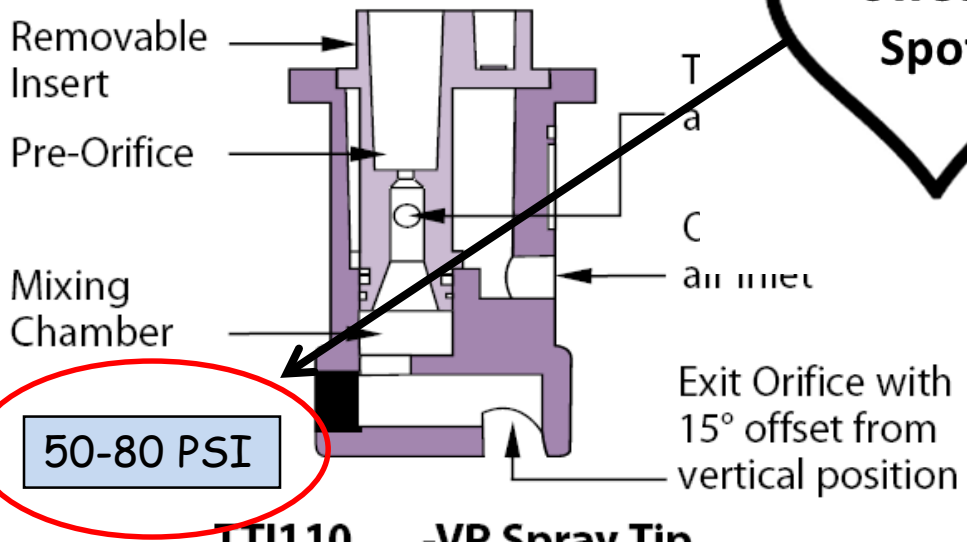
## Air Induction Nozzle for Maximum Drift Control

**Best drift mitigation option!**

**Single Outlet**

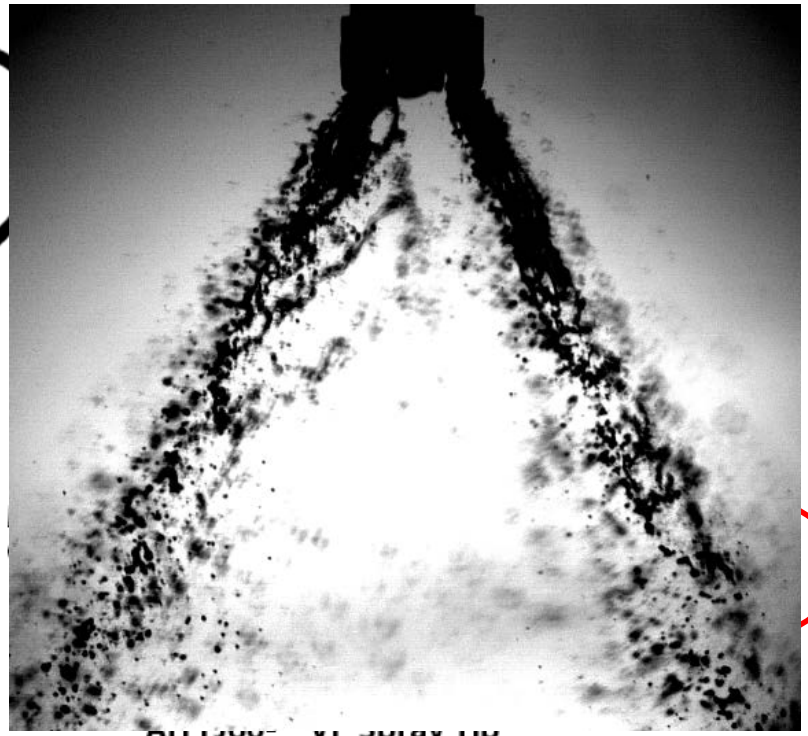
**Double Outlet**

**Turbo Induction - TI**



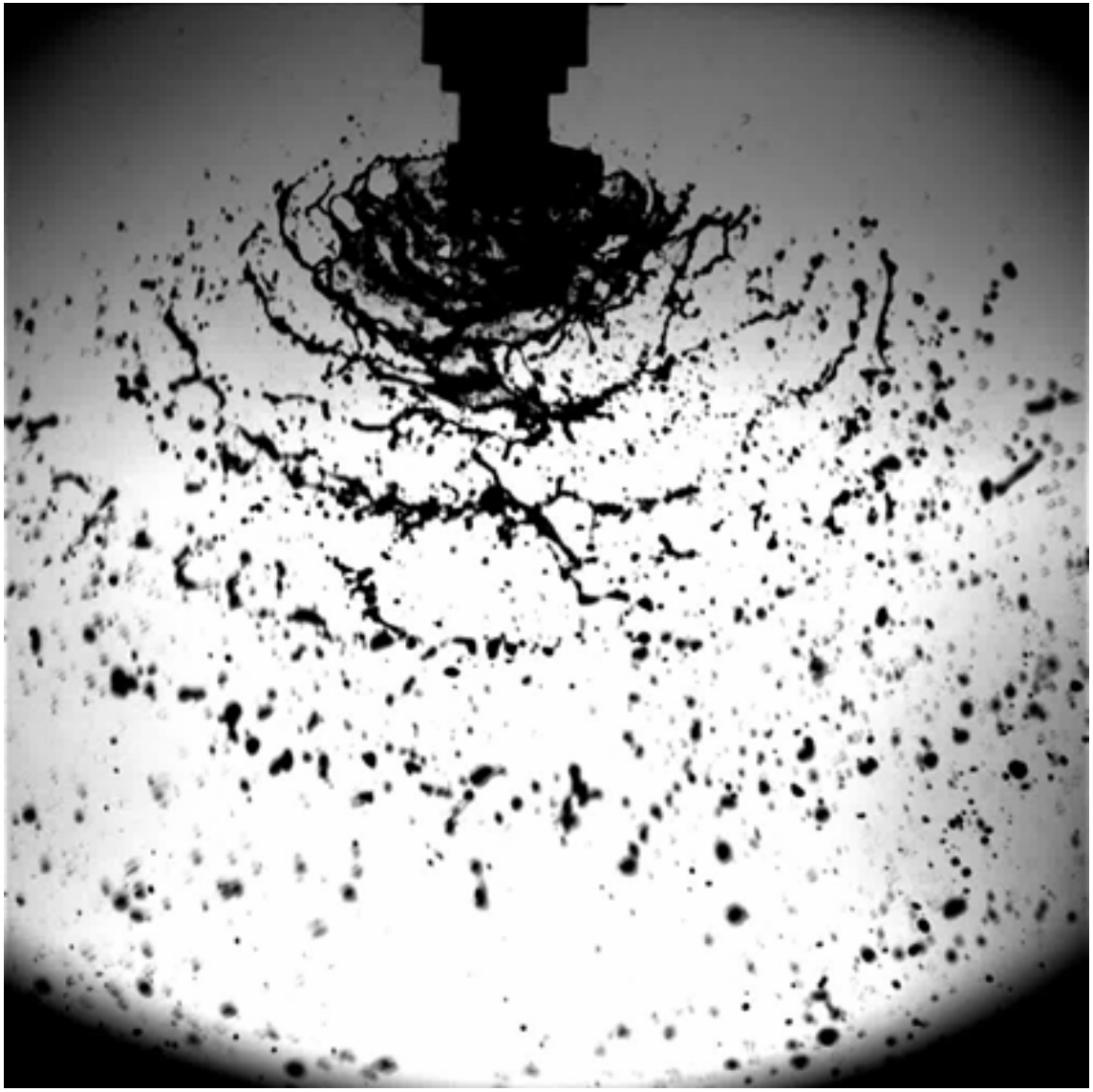

**TTI110___-VP Spray Tip**
(Cross Section View)

**Sweet Spot**



(Cross Section View)

# TTI 11004-60 psi

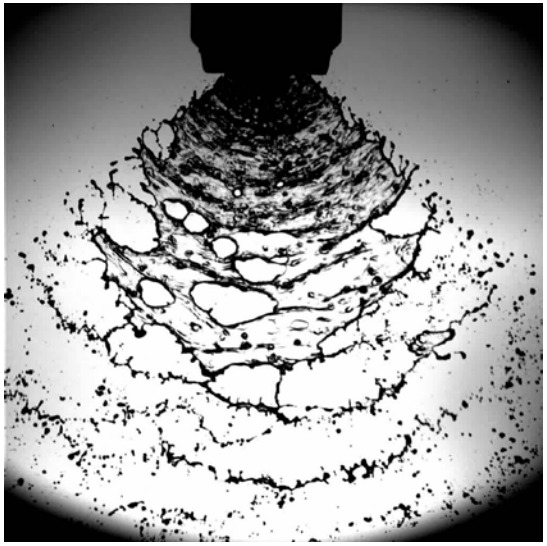


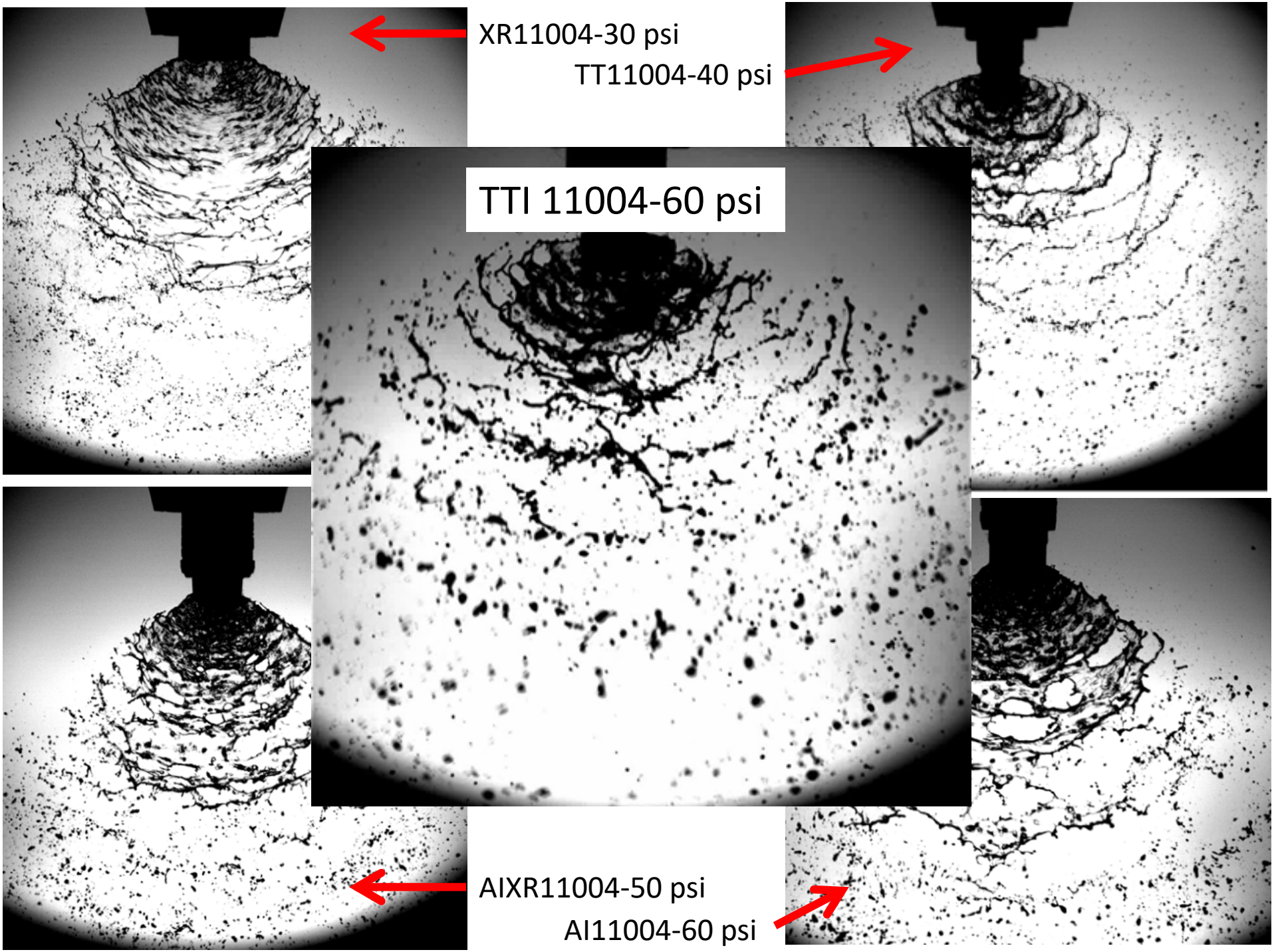
# Nozzle Demonstration


TTI 11004-60 psi

TDXL11004-60 psi


ULD120-04-60 psi




XR11004-30 psi
TT11004-40 psi
TTI 11004-60 psi
AIXR11004-50 psi
AI11004-60 psi

# Nozzles-Recommended Use

## Not Recommended!!


chamber 30-40 PSI


Low Pressure Venturi 40 PSI


High Pressure Venturi 50-80 PSI

Watch closely! May be an option in the future!

Venturi Designed
Twin Sprays

# *Modular Versatility*

| TDXL11003 | TADF03 | TDXL11003-D | TADF03-D |
|---|---|---|---|
| M C VC | M C VC | VC XC UC | VC XC UC |

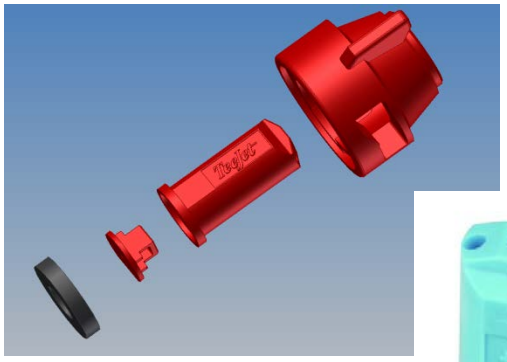
***One TurboDrop® Venturi.***
***Any pattern or spray category you need.***

# Nozzles for fertilizer on wheat:

- Hi-Flow


- StreamJet-7

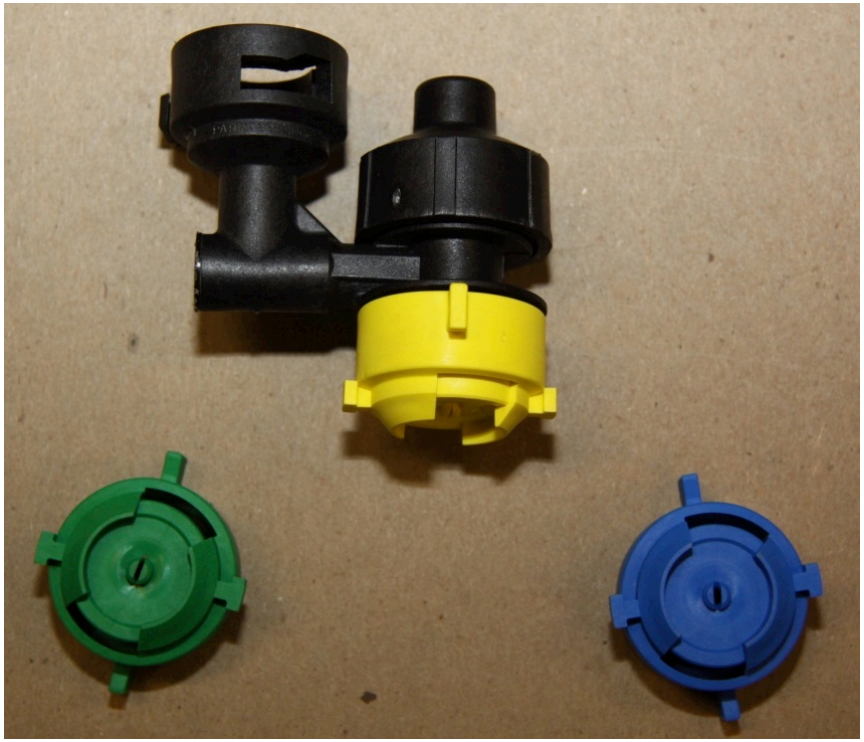
- StreamJet-3



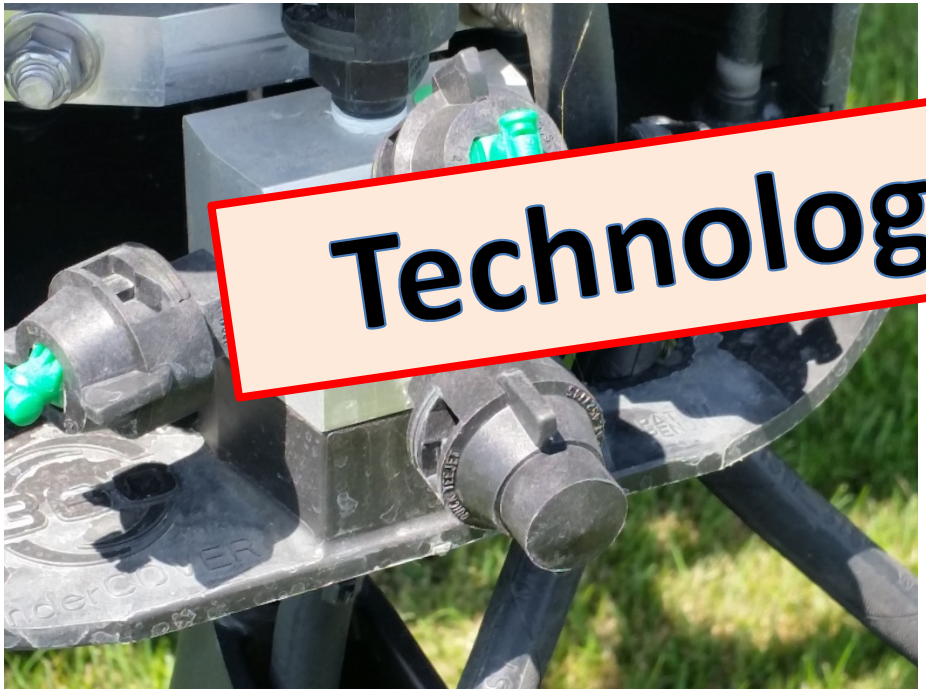
- **CP Triple Stream Tip**

# Variable flow flat fan nozzle

- Flow varied by moving plunger in sleeve
- Plunger position determined by diaphragm and spray pressure – use pressure to adjust GPM
- 0.15 to 0.80 GPM, 110 degree spray angle,
- Available with various droplet size caps,15 - 50 psi



360 YIELD CENTER

# Technology Alert!!!

Undercover

Y-Drops

360 UNDERCOVER®

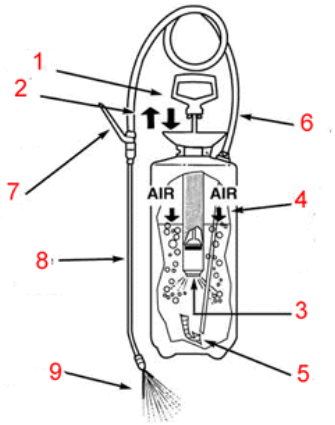
360 Y-DROP®


JOHN DEERE
Input 1
Input 2
Input 3
0.7°
Technology Alert!!!
AutoTrac™ RowSense™

# Backpack Sprayer Drift Mitigation



Spray Management Valves



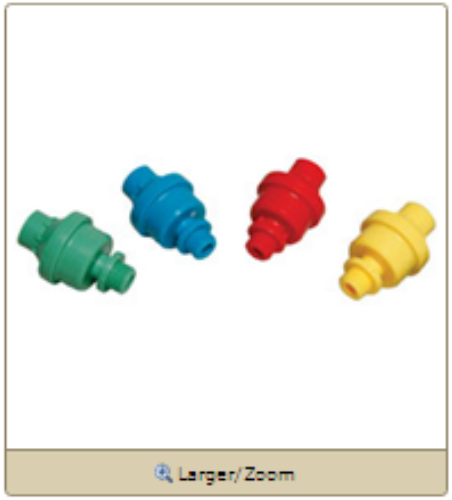



# Spray Management Valve

CF Valve™


*Reduce chemical use by up to 24%... Less sprayer pumping too!*

- Reduces number of times manual sprayer needs to be pumped.
- Regulates pressure for steady, even flow.
- Shuts off spray if pressure falls below set amount.
- Allows for constant, precisely calibrated spray application.
- Reduces drift and spray waste- *environmentally sound.*
- Makes operator training faster and easier.
- Available in 15, 21, 29, and 44 psi (1, 1.5, 2, and 3 BAR)
- Costs less than $10 (Sug. list)




**CFValve -- Constant Flow Valve**

Item No: 163124

Price: $18.95

Pressure -Select- Qty 1

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- Consistent flow rate with ±1.5% accuracy

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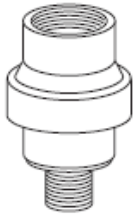
**Phone 1-800-745-2392 to learn more about our CF Valves.**

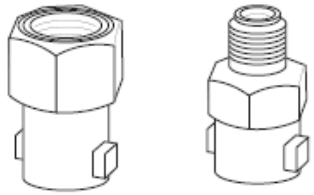


# Converting to a flat-fan and/or drift reducing nozzle

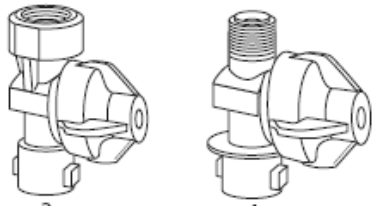
addition of a spray management valve (SMV) to a compression or backpack sprayer will help maintain a constant pressure while spraying. Thus, spray rates and patterns will be more consistent, drift potential is reduced, calibration is easier, and the valve will provide an instant on and off with no dripping. Spray management valves are available in four preset pressure ranges: 14.5, 21.0, 29.0, and 43.5 pounds per square inch (psi). Find information about purchasing a spray management valve at *www.hdhudson.com/green-garde.html*. The cost is minimal.



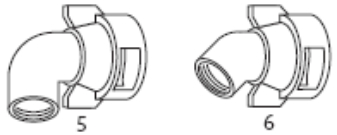
**Spray management valve (SMV)**



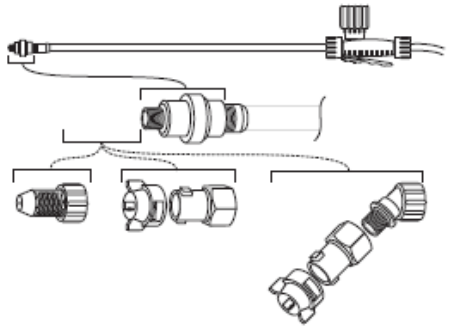
**Female (1) and male (2) adapters without diaphragm**



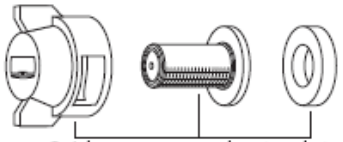
**Female (3) and male (4) adapters with diaphragm**



**90-degree (5) and 45-degree (6) elbow adapters**



**Hand sprayer with pressure gauge, pressure valve, and nozzle options**




**Quick cap, screen, and seat gasket set (7)**

**Converting common hand sprayer adjustable nozzle systems to flat-spray nozzle types**

For certain applications, it may be advantageous

# Hand Sprayer Calibration Steps Worksheet

*Robert E. Wolf, Extension Specialist, Biological and Agricultural Engineering, Kansas State University*

Application Technology Series

The key to handgun calibration is knowing the volume you are spraying over a given time period. If you know the area you cover at a set pace, you can calibrate your handgun applications.

Here is a simple formula:

1 acre = 43,560 square feet

1 gallon = 128 ounces

1/128 acre ≈ 340 square feet

18.5 feet by 18.5 feet = 1/128 acre

1. Mark off an area 18.5 feet by 18.5 feet; flag the corners.
2. With a stopwatch, time how long it takes you to spray the area, using a proper technique to achieve uniform coverage, at your normal walking pace. This can be done with a handgun on an ATV, a backpack sprayer, or a pump-up sprayer.
3. Now, spray into a bucket or measuring cup (item 8, page 2) at the same pressure for the same time you recorded in step 2 and record that volume in ounces.
4. The rate per acre is 1 gallon for each captured ounce.

**Example:** It takes 20 seconds to make three passes that cover the marked area. Spray into a bucket for 20 seconds with the sprayer and then pour the fluid into a measuring cup marked in ounces. In this example, there are 31 ounces of water. The 31 ounces covers approximately 340 square feet. Multiplying 340 times 128 equals 43,520 square feet (about 1 acre). Then, 31 ounces times 128 equals 3,968 ounces. Dividing 3,968 by 128 ounces equals 31 gallons per acre.

**Table 1.** Sample spot application rates

| Sprayer size | 1 gallon | 3 gallons | 5 gallons | 10 gallons | 14 gallons | 25 gallons | 100 gallons |
|---|---|---|---|---|---|---|---|
| 2% solution | 16 teaspoons | 8 fluid ounces | 12.8 fluid ounces | 25.6 fluid ounces | 36 fluid ounces | 4 pints | 8 quarts |

For individual plant treatments on brush, the common terminology used is "spray to wet," but on some labels "spray to run-off" is referenced. **These are not the same.** Spray to wet means to just get coverage on all the foliage. Continuing to spray will achieve spray to run-off, or dripping from the leaves.

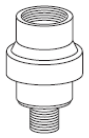
For spot applications of brush products, a general rule is to apply 75 to 100 gallons per acre on a foliar spray. The same timed procedure described above can be used to calibrate the sprayer.

A good method for determining the exact spray technique and nozzle height for the most uniform coverage is to spray on a warm, dry surface, such as a road or parking lot, and observe the drying rate. A uniform drying rate indicates uniform coverage, whereas streaking indicates uneven coverage. Adjust the nozzle height or application technique to eliminate excess streaking.

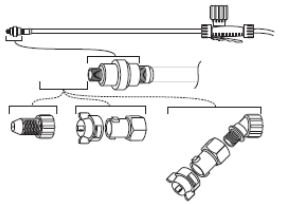
Many labels will have spot application rates and recommendations for noncrop uses. In some cases, crop chemicals have small area rates listed. In other cases, you have to do the math to figure your correct mixtures. See Table 1 for some examples.

### Using spray management valves to maintain a uniform pressure and constant flow rate

Calibration and precise application with handheld spray equipment is difficult to achieve because pressures vary during application and from operator to operator. High pressures will relate to higher flows with more driftable droplets. Lower pressures will result in lower flows and larger drift-resistant droplets that may not achieve the desired coverage. A pressure gauge on the spray wand is the best option for monitoring the output pressure. Also, the addition of a spray management valve (SMV) to a compression or backpack sprayer will help maintain a constant pressure while spraying. Thus, spray rates and patterns will be more consistent, drift potential is reduced, calibration is easier, and the valve will provide an instant on and off with no dripping. Spray management valves are available in four preset pressure ranges: 14.5, 21.0, 29.0, and 43.5 pounds per square inch (psi). Find information about purchasing a spray management valve at *www.bdhudson.com/green-garde.html*. The cost is minimal.



Spray management valve (SMV)

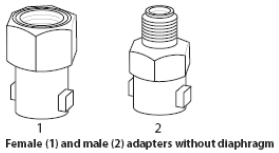


Hand sprayer with pressure gauge, pressure valve, and nozzle options

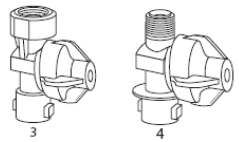
### Converting common hand sprayer adjustable nozzle systems to flat-spray nozzle types

For certain applications, it may be advantageous to adapt a common hand sprayer wand with an adjustable nozzle (straight stream to broadcast) so it can be equipped with a nozzle type that can provide more uniform coverage with less drift potential. By changing the system to a flat-spray nozzle type, a more uniform pattern can be achieved. It also is possible to use nozzle designs that can reduce drift and provide more efficient applications by reducing off-target movement of the spray.

Converting a handheld spray wand to use flat-spray and drift-reducing nozzle types is a simple process. First, remove the adjustable nozzle. If you are using an SMV, add an adapter designed for connecting quick-attach nozzle (item 7) types (items 1 or 2), or use item 3 or 4 if no SMV is in use.

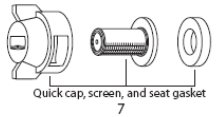



Female (1) and male (2) adapters without diaphragm

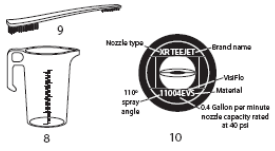



Female (3) and male (4) adapters with diaphragm


90-degree (5) and 45-degree (6) elbow adapters



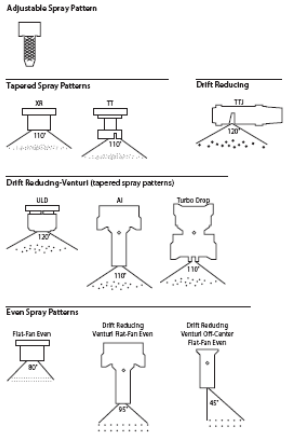

Quick cap, screen, and seat gasket set (7)




Calibration cup (8) and nozzle cleaning brush (9); Flat-fan nozzle nomenclature (10)



The following nozzle types are commonly used for boom sprayer applications. The patterns are tapered, so they will not suffice as a single uniform pass. However, with proper overlap (about 30 percent on each edge) the patterns are very uniform.




Adapters and quick attach nozzles shown are available from spray equipment supply outlets. Refer to websites listed in Table 2.

### Nozzle types with more uniform patterns and drift reduction potential

Items 3 and 4 are equipped with diaphragm check valves that prevent dripping when the hand wand is shut off. They do not manage the spray pressure like the SMV. A 90- or 45-degree elbow may be useful for positioning the nozzle (item 5 or 6). See hand wand adapter options pictured earlier.

Some nozzle styles are available with even spray patterns (designated with the letter "E" in the number scheme — see item 10) and could be used in single-pass operations. Brass nozzles are not recommended. Nozzles constructed of plastic or stainless materials provide uniform flows and patterns for a longer period of use. Refer to K-State Research and Extension publication MF2541, *Nozzle Types for Boom Sprayer Applications of Crop Protection Products*, for a more detailed discussion of nozzle types.

Some basic nozzle designs recommended for use on handheld or backpack spray systems are the extended range flat-fan (XR, TR), turbo flat-fan (TT), drift reduction flat-fan (examples are ULD, AIC, and Turbo Drop), and turfjet (TTJ). Though the extended range and turbo flat-fan designs provide for a more uniform spray, they also could be more drift prone. Thus, adding the drift-reducing nozzle designs with larger droplets could be beneficial when drift is a concern. Most of these are available only in tapered edge patterns; however, some come as even spray, and a few come as off-center flat-spray patterns. Off-center flat-fan nozzles are typically available as even spray patterns. Off-center designs are best suited for spraying along fences, curbs, and guardrails.

Proper nozzle maintenance includes proper cleaning of the orifice. Use a soft-bristled brush for this purpose (item 9).

### Additional information

Additional equations and illustrations on page 4 will help you determine ground speed and the square footage of areas of different shapes.

**Table 2.** Selected nozzle manufacturer websites.

| | |
|---|---|
| Spraying Systems - TeeJet | *http://www.teejet.com/* |
| GreenleafTechnologies | *http://www.turbodrop.com/* |
| Hypro Pumps | *http://www.hypropumps.com/* |
| Wilger | *http://www.wilger.net/* |
| Hardi – North America | *http://www.hardi-us.com/* |
| Lechler | *http://www.lechlerusa.com/* |
| CP Products | *http://www.cpproductsinc.com/* |
| ABJ Agri Products | *http://www.abjagri.com/* |



# Fact Sheet: MF2915

http://www.bae.ksu.edu/faculty/wolf/PDF/MF2915-Hand%20Sprayer.pdf

# Boomless Nozzles

# Off-Center Venturi Flat-fan



SPRAY RIDER

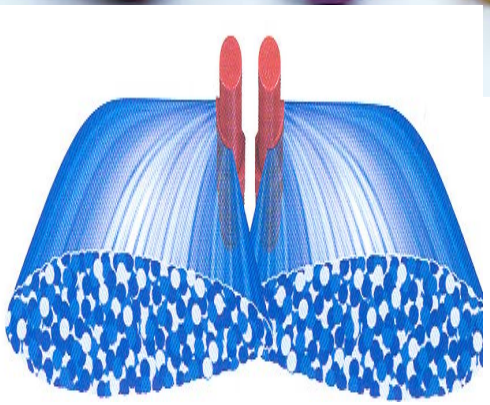

SPRAYERS


Ford
4x4
MEYER

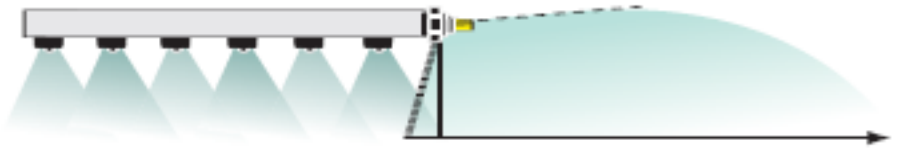
# Boom Buster


# XP BoomJet

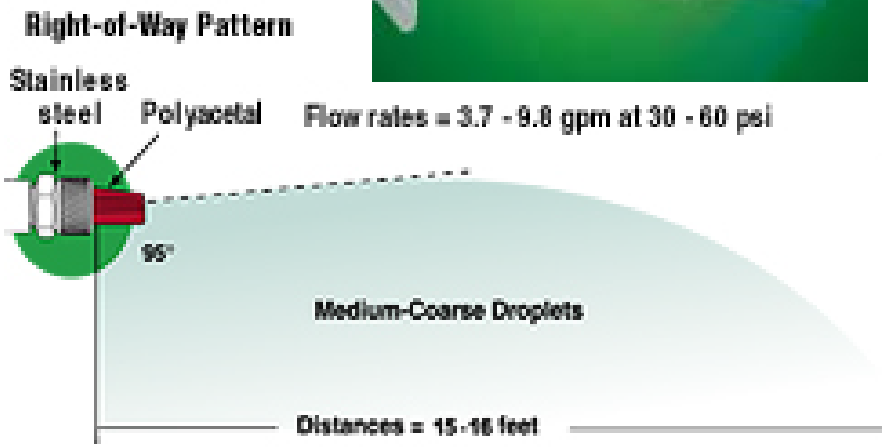




# Boom Extender:



Boom X Tender® Spraying
(last tip on the boom)



Fact Sheet: EP156ATV

# An Evaluation of ATV-Mounted Boomless Spray Nozzles for Weed Control

K-STATE Kansas State University

Application Technology Series

**Robert Wolf,** *Associate Professor and Extension Specialist, Bio and Ag Engineering*

**Dallas Peterson,** *Extension Weed Management Specialist*

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**Jeffery Davidson,** *Extension Ag & Natural Resources Agent, Eureka*

**Gary Kilgore,** *Extension Crops and Soils Specialist, Chanute*



In recent years, all-terrain vehicles (ATVs) equipped with small-capacity spray tanks and boomless nozzle systems have become popular for controlling and eliminating [illegible] and are thought to have potential to spray 25-30 foot swaths using a centrally located single or dual nozzle arrangement.

Several nozzle designs have recently been introduced for ATV-mounted application systems. Use of these nozzles, however, is occurring without a clear understanding of correct operating procedures. These nozzles may not be effective for weed control. The large spray droplets created by these nozzle types often do not provide full weed coverage over the entire spray width.

## Considerations for Using Boomless Nozzles

7. A different pump may be desirable [illegible] properly atomize the spray droplets.

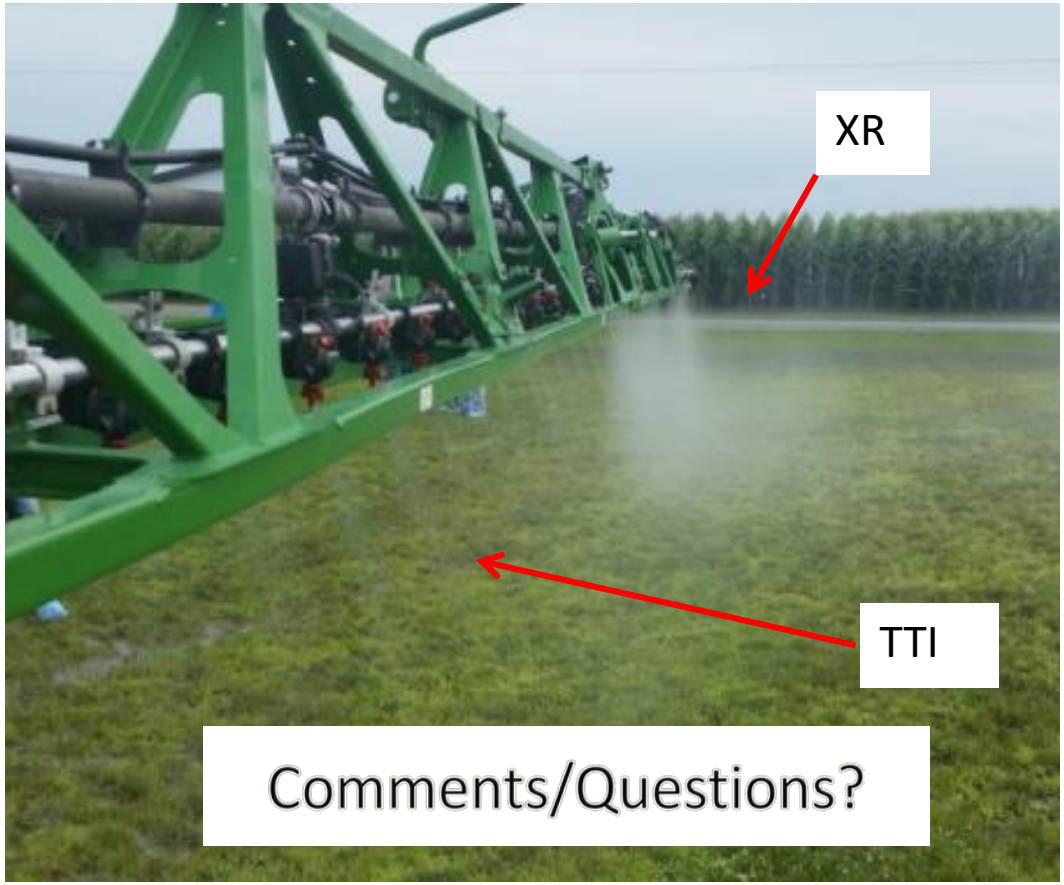
## Field Trials

Field trials were conducted to evaluate the effectiveness of spray nozzles on ATVs.

Trials evaluated pattern quality, swath width, droplet range, and coverage effectiveness using four different nozzle types

**Figure 1.** Boombuster (left), XP BoomJet (upper right), and XT Boom

# Thank You

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