Technology For the Application of Crop Protection Materials?

Robert E. Wolf

Extension Specialist Application Technology

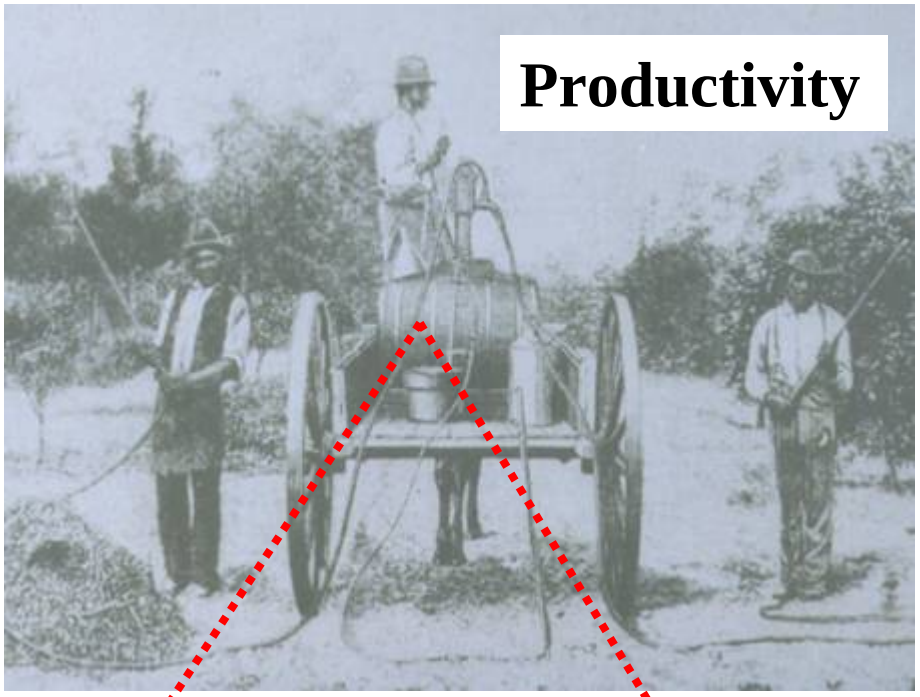
Biological and Agricultural Engineering

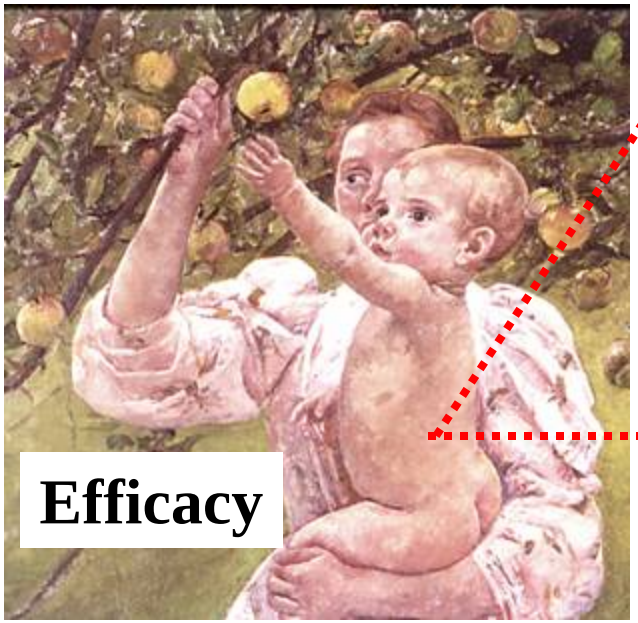
Changes in the Application Industry!

Product Related!!!

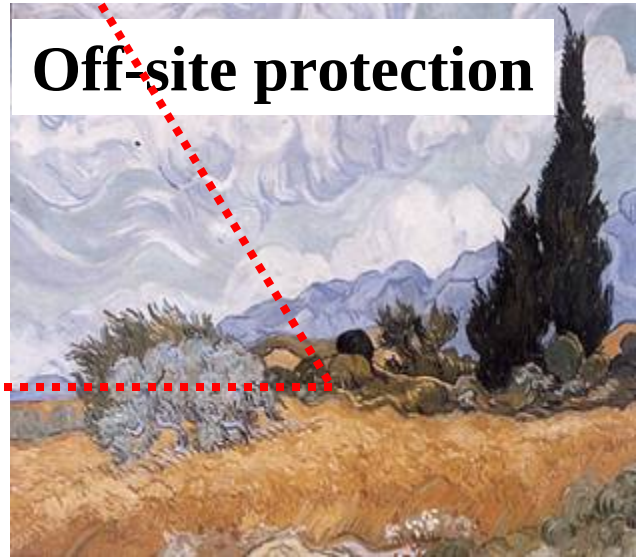
- ✓ Historically inefficient process
- ✓ Increased cost of pesticides
- ✓ Product rates are changing (< an ounce/acre)
- ✓ More pest specific products
- ✓ Biotechnology and GMO's (Roundup Ready, Bt's)
- ✓ More sophisticated equipment (electronics) $$$
- ✓ Farmers doing there own spraying????
- ✓ Variable rates
- ✓ Site-specific
- ✓ Focus on Drift
- ✓ Canopy Penetration

The application triangle



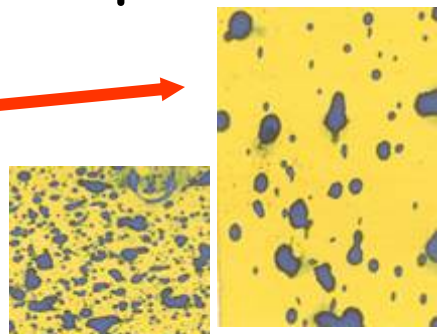


balance



Coverage/deposition into Canopy!

- ✓ Need knowledge of the product being used.
  - Systemic
  - Contact
- ✓ What is the target?
  - Soil
  - Grass
  - Broadleaf (smooth, hairy, waxy)
  - Leaf orientation – time of day
  - Penetration into canopy



Technology for the Spray Industry

Air-Assist Sprayers:

Where a curtain of high speed air is used to assist with particle movement after leaving the nozzle.

Air Assist Spraying:

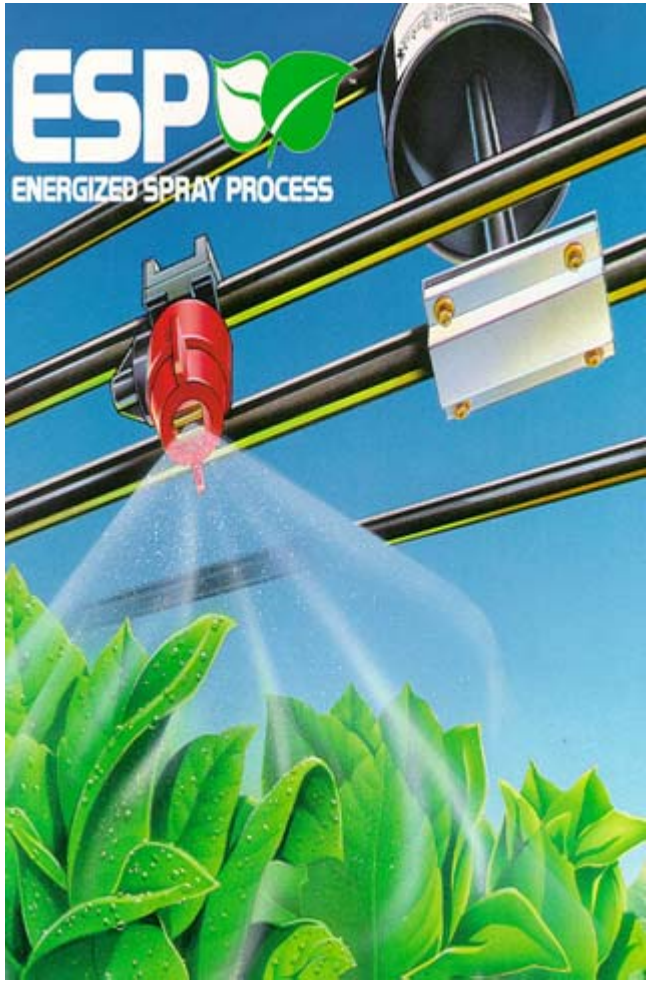
Process using pneumatic energy to aid in the
atomization,
transportation,
penetration,
deposition
of spray products. Air stream becomes the carrier. Potential for reduced rates of carrier and active ingredients.

Adjustment of the air assistance:

Adjust to:

- ✓ wind speed
- ✓ nozzle size
- ✓ plant density
- ✓ crop height
- ✓ target location

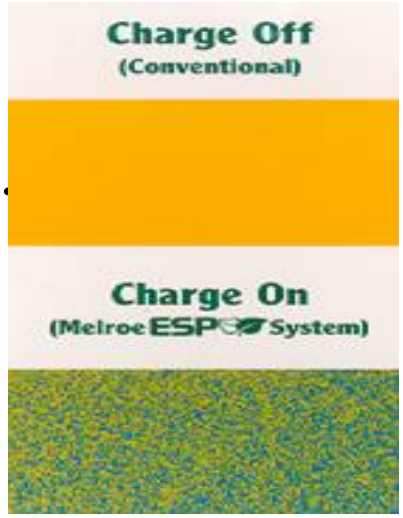
Electrostatic Spraying

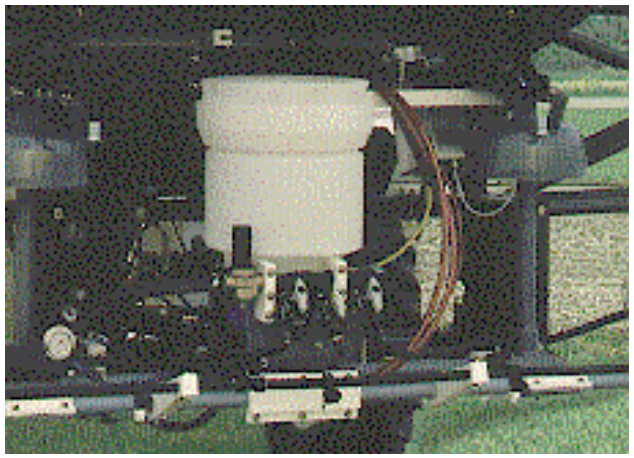


Spray Coupe with ESP

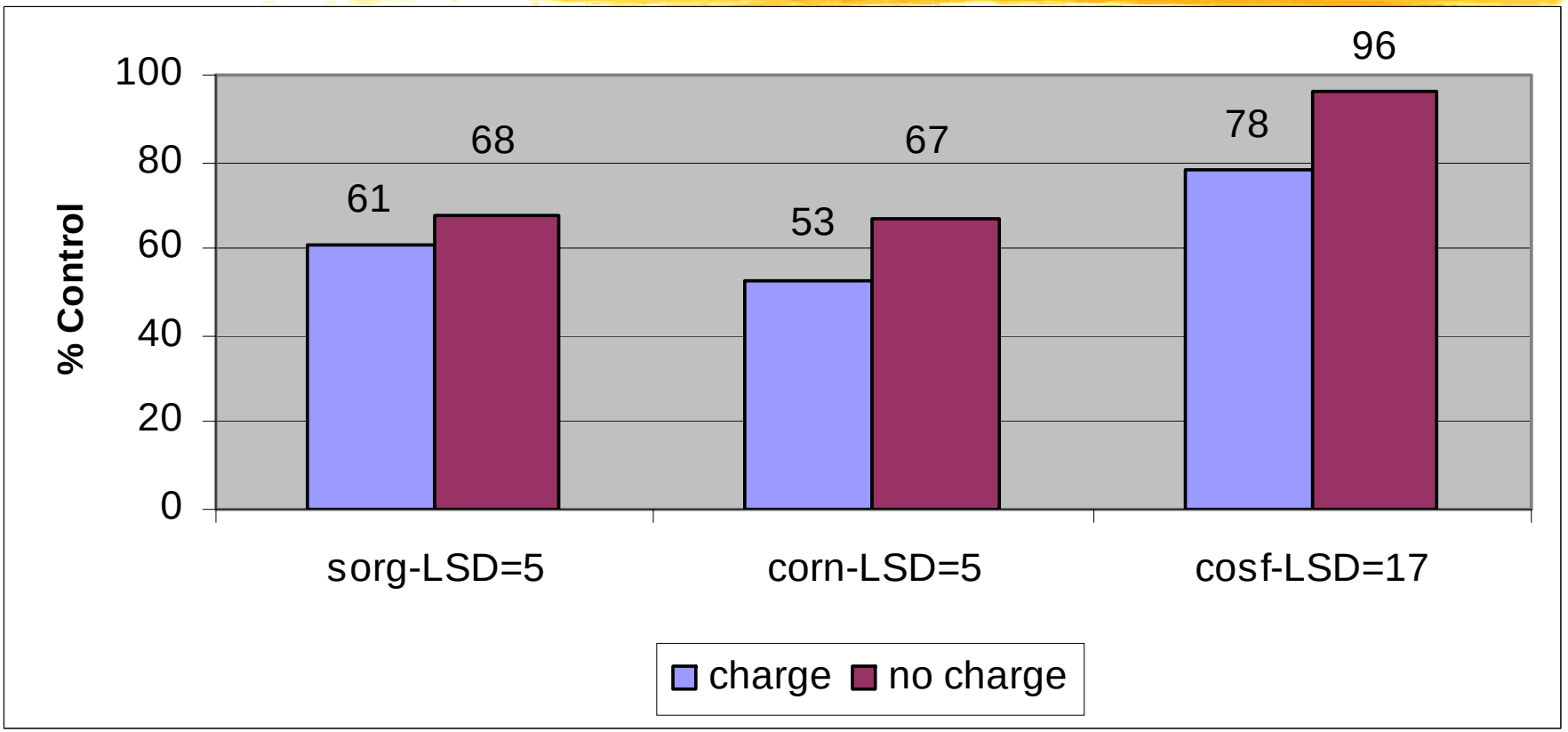
The Process:

- ✓ High intensity electrostatic field.
- ✓ Accelerated droplet speed toward the plants.
- ✓ Increased topside and underside leaf coverage.
- ✓ More efficient use of chemicals.

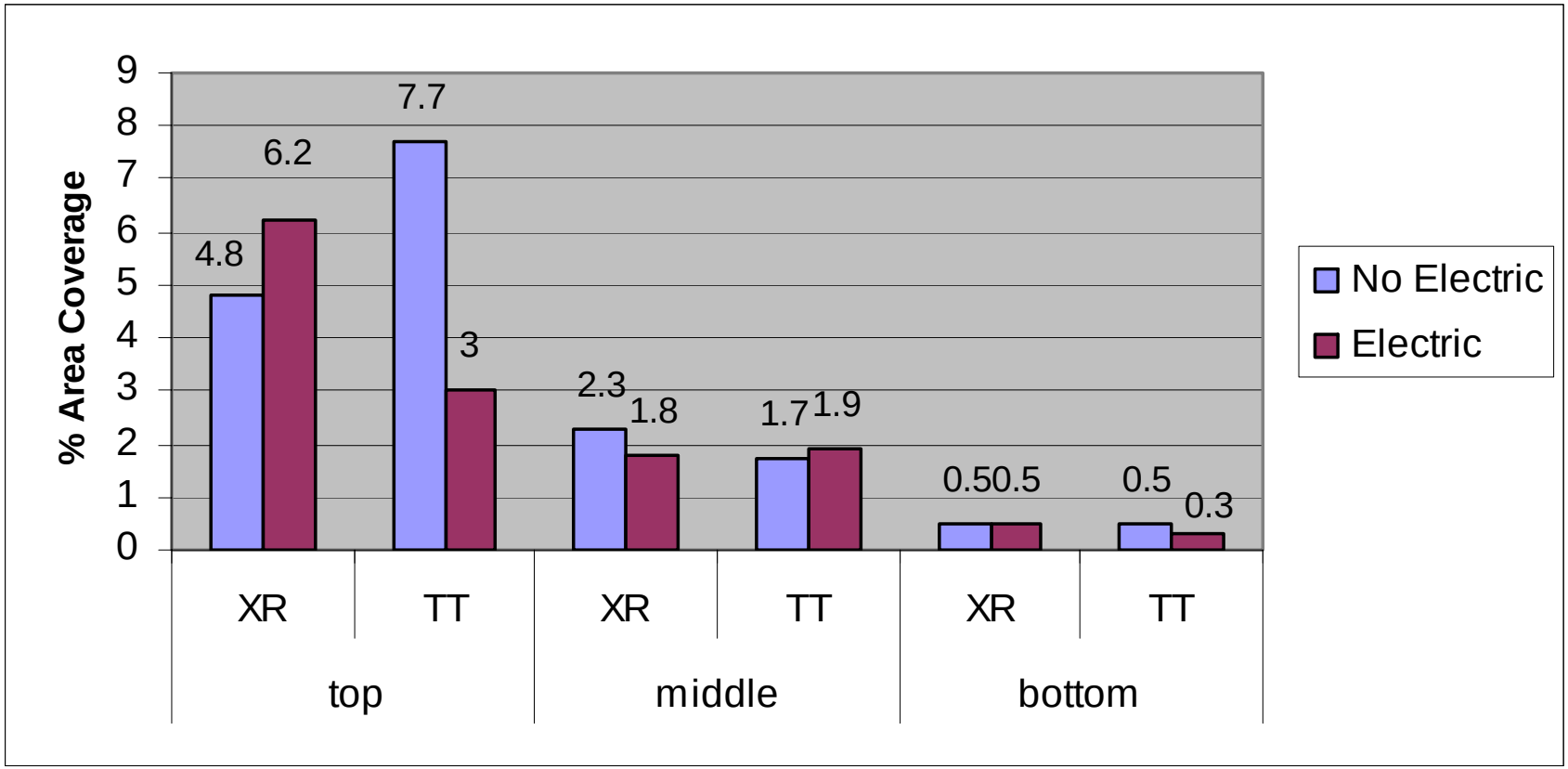




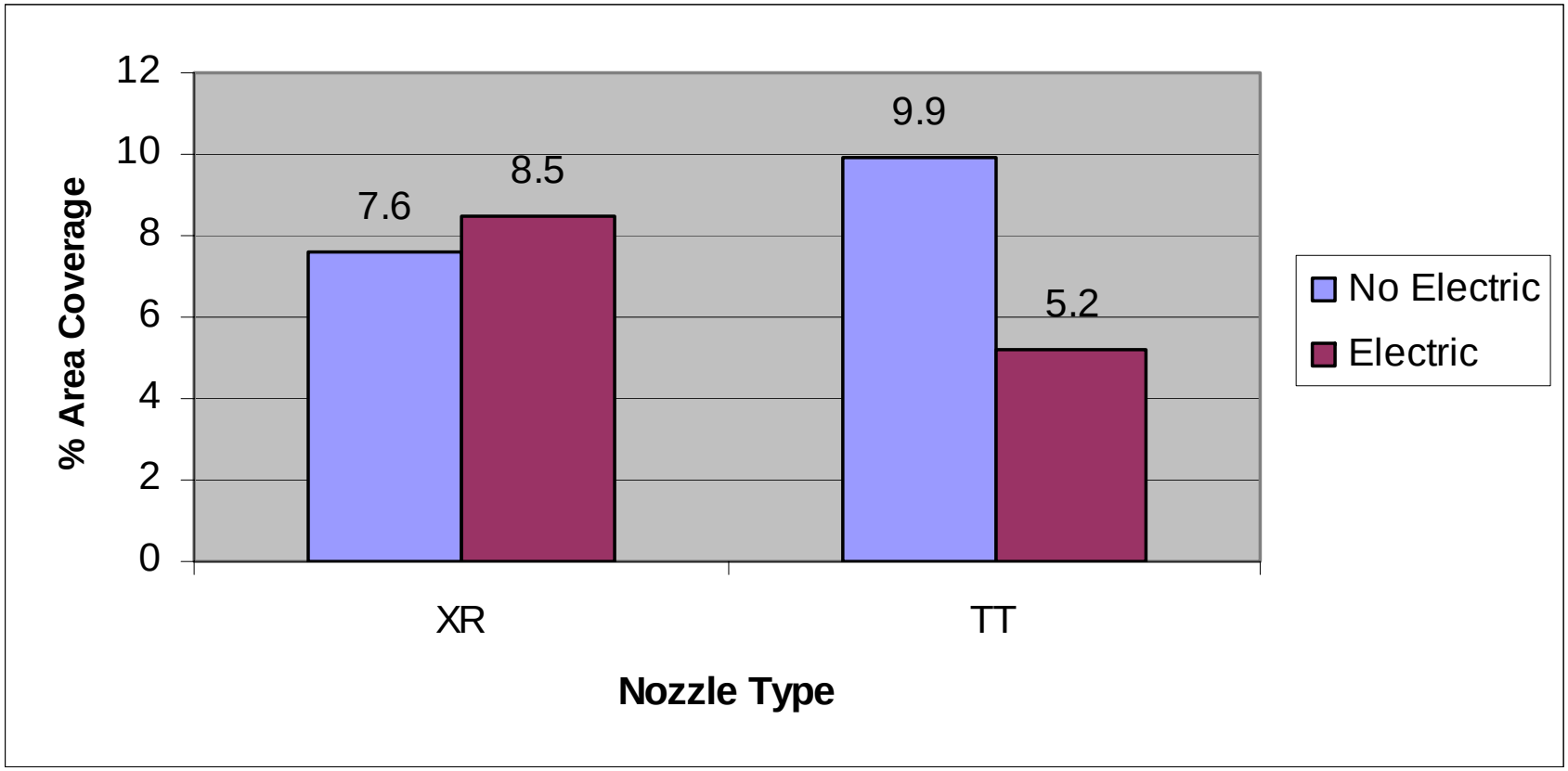
Control: Charge by No Charge



Coverage: Charge by Nozzle Type



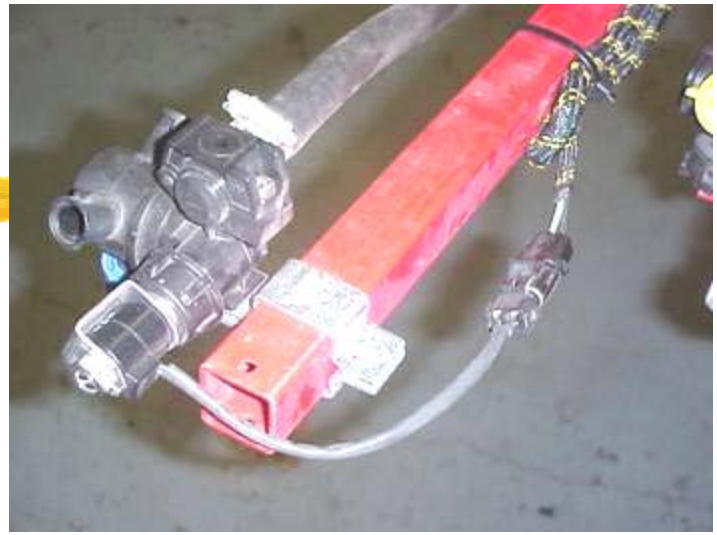
Coverage: Charge by Nozzle Type



Pulse Width Modulation - PWM

Pulsed Emissions from Nozzles

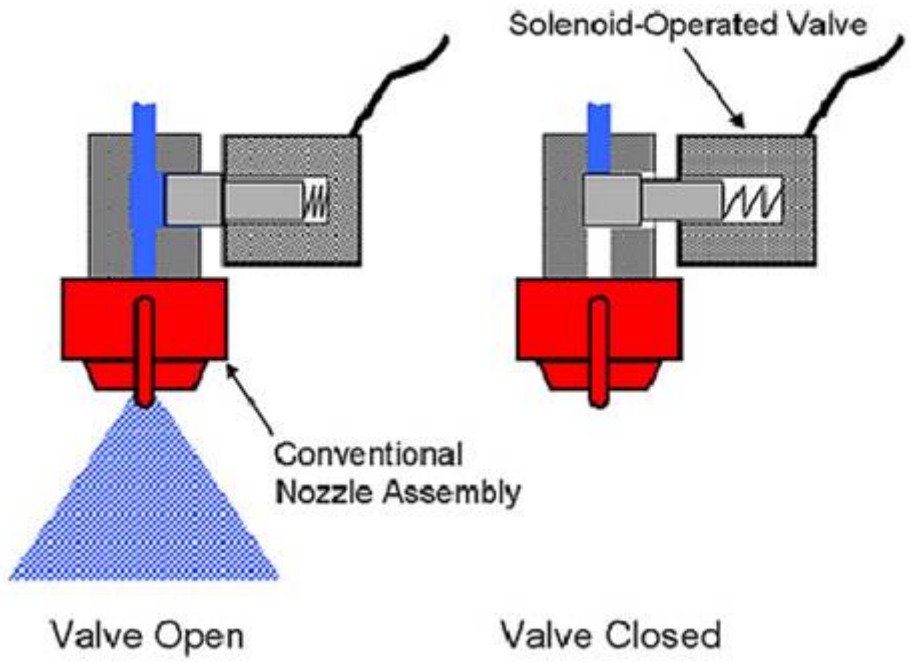
Synchro Nozzles:



- ✓ Blended Pulse Technology
- ✓ Independent Flow Control (1-8X)
- ✓ Independent Drop Size Control
- ✓ Separate boom section controls
- ✓ GPS - program management control

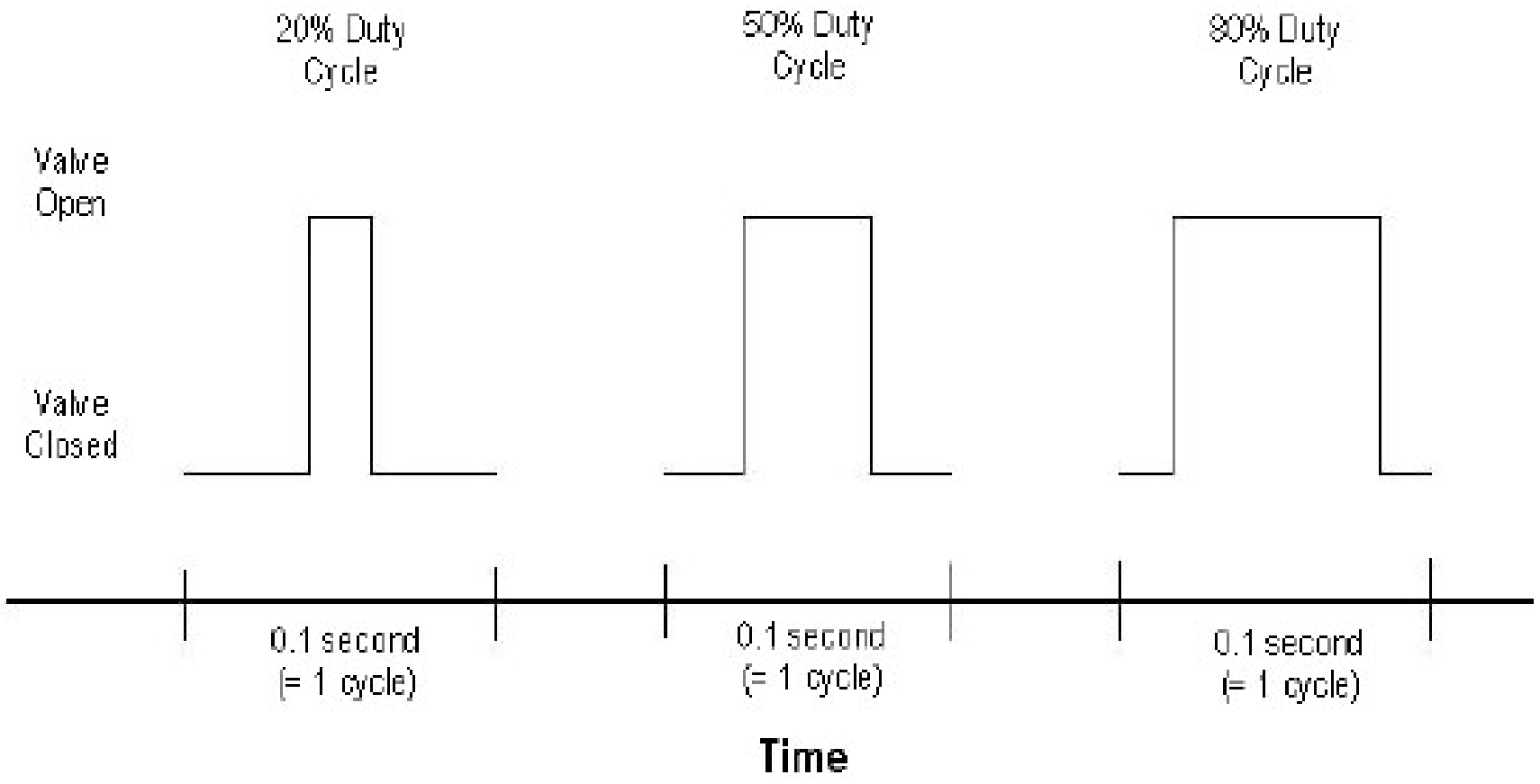
How it Works:

- ✓ Uses high speed solenoid valves to regulate flow
- ✓ Varies application rate with duty cycle: independently of pressure



What is Pulse Width?

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



Electronics/Rate Controllers

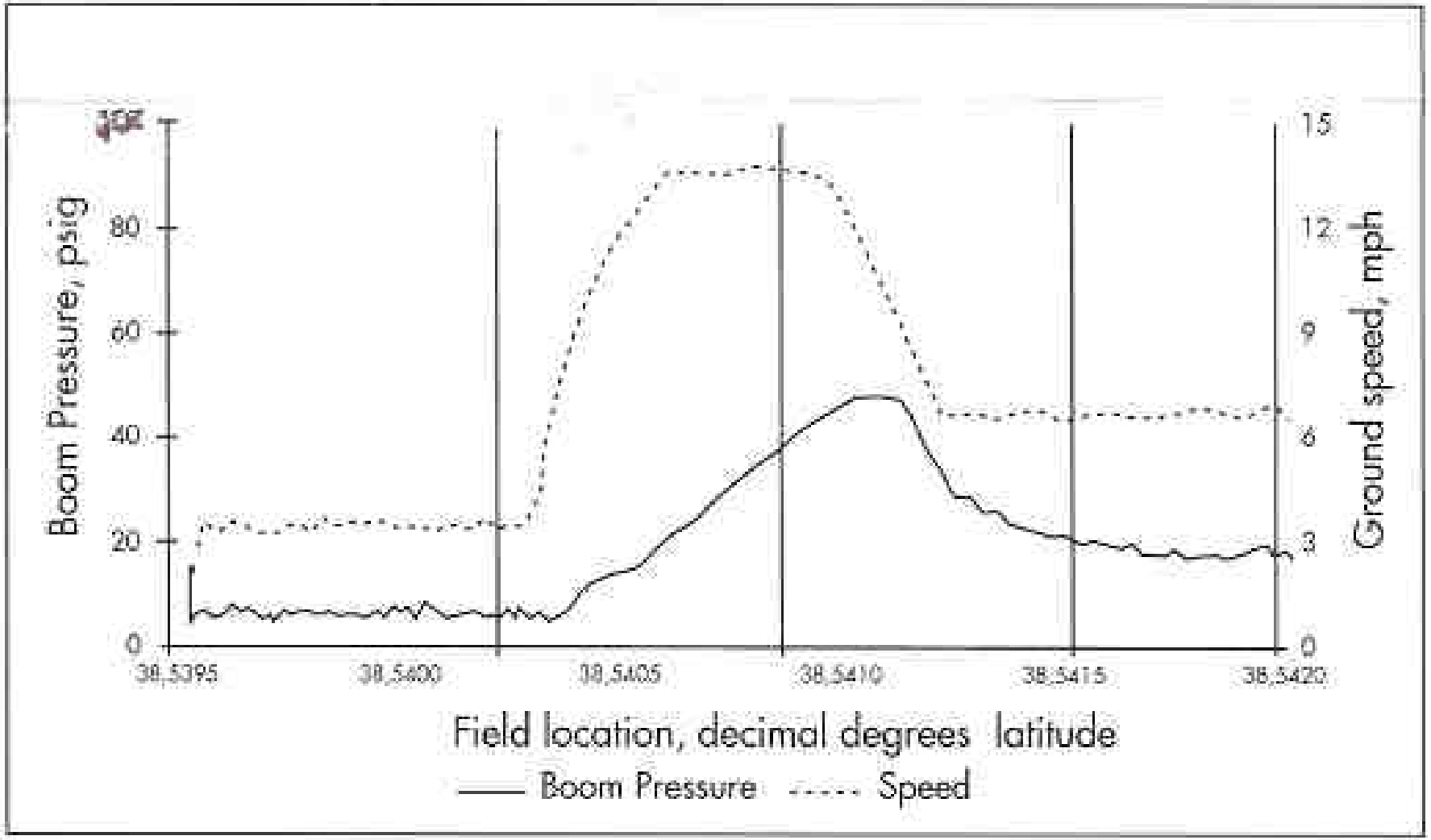
- ✓How does your system work when speed changes?
- ✓Is it pressure based?
- ✓What is the effect of going slower?
- ✓What is the effect of going faster?

Electronic Control Systems:

Rate Controller systems include:

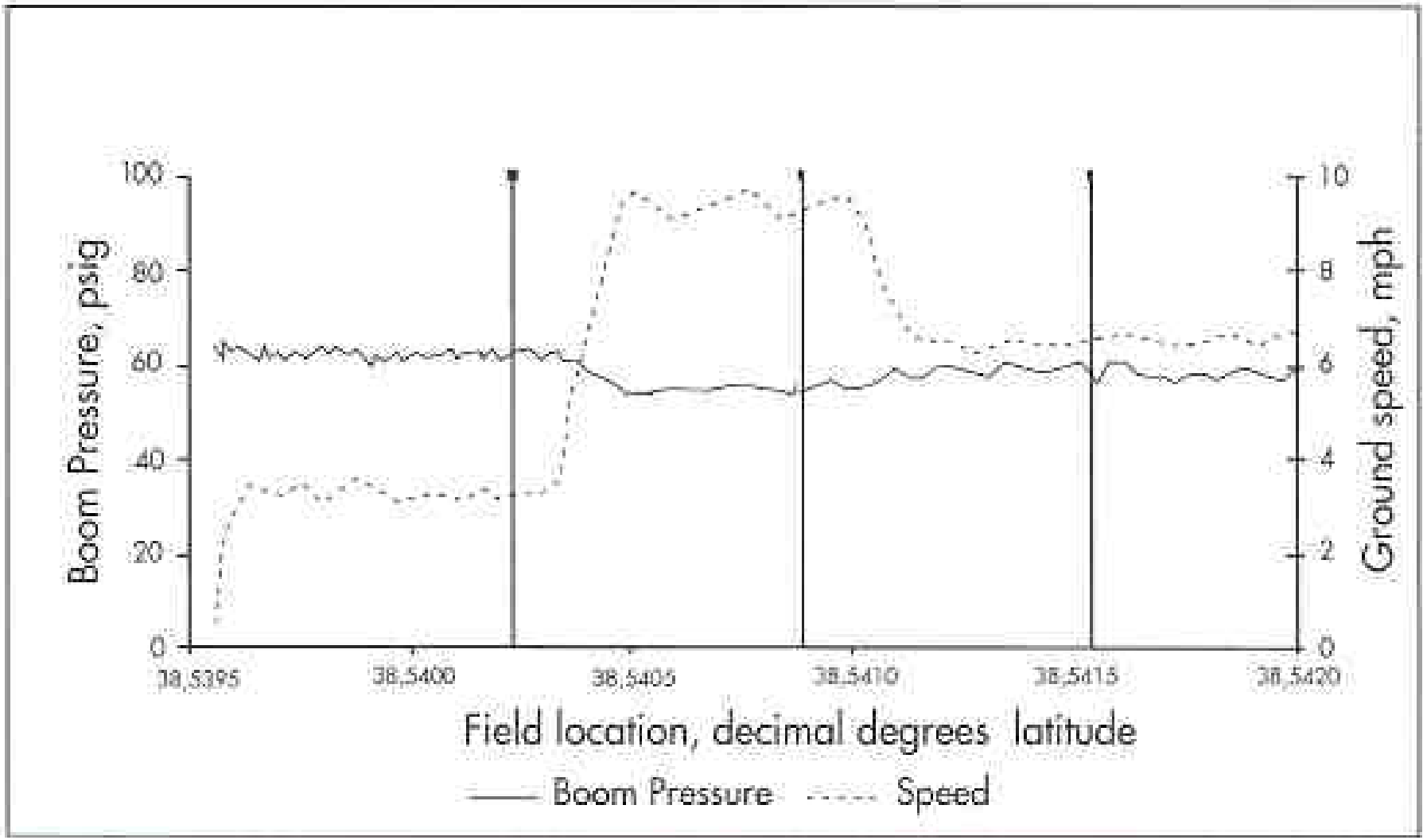
- ✓Speed sensor
- ✓Servo-valve/flow meter
- ✓Calculation
- ✓Adjustment on-the-go

Figure 1.
Conventional Application: Pressure varies with changing speeds



Courtesy of Ken Giles, U of California Davis

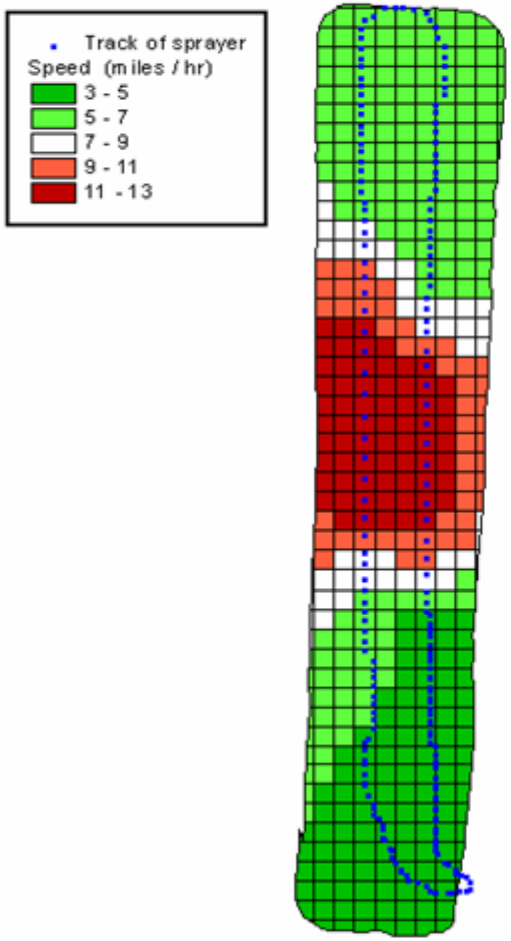
Figure 2.
AIM Command Application: Pressure stable as speed varies



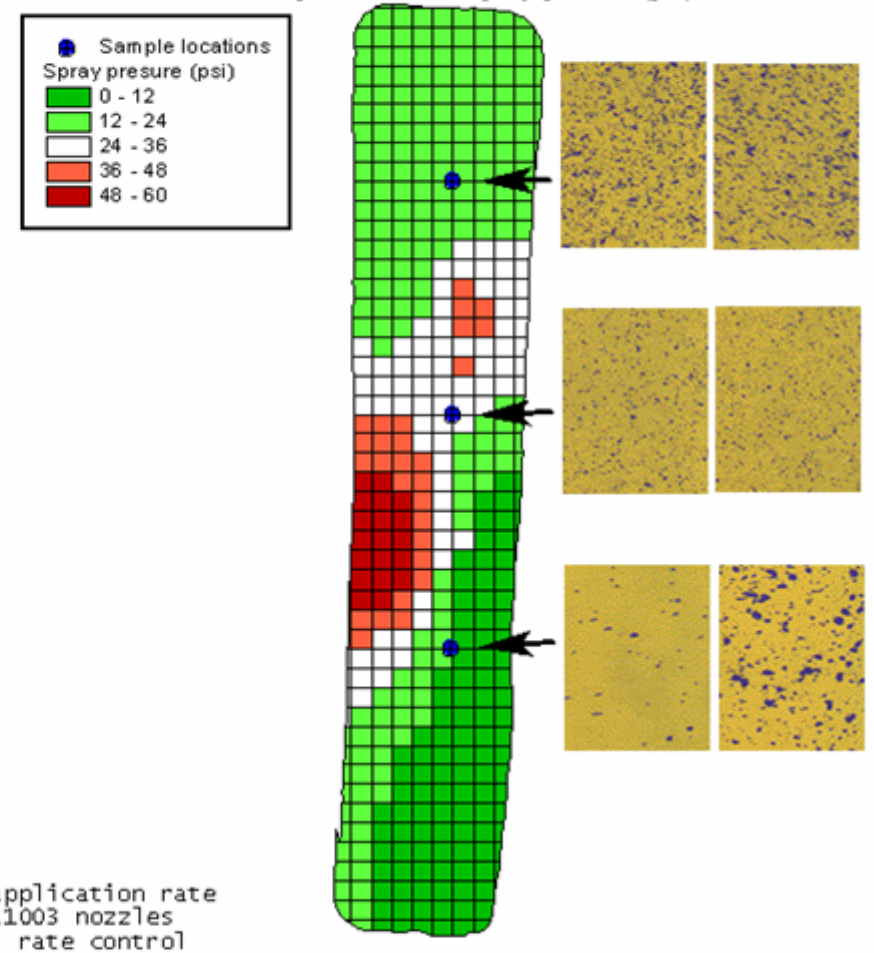
Courtesy of Ken Giles, U of California Davis

Western Center for Agricultural Equipment - Quality Control Mapping Project

Track of sprayer, Speed (miles / hr)



Sample locations, Spray presure (psi)



7 gal / acre application rate
TeeJet XR 11003 nozzles
Conventional rate control

Date: 3 October 2000
Field Name: Conventional Monsanto Field
Farm Name: Farm 44 / Case Tyler
Client Name: Quality Control Mapping Project
Total Acres: 3.7
Field Boundary Start Location:
Latitude: 38.53970687
Longitude: -121.77267248

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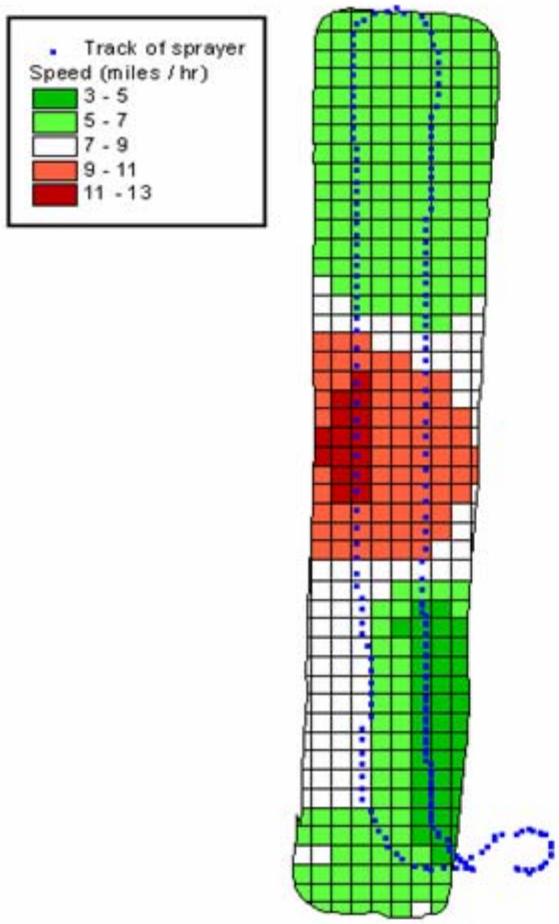
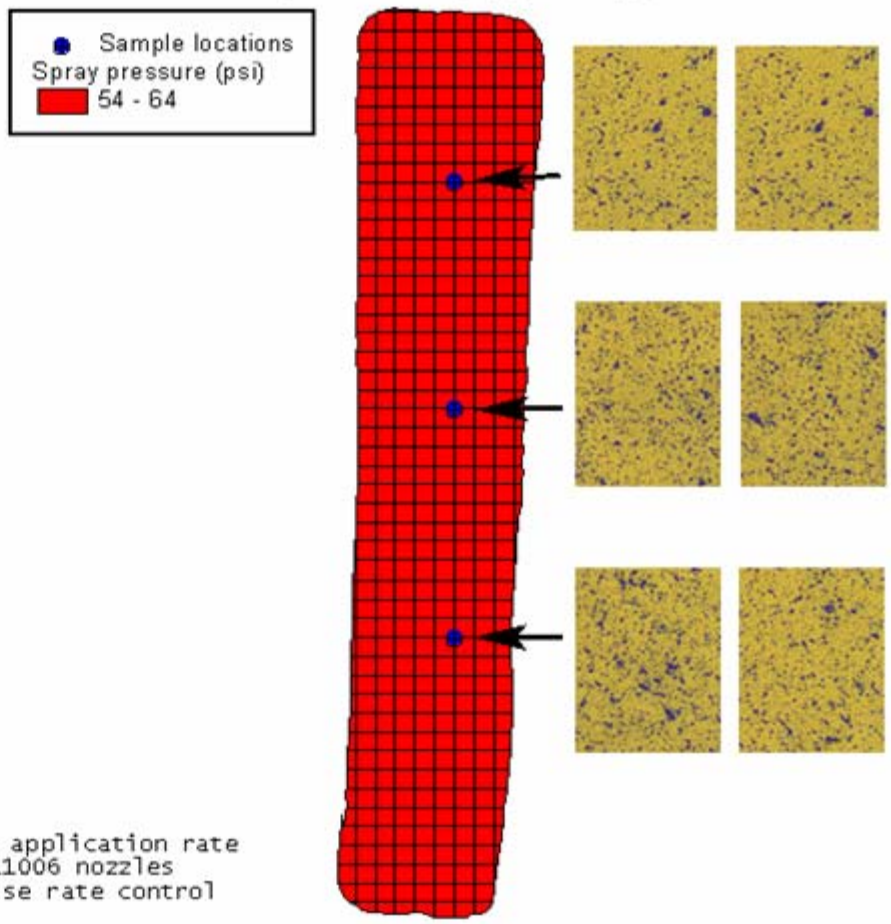
University of California, Davis
Davis, CA 95616

Western Center for Agricultural Equipment - Quality Control Mapping Project

Track of sprayer, Speed (miles / hr)



Sample locations, Spray pressure (psi)



7 gal / acre application rate
TeeJet 11006 nozzles
Blended pulse rate control

Date: 3 October 2000
Field Name: AIM Command Monsanto Field
Farm Name: Farm 44 / Case Tyler
Client Name: Quality Control Mapping Project
Total Acres: 3.7
Field Boundary Start Location:
Latitude: 38.53970687
Longitude: -121.77267248

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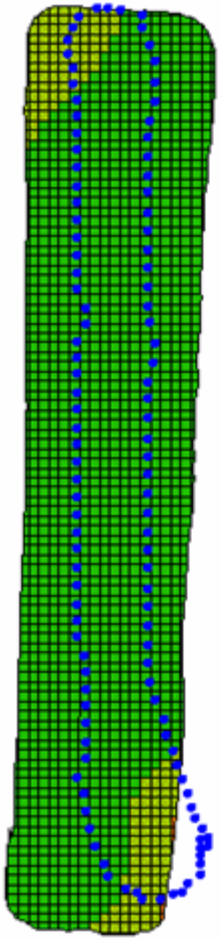
Ground Track of Sprayer, Ground Speed (mph)



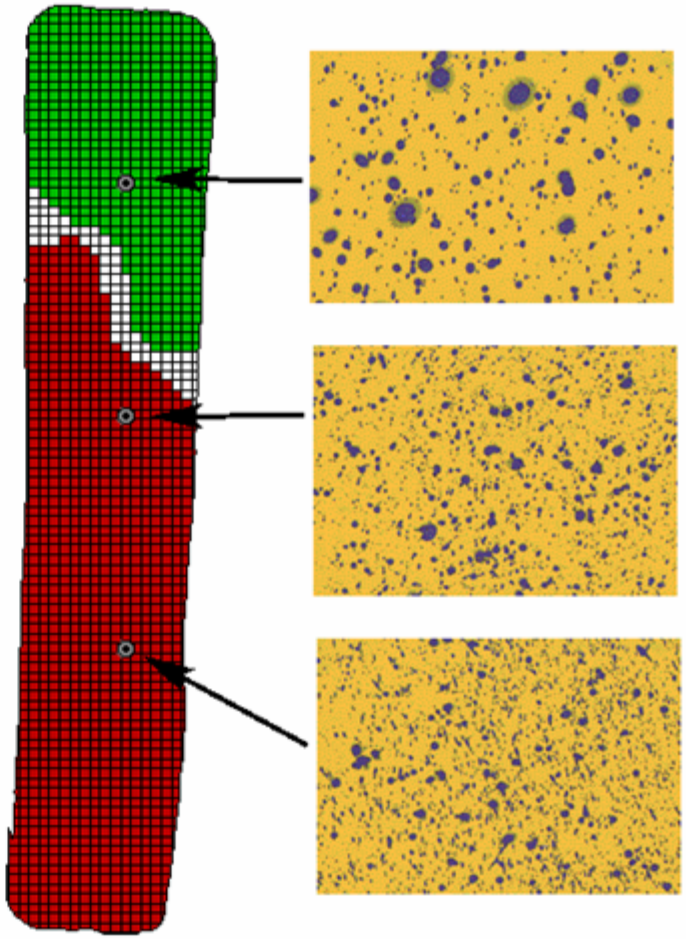
Ground Track of Sprayer
Ground Speed (mph)
2.4 - 4.8
4.8 - 7.2
7.2 - 9.6
9.6 - 12
12 - 14.4

7 gal/acre constant rate
TeeJet XR 11006 nozzles
13 mph ground speed
Drift Reduction Mode for SW wind
AIM Command application

Sample Card Locations
Spray Pressure (psi)
2 - 25
25 - 50
50 - 75

Wind

Sample Card Locations, Spray Pressure (psi)



Date: Sep 18, 2000
Field Name: Monsanto Field 25
Farm Name: Western Center for Agricultural Equipment
Client Name: Case Tyler Business Unit
Total Acres: 03.7
Field Boundary Start Location:
Latitude: 38.53970687
Longitude: -121.77267248

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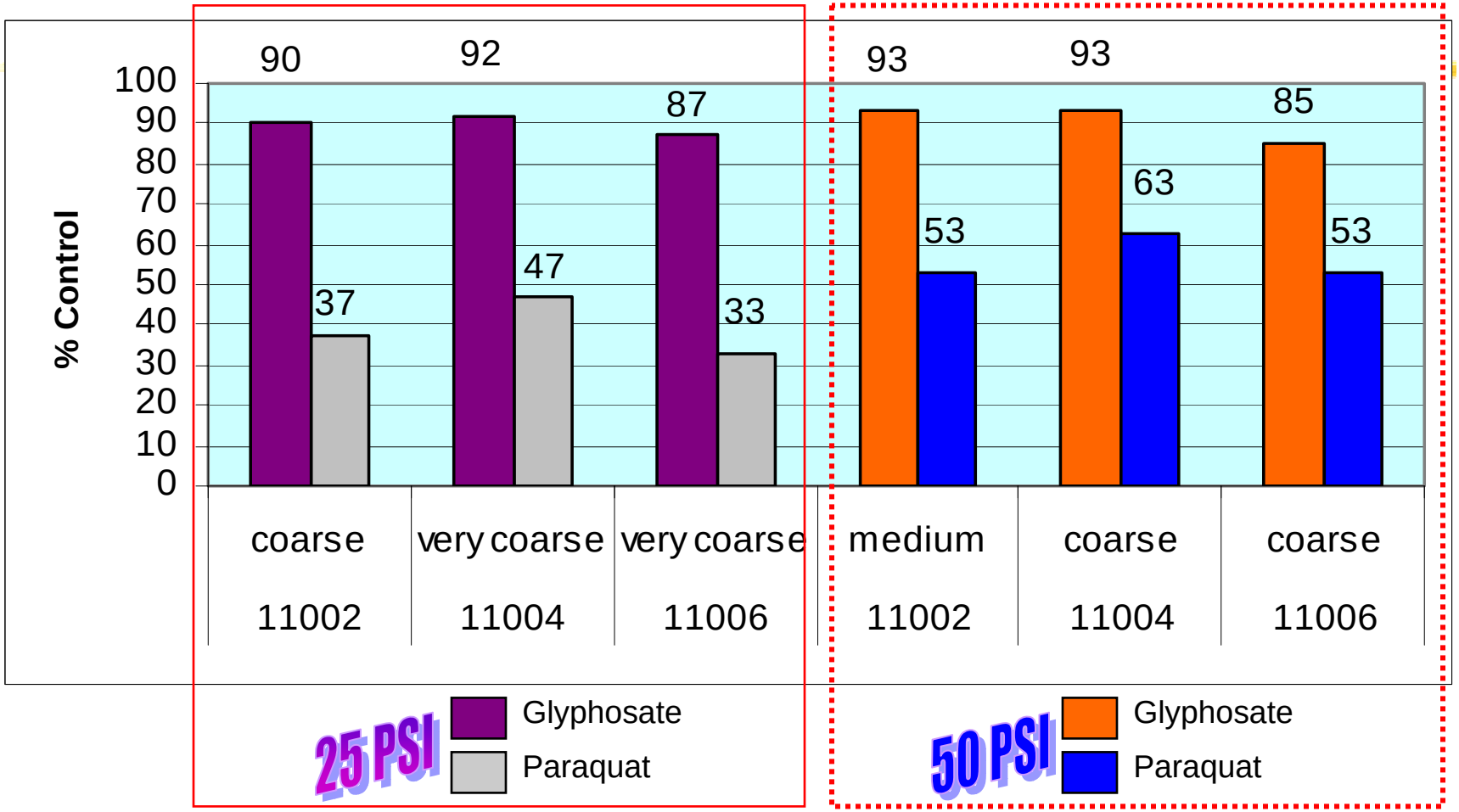
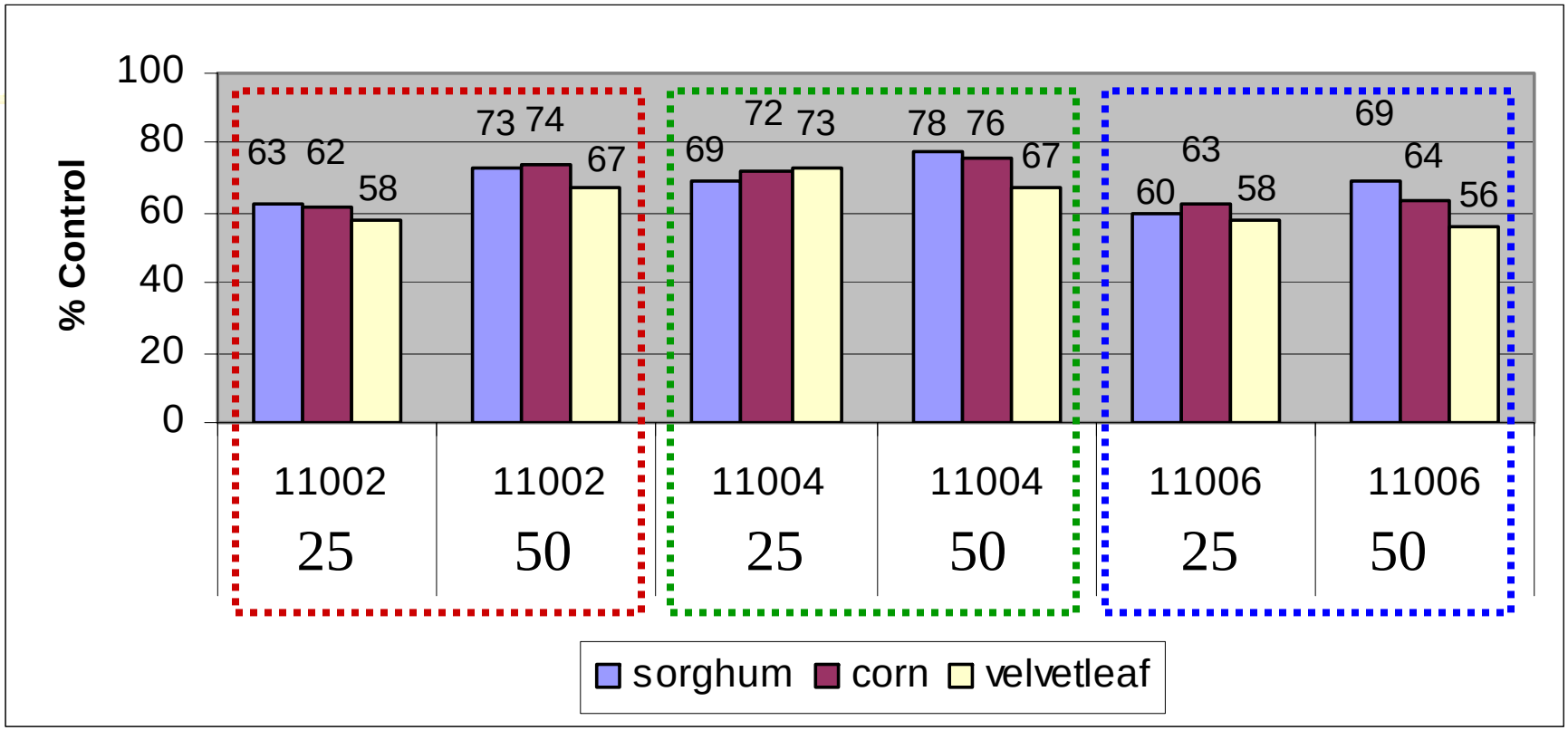
Sorghum Control: Nozzle, Pressure, Chemical, Interaction – 27 DAT



LSD = 9

Pressure Affect – 27 DAT



Sorghum LSD = 7

Corn LSD = 9

Velvetleaf LSD = 10

	25 psi	50 psi
11002	coarse	medium
11004	very coarse	coarse
11006	very coarse	coarse

Hoods & Shields:

- ✓ Broadcast spray hoods
- ✓ Individual row hoods
- ✓ Shields

The Influence of Precision Agriculture

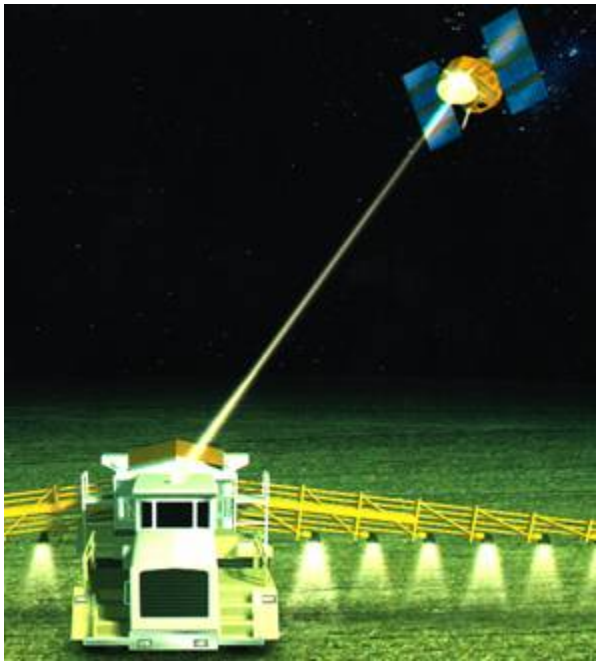
Enabling Technology:

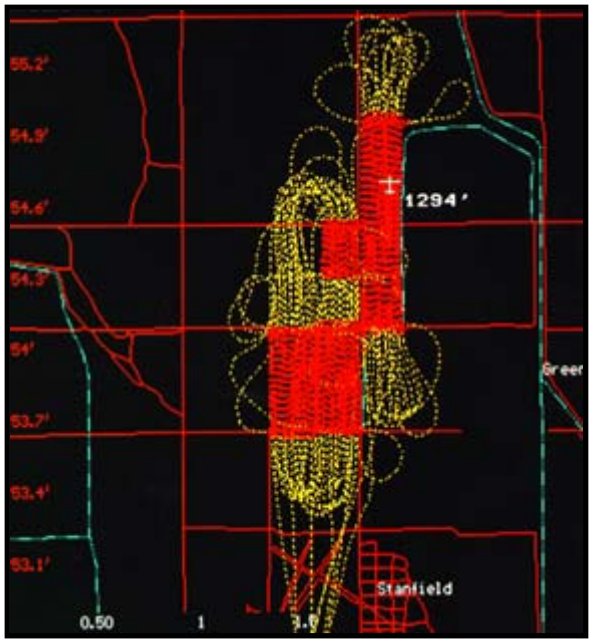
- ✓ GPS (Global Positioning System)
- ✓ Increased computing power in smaller packages

Today's Focus: GPS Guidance Systems

Parallel Swathing:

- ✓ Light Bar
- ✓ Follow parallel track, A-B line
- ✓ Straight
- ✓ Curves
- ✓ Circles



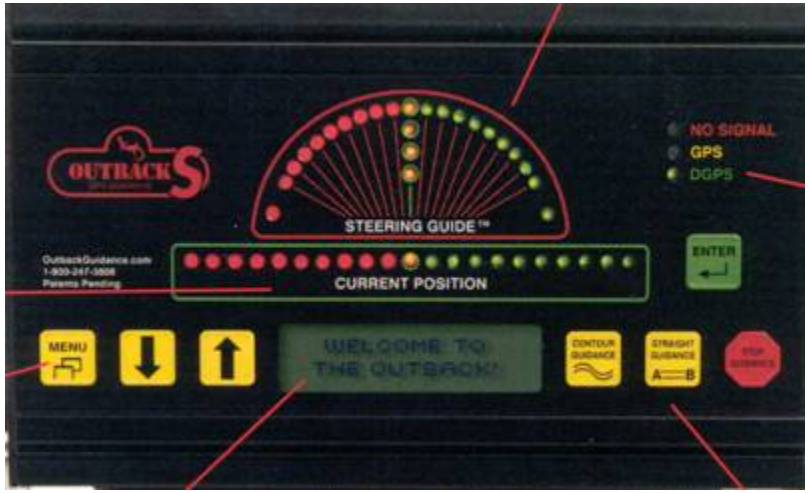


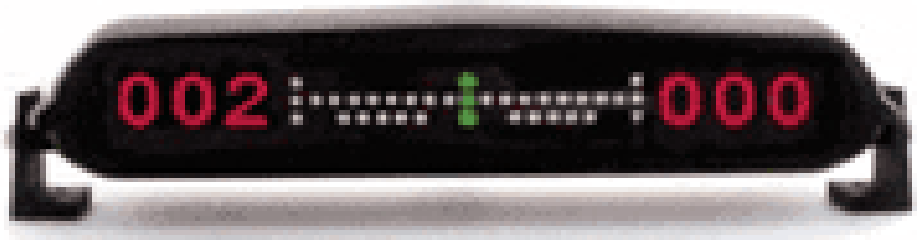
Operator Interface:

- ✓ GPS accuracy is irrelevant if the operator cannot interpret the signal and make timely steering corrections
- ✓ Two basic designs
  - Light based
  - Image based

Light Based Interface:

- ✓ Uses lights to indicate what the operator should do to maintain the desired path





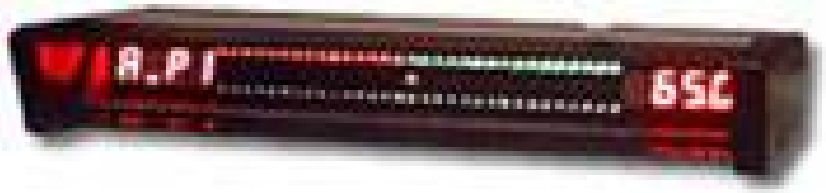


Image Based Interface:

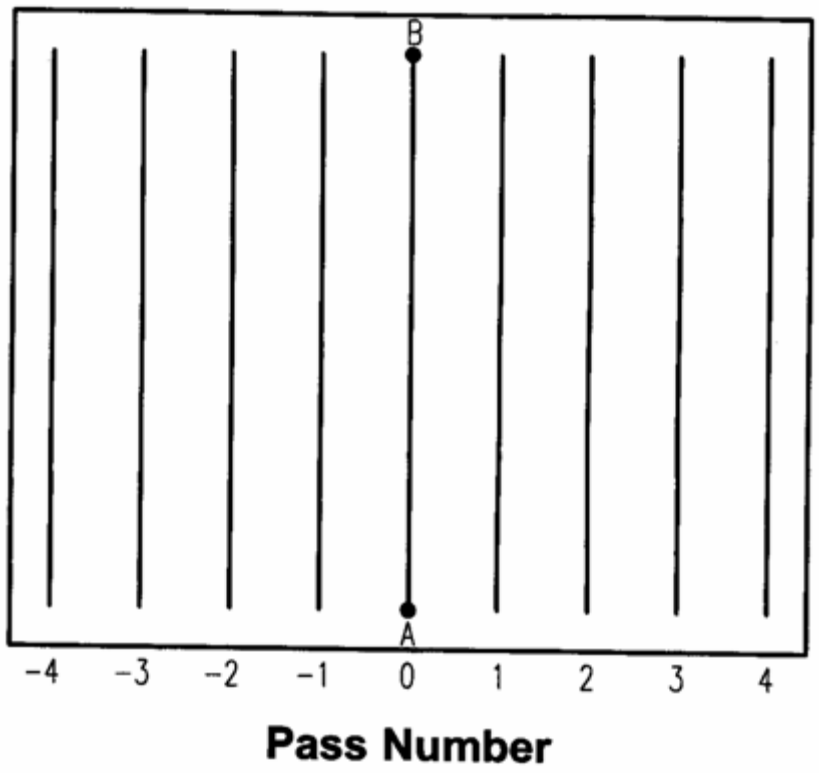
- ✓ Uses an image of the vehicle and an indication of where the vehicle should be

Features and Abilities:

- ✓ Straight line guidance
  - Back and forth or racetrack patterns
- ✓ Contour guidance
  - Curved swaths
- ✓ Return to a point
  - Stopped spraying to refill and want to restart where you left off

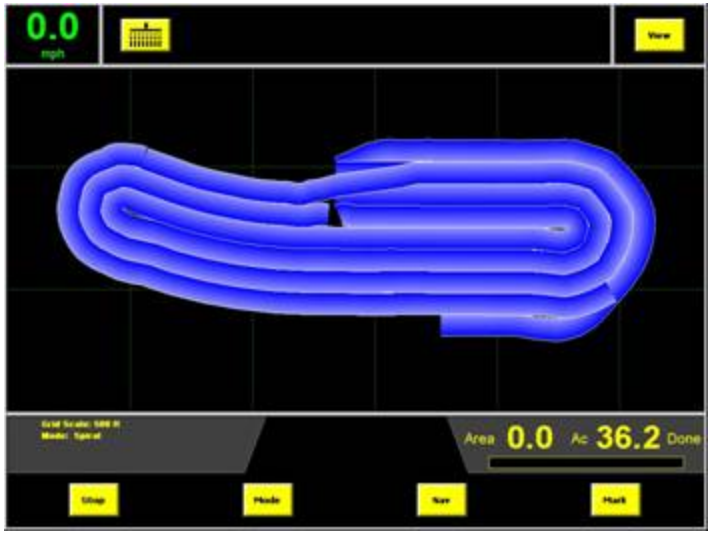
Straight Line Guidance:

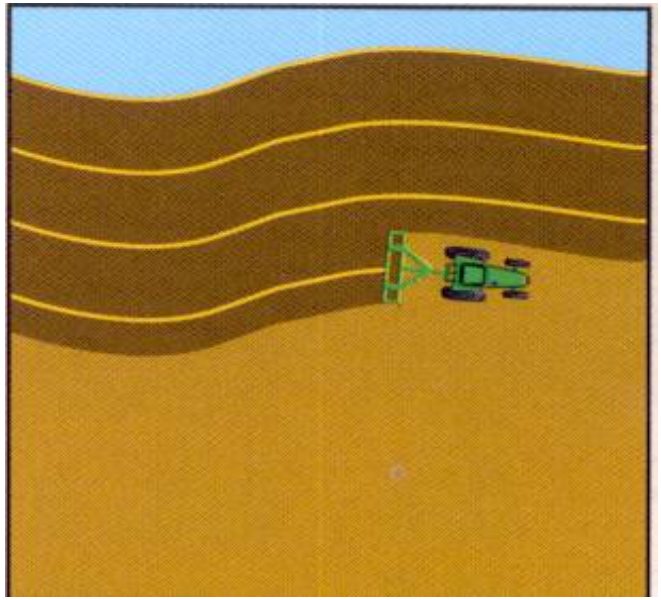
- ✓ Set an A-B line in a location that you can drive straight
- ✓ Other passes are relative to the initial A-B line



Contour Guidance:

- ✓ Drive any pass – possibly along a terrace
- ✓ Each subsequent pass is parallel to the previous pass





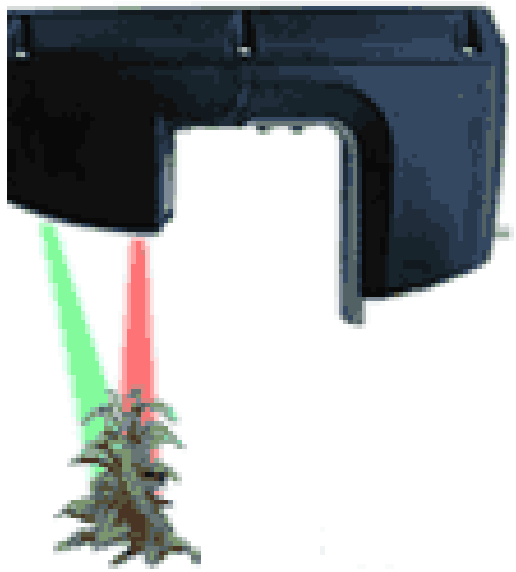
Auto Steering:

- ✓ Trimble AgGPS® Autopilot
- ✓ Trimble-TeeJet/Mid-Tech
  - Field Pilot
- ✓ BEELINE Navigator
  - AGCO Challenger
- ✓ IntegriNautics

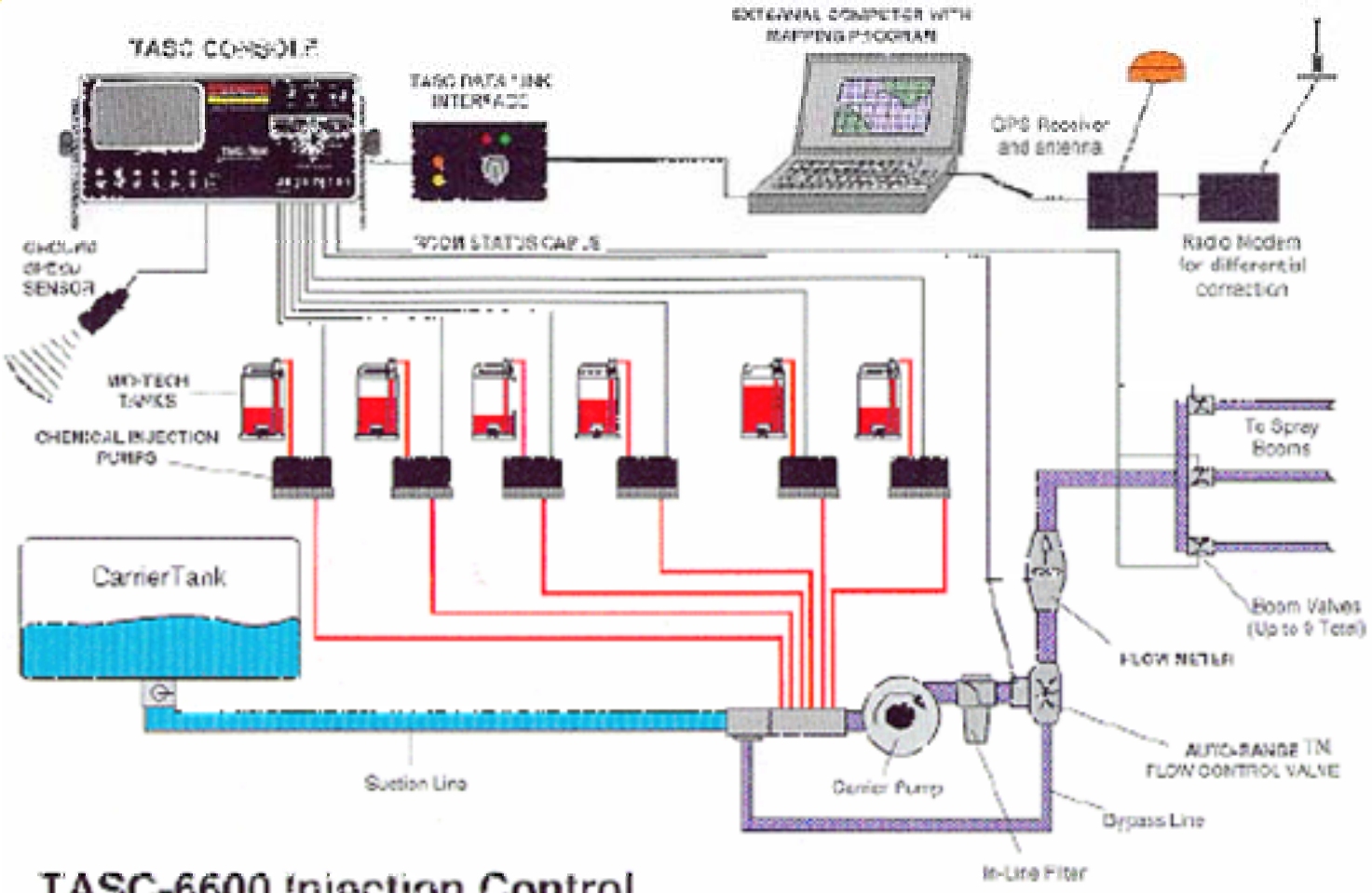
Variable Rate/Mapped Applications:

- ✓ Predeveloped application rates dependent on target variables (weed pressures, species, size)
- ✓ Issues with application speed

Weedseeker:



Chemical Injection Systems:

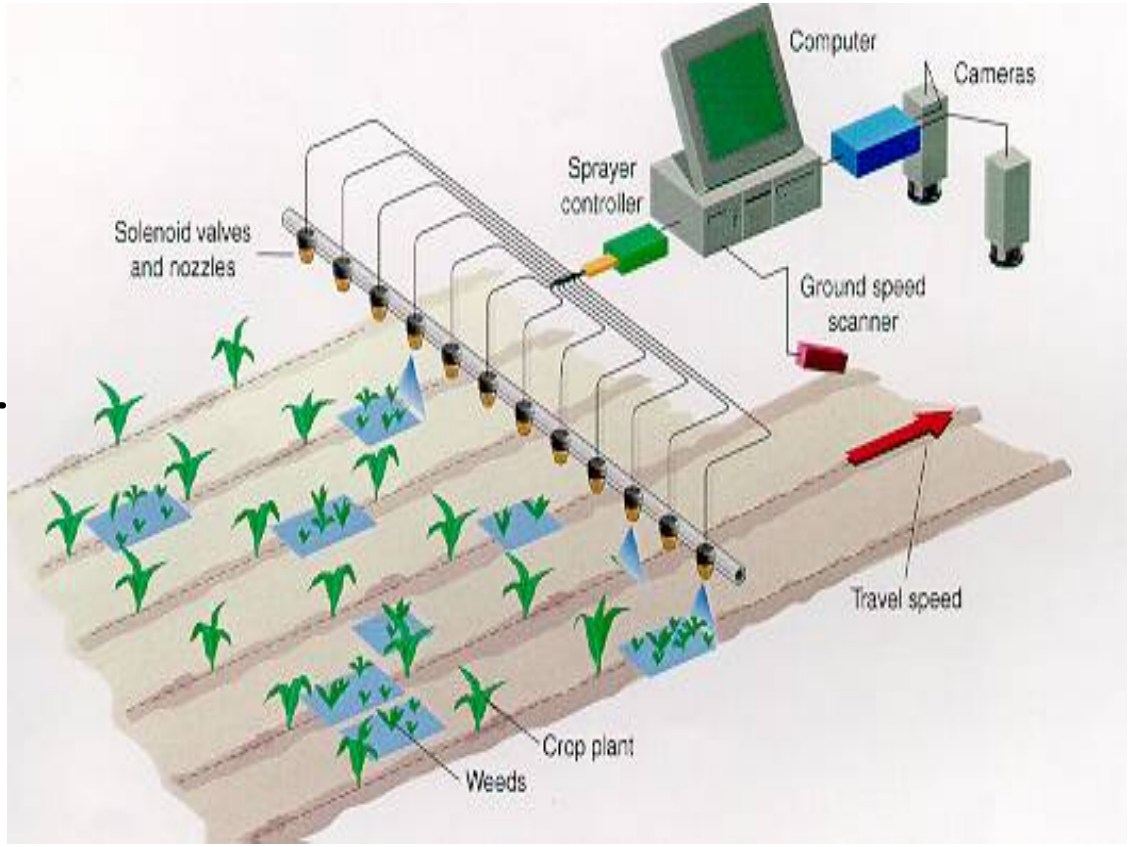


TASC-6600 Injection Control System

With DATA LINK INTERFACE for Variable Rate Application

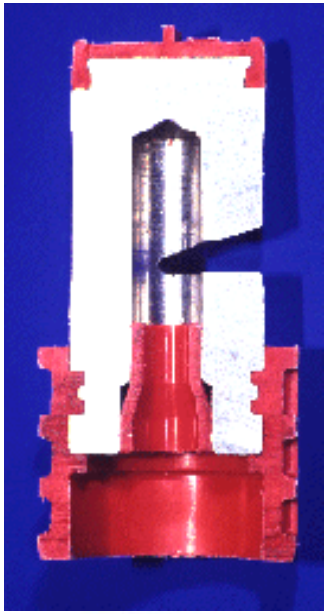
Smart Sprayers:

- ✓ Computer guided vision systems on sprayers
- ✓ Real-time
- ✓ ID weeds, insects, diseases
- ✓ Determine where, what and when to spray



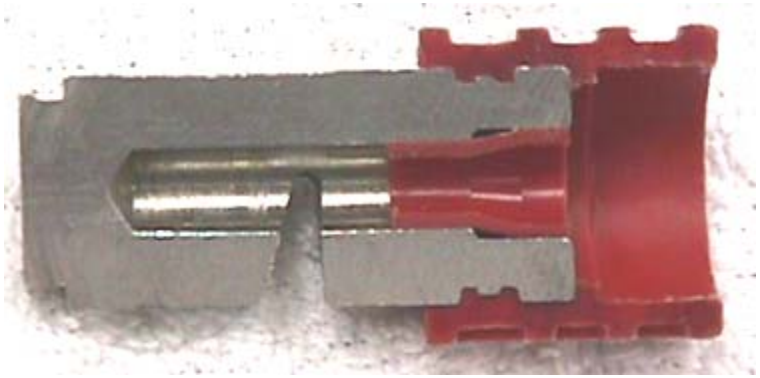
Nozzle Technology……

- ✓ Nozzles designed to reduce drift
- ✓ Improved drop size control
- ✓ Emphasis on 'Spray Quality'



Nozzles Types?

flat spray

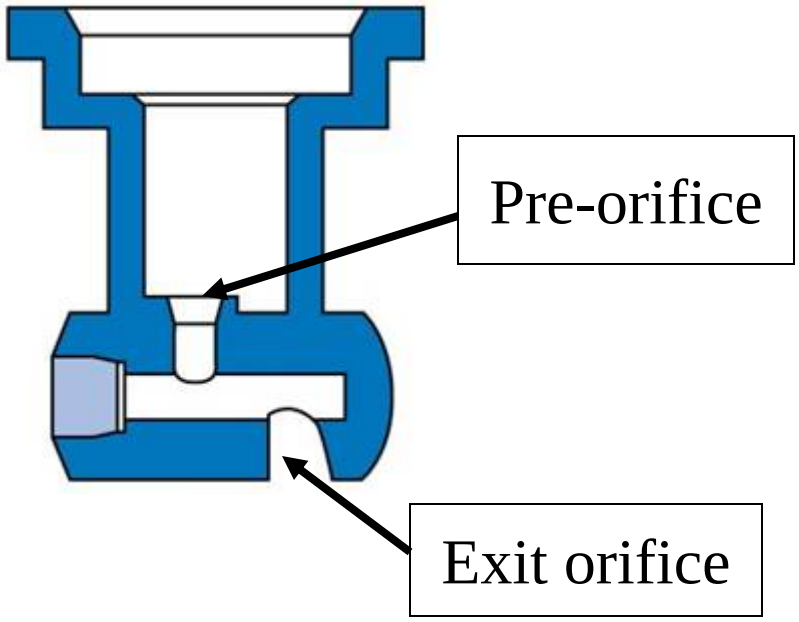


chamber

air induced

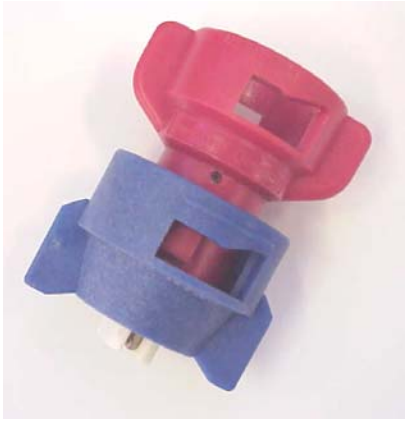
Chamber - Pre-orifice Nozzles:

- ✓ Advancements in plastic molding allowed for new non-conventional geometry and molded in pre-orifices.



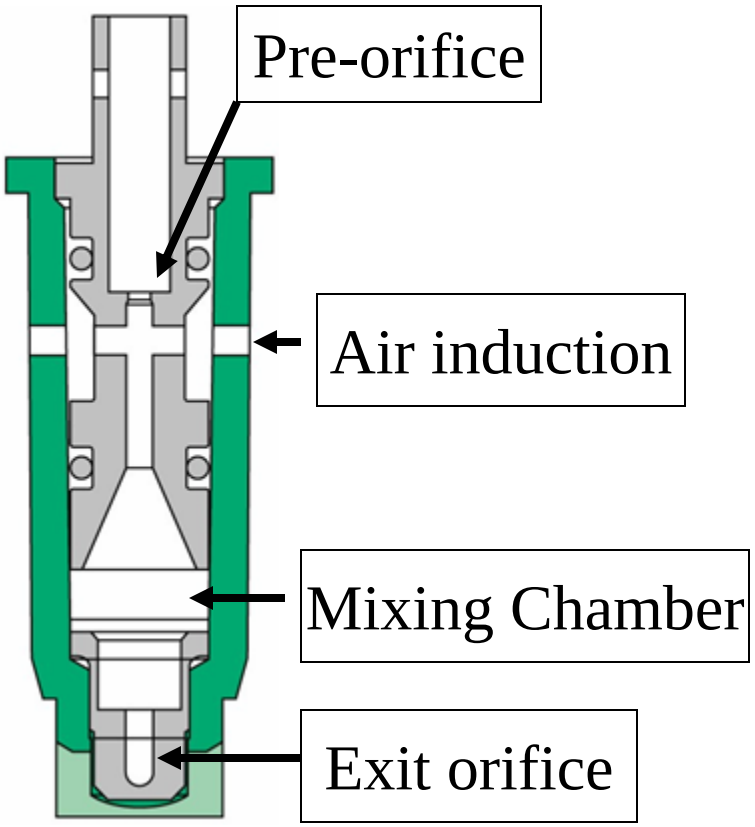
Air-Induction/Venturi Nozzles

Where air is drawn into the nozzle cavity and exits with the fluid.



Pre-orifice Air Induction Nozzles:

- ✓ Spraying Systems AI TeeJet
- ✓ Air intake venturi section
- ✓ Mixing Chamber - air and spray solution blended
- ✓ Exit orifice - Pattern tip - forms large air-bubble drops



- ✓ Better Penetration?
- ✓ Reduced run-off?
- ✓ Improved coverage?
- ✓ Adequate efficacy?
- ✓ Reduced drift? YES!!!

Driftable Droplets: Spraying Systems-2000

Nozzle Type (0.5 GPM Flow)	Approximate % of Spray Volume < 200 Microns	
	15 PSI	40 PSI
XR 11005	14%	22%
XR 8005	6%	12%
DG 11005	N/A	11%
DG 8005	N/A	7%
TT 11005	<1%	<6%
TF-2.5	<1%	<1%
AI 11005	N/A	<1%

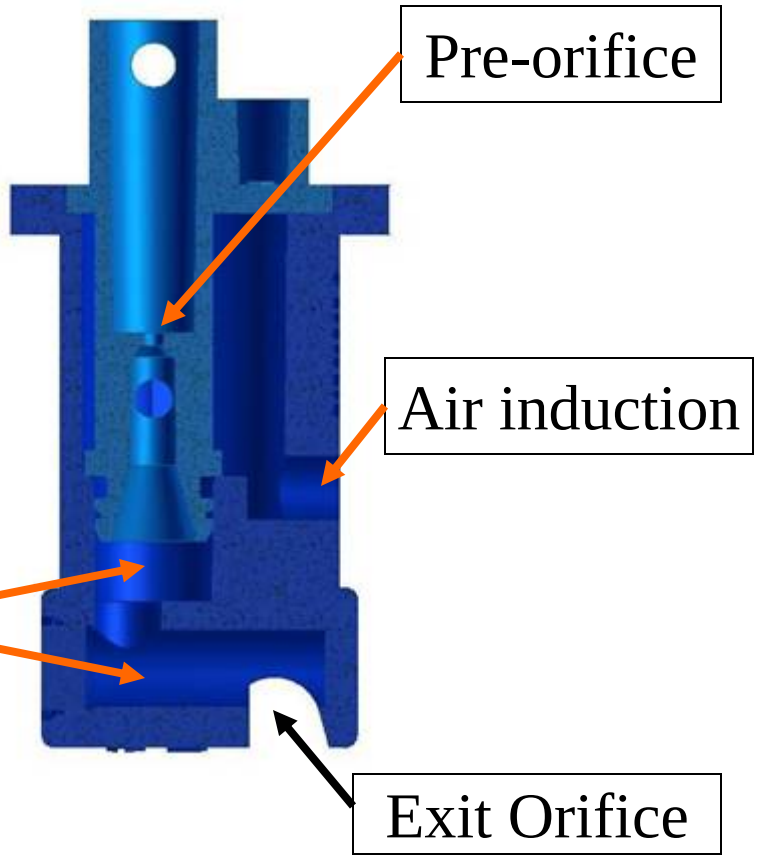
Venturi nozzles available in a variety of styles and prices

Model	Pressure range	Tip material	Cost	Model	Pressure range	Tip material	Cost
 Lechler IDK GO agriculture.com/go/5136	15-90 psi	Poly	$4.49	Deere Spraymaster Ultra Plus GO agriculture.com/go/5144	30-100 psi	Ceramic	$8.62 
 Greenleaf Airmix GO agriculture.com/go/5137	15-90 psi	Poly	$5.50	Pneu'Jet XL GO agriculture.com/go/5145	40-100 psi	Poly	$5.15 
 Deere Spraymaster Ultra GO agriculture.com/go/5138	15-115 psi	Poly	$5.62	TeeJet AI GO agriculture.com/go/5146	30-100 psi	Stainless steel	$10.59 
 Hypro Ultra ULD GO agriculture.com/go/5139	15-115 psi	Poly	$6.48	TeeJet TipCap GO agriculture.com/go/5147	30-100 psi	Poly Stainless steel	$5.29 $11.49 
 Hypro Fastcap GO agriculture.com/go/5140	15-115 psi	Poly	$7.70	Lechler ID GO agriculture.com/go/5148	40-100 psi	Poly with cap Ceramic	$4.99 $10.99 
 Air Bubble Jet GO agriculture.com/go/5141	20-90 psi	Poly	$8.40	Lechler ITR (cone) GO agriculture.com/go/5149	40-120 psi	Ceramic	$14.99 
 TurboDrop XL GO agriculture.com/go/5142	20-120 psi 30-120 psi	Poly Ceramic	$11.25 $19.50	TurboDrop GO agriculture.com/go/5150	40-150 psi	Ceramic	$24.50 
 Albuz AVI GO agriculture.com/go/5143	30-100 psi	Ceramic	$9.95	Air-injected nozzles are not available for direct purchase. Use the GO LINKS to check on sizes available and to find distributors. GO LINKS save clicks by taking you directly to the intended product page, rather than the site's home page.			

Source: Successful Farming – Feb. 2004

Next Generation Air Induction Nozzles:

- ✓ Next generation:
  - More compact
  - Larger drops
  - Operates at lower pressures
  - Percentage of fines do not increase with pressure



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- ✓ Brand names appearing in this presentation are for identification and illustration purposes only.
- ✓ No endorsement is intended, nor is criticism implied of similar products not mentioned.


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For more information contact:
rewolf@ksu.edu
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