Nozzle Type Effect on Soybean Canopy Penetration

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BIOLOGICAL AND AGRICULTURAL ENGINEERING

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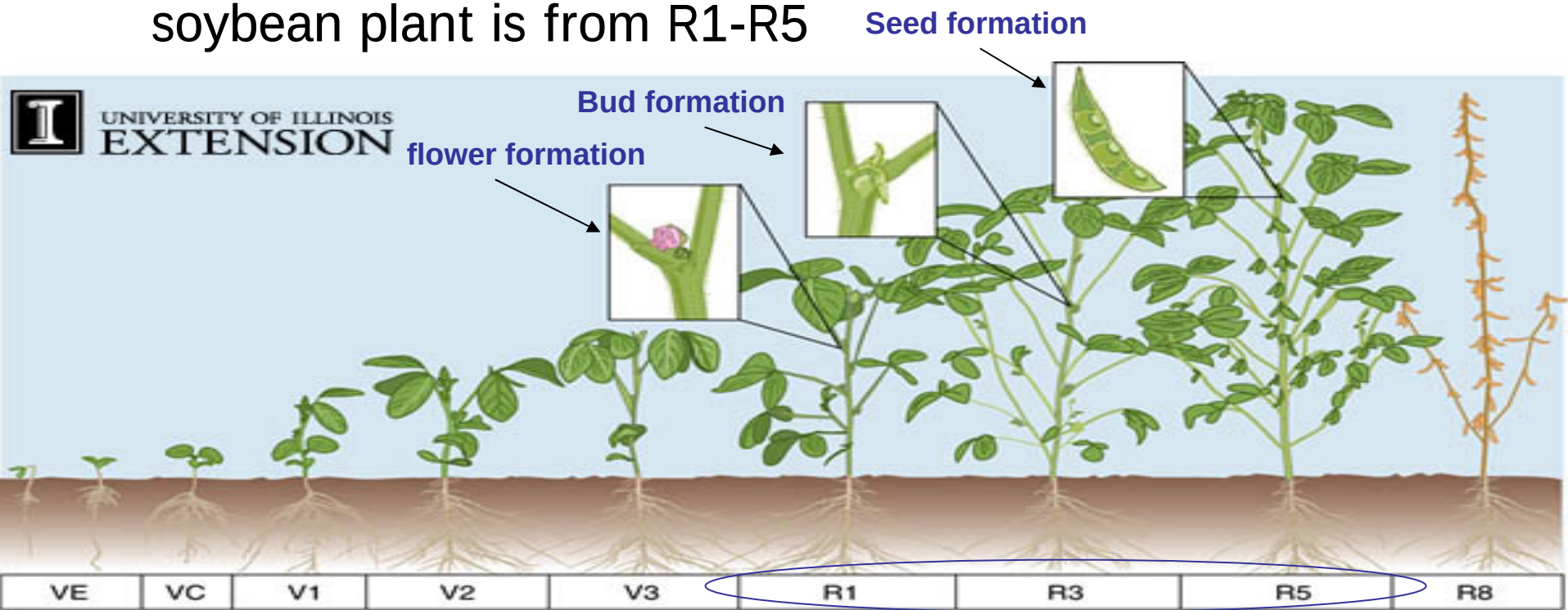
INTRODUCTION:

- Asian soybean rust can cause severe damage to the soybean crop.
- If the disease goes untreated, the plant may defoliate in 10 to 14 days.
- The critical stage for the disease to affect soybean plant is from R1-R5



INTRODUCTION:

- The disease symptoms generally occur in the lower parts of soybean plants.
- In general, a soybean canopy has a very heavy canopy.

- Penetration of spray to the lower part is very difficult using conventional ground spraying systems.

Canopy Density-

Timing a factor!

Light – more visible soil surface than vegetative plant surface. Plant height from 12 – 14 inches (VE to V6).

Medium – some soil surface still visible. Plant height from 15 – 22 inches (R1 to R2).

Heavy – no soil surface visible. Plant height at least 23 inches (R3-R8).

Light Canopy

Light to Medium Canopy

Heavy Canopy

OBJECTIVE:

The objective of this study was to conduct laboratory and field trials to compare ground sprayer nozzle options for applying fungicides to obtain the most coverage in the lower parts of the soybean canopy.

MATERIALS AND METHODS:

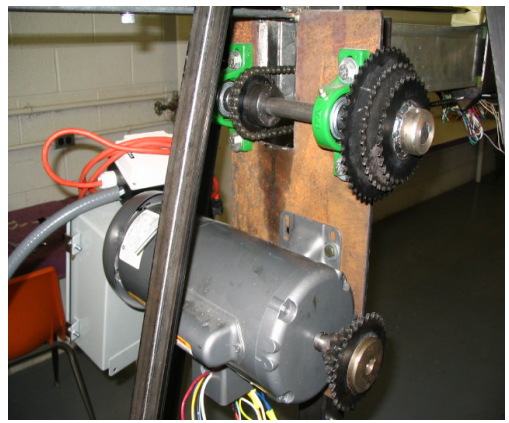
- Part 1: Lab studies
  - testing with spray-track machine
  - Soybean plants simulated drilled
  - 61 cm tall
  - growth stage R1 –R2
  - 90 to 95% canopy fill
- Application parameters
  - Application volume – 20 GPA
  - Water and NIS @ .5% v/v
  - Boom Speed – 10 MPH
  - Flow rate required – 0.67 GPM
  - Droplet size goal – 200-300 VMD
    - high fine to mid medium (water based)
    - Pressure and orifice size – varied
- 20 nozzle types
  - single and double orifices

MATERIALS AND METHODS:

- Part 2: Field trials
  - Ashland Bottoms, Agronomy Research Station near Manhattan, KS
  - Spray Track machine
  - Drilled soybean plants were 46 cm tall
  - Growth stage R3 – R4
  - 75% canopy fill
- Application parameters
  - Application rate – 20 GPA & Speed -10 MPH
  - Water, NIS, and Headline fungicide
  - Flow rate required – 0.67 GPM
  - droplet size – 200-300 VMD
    - high fine to mid medium
    - pressure and orifice size – varied
- 12 Nozzle types
  - single and double orifices

Spray track machine:

- Designed to simulate actual field conditions
- Aluminum bar – 24 ft
- Electric motor, gear and chain assembly
- Field generator for field studies
- Sprayer boom – 2 nozzles @ 20 inches
  - solenoid controlled with remote control
- Pressure – Air Compressor - Co_2 cylinder
- Spray bottles – 500 ml/180 psi rated

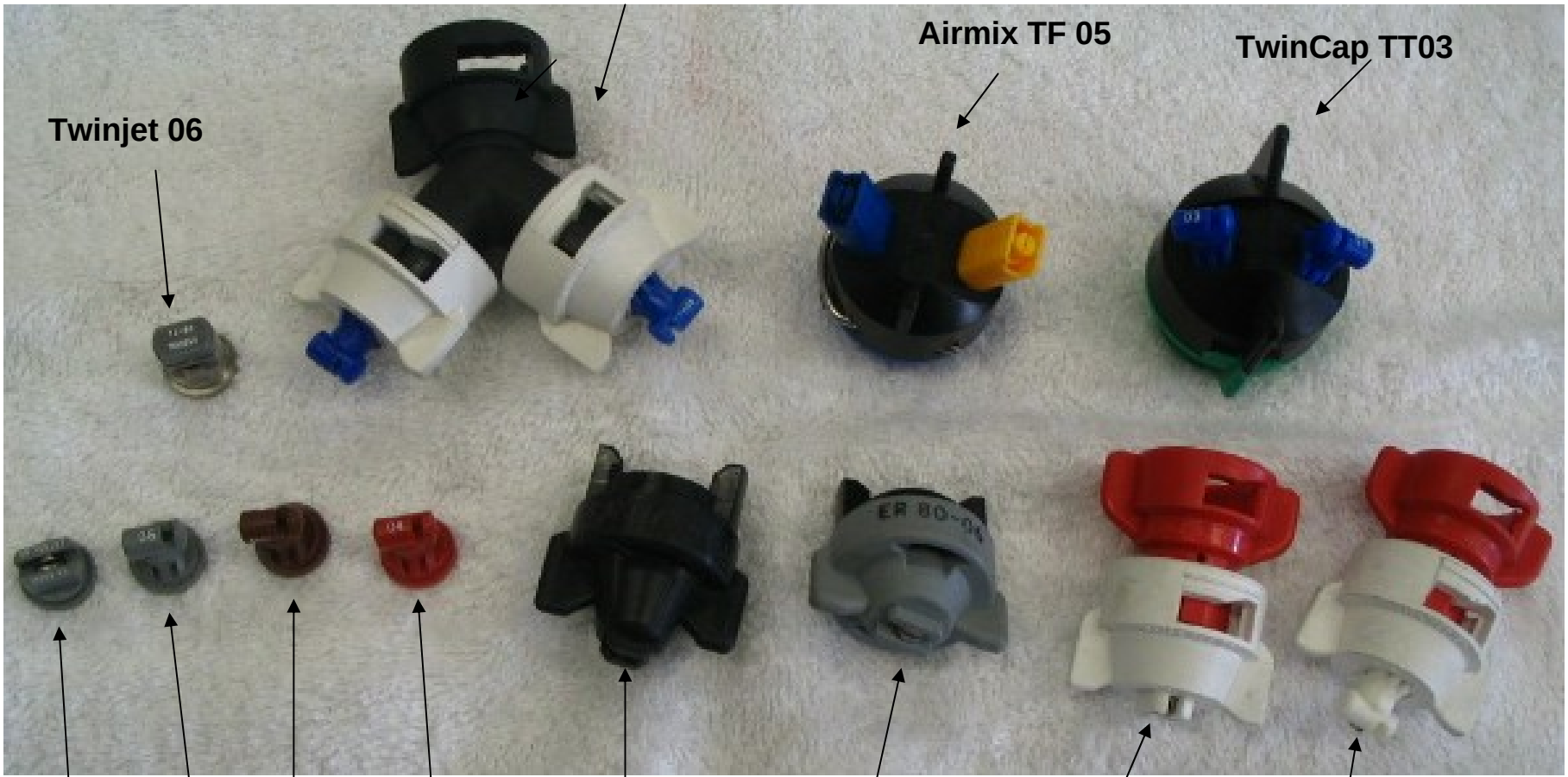


Lab Trial Nozzles:

Lab Trial Treatments:

Treatment	Nozzle	Pressure (PSI)	DSC
1	XR11006	50	Medium
2	TT11006	50	Coarse
3	TT11005	75	Coarse/Medium
4	TT11004	95	Medium
5	TD XR04	115	Medium
6	TD TT04	115	Medium
7	TD XL04	115	Medium
8	SR 110-05	75	Medium
9	SR 110-06	50	Medium
10	ER 80-06	50	Fine/Medium
11	TwinCap TT03	50	Medium
12	TwinCap TT04	27	Medium
13	Twinjet 06	50	Medium
14	TJ Duo TT03-Wide	50	Medium
15	TJ Duo TT03-Narrow	50	Medium
16	TJ Duo XR03	50	Medium
17	Airmix TF 05	75	Medium
18	TwinCap TT03	50	Medium
19	SR 110-03	50	Medium
20	MR 110-025	75	Medium

Field Trial Nozzles:



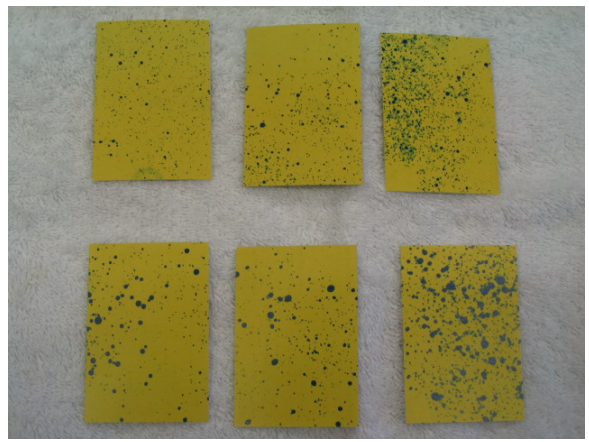
Field Trial Treatments:

Treatment[1]	Nozzle	Pressure (PSI)	Droplet Spectra Classification / DSC[2]
1	XR11006	50	Medium
2	TT11006	50	Coarse
3	TT11005	75	Coarse / Medium
4	TT11004	95	Medium
5	SR 11006	50	Medium
6	ER 8006	50	Medium
7	TD XR04	115	Medium
8	TD TT04	115	Medium
9	Twinjet 06[3]	50	Medium
10	TJ Duo TT03-Narrow[3]	50	Medium
11	Airmix TF 05[3]	75	Medium
12	TwinCap TT03[3]	50	Medium

[1]All treatments used a tank mix solution of tap water, non-ionic surfactant, and headline fungicide.
[2]Based on ASABE S-572 Droplet Spectra Classification and nozzle manufacturers' charts.
[3]Twin or double orifice nozzles.

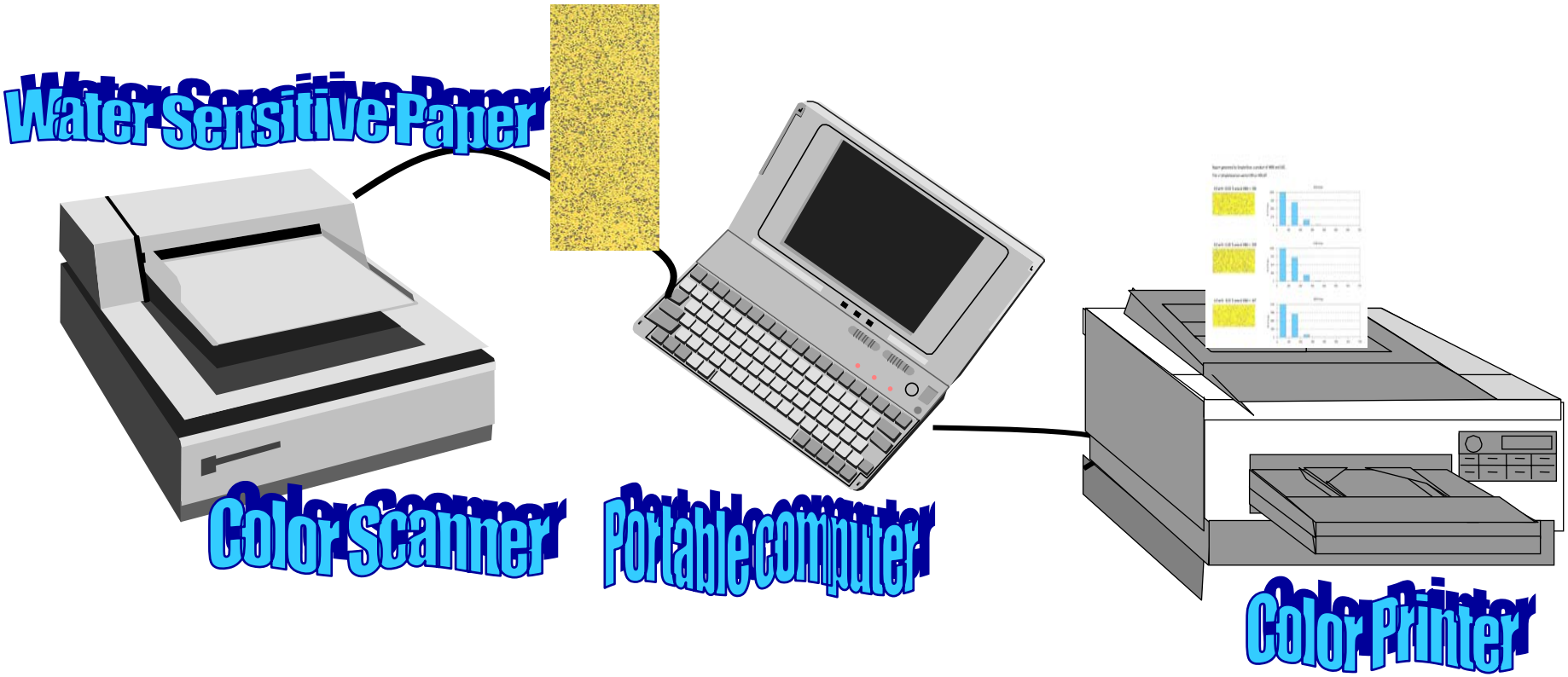
Droplet Collectors:

- Water sensitive papers were placed in the lower canopy at a height of 10 cm from ground
- 6 Water sensitive papers per treatment



- 2 replications were done

DropletScan™ used to analyze droplets



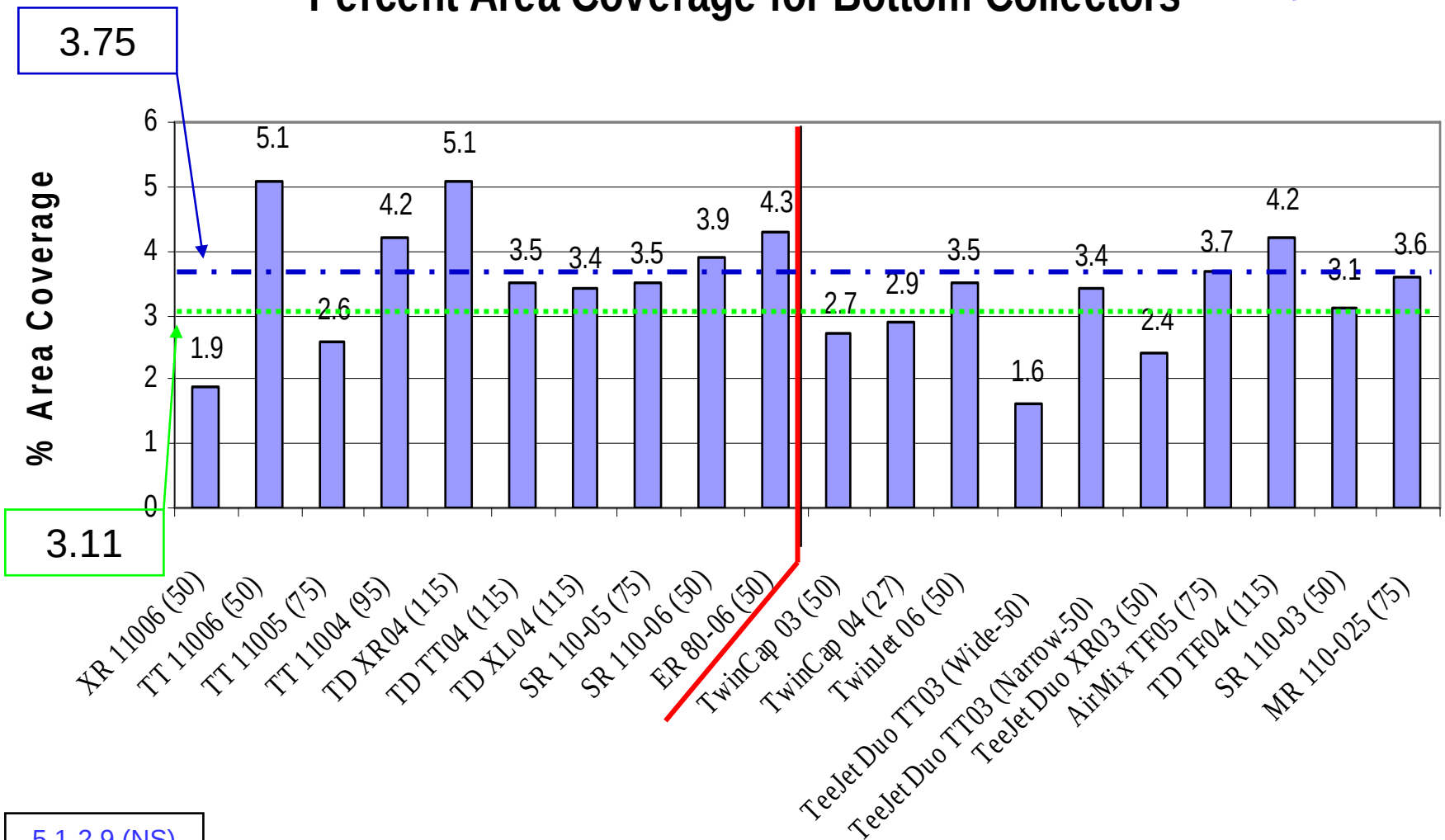
- Statistical comparisons volume medium diameter (VMD), Percentage Area Coverage (PAC), and Droplets per Square centimeter (D/SC)
- Statistical analysis with SAS Proc GLM - LS Means compared with Alpha = 0.10

Results and Discussions

- Comparison of nozzles based on Percentage Coverage Area (PAC)
- Comparison of nozzles based on Droplets per Square centimeter (D/SC)
- Comparison of nozzles based on VMD and comparing with calibrated droplet spectra of 200-300 microns

Canopy Penetration Study at 20 GPA and 10 MPH
Percent Area Coverage for Bottom Collectors

LAB TRIAL



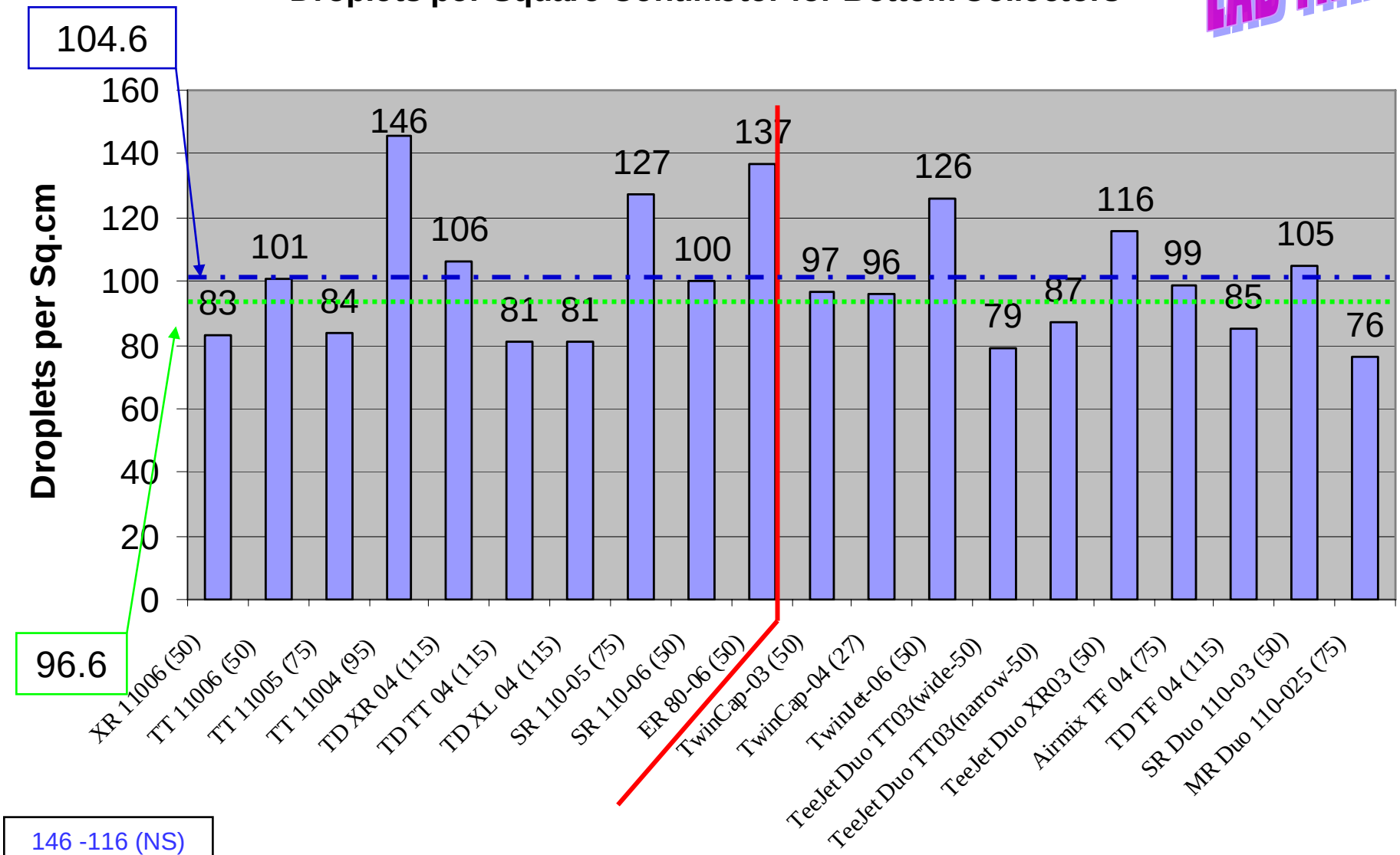
5.1-2.9 (NS)

LSD=2.29

Nozzle Type (PSI) Left half are singles - Right half are doubles

Canopy Penetration Study at 20 GPA and 10 MPH
Droplets per Square Centimeter for Bottom Collectors

LAB TRIAL

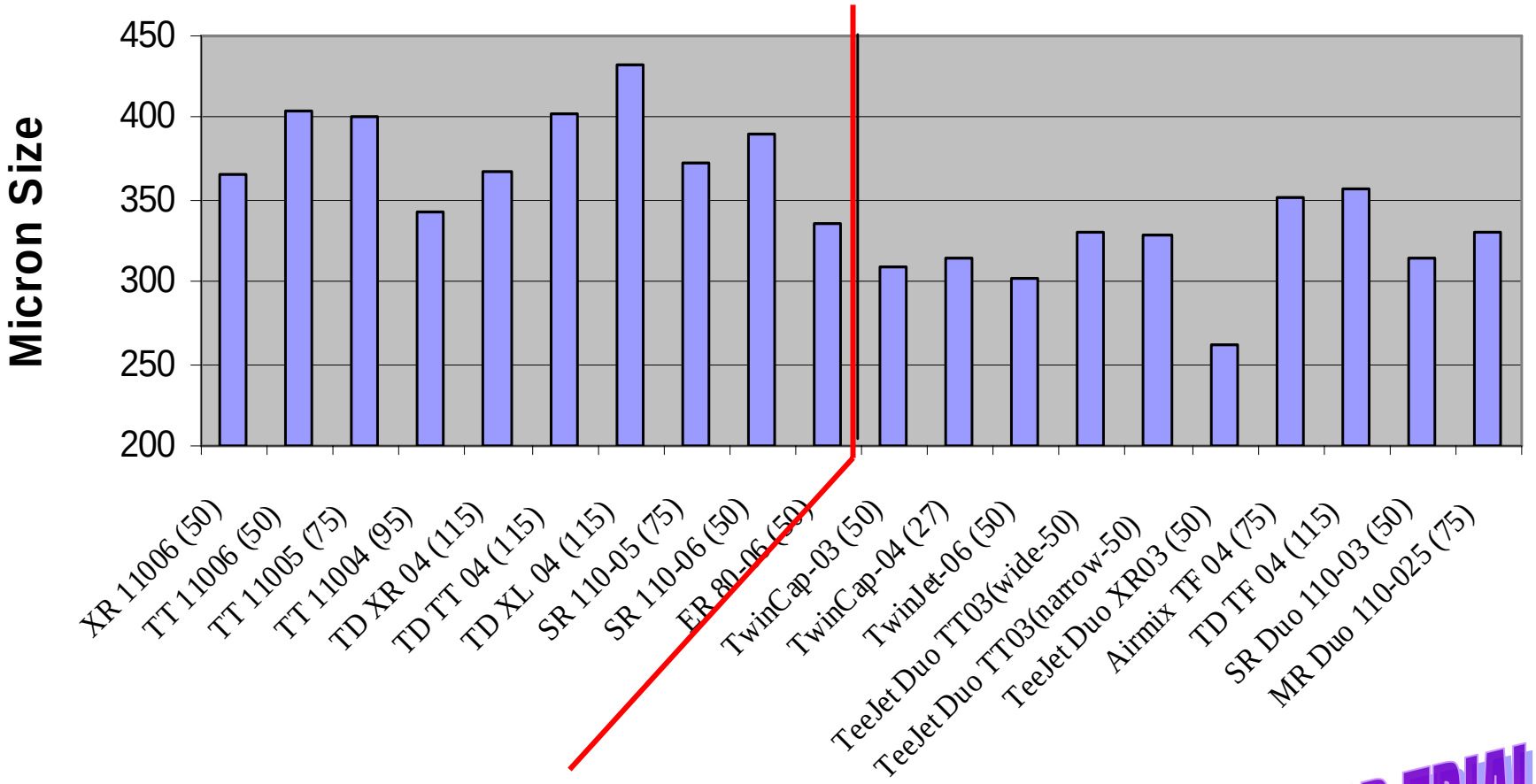


146 -116 (NS)

LSD=37.2

Nozzle Type (PSI) Left half are singles - Right half are doubles

Canopy Penetration Study at 20 GPA and 10 MPH
VMD for Bottom Collectors



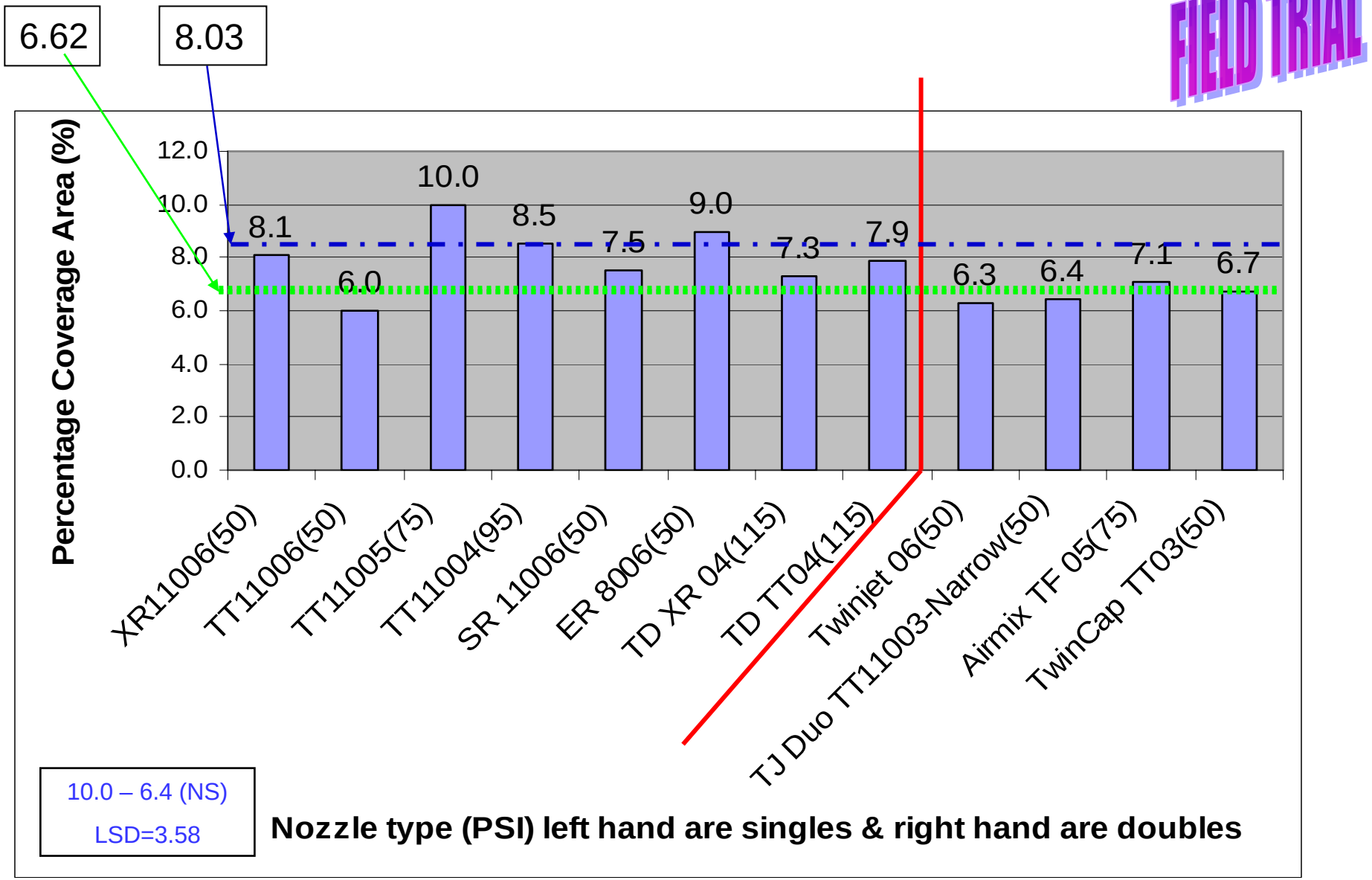
434 – 342 microns (NS) LSD – 85.4 microns

Calibrated Droplet Spectra – 200-300 microns

LAB TRIAL

Percentage Coverage Area for Different Nozzle Types

FIELD TRIAL

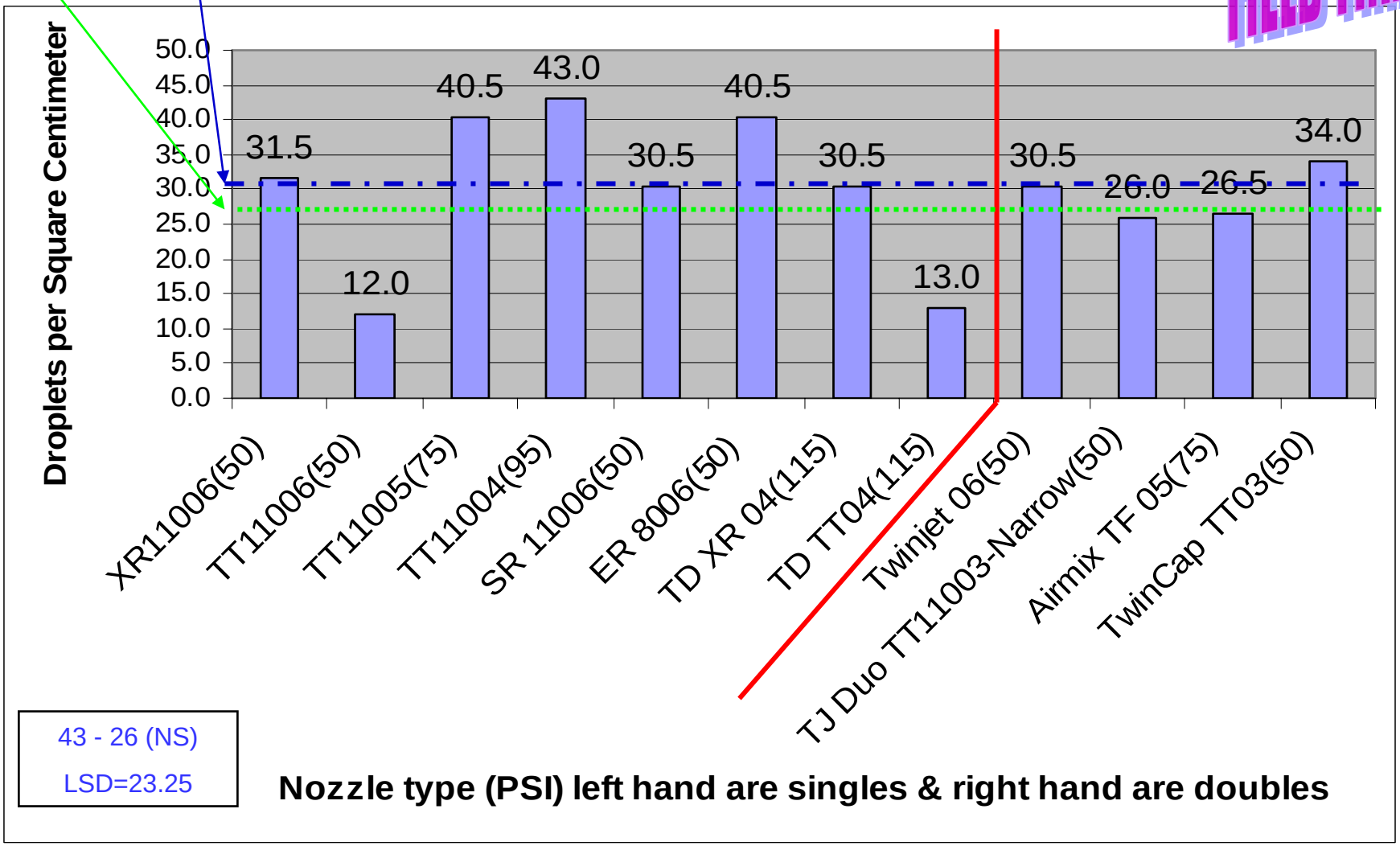


Droplets per Square Centimeter for different Nozzle Types

FIELD TRIAL

27.75

30.18



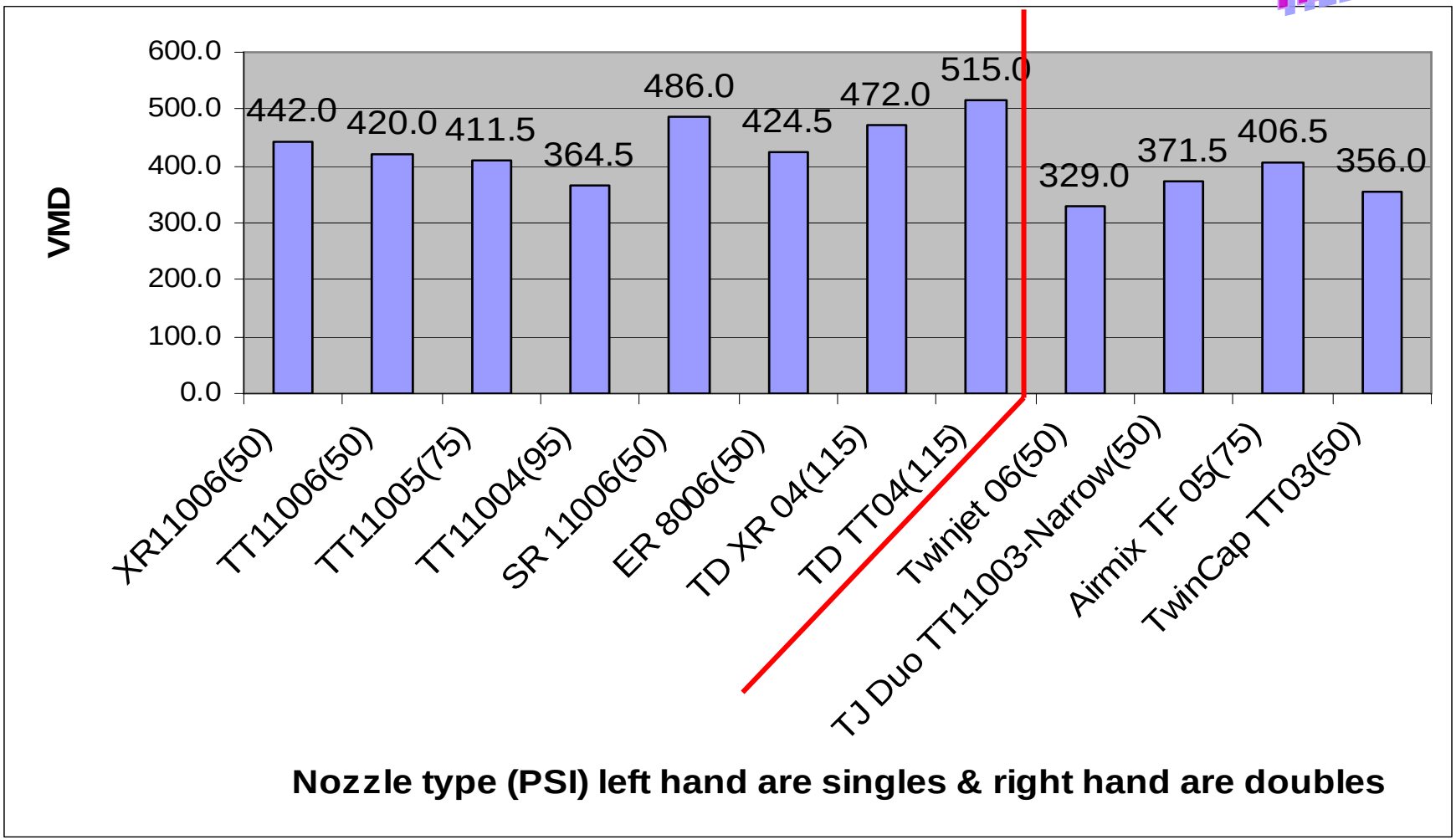
43 - 26 (NS)

LSD=23.25

Nozzle type (PSI) left hand are singles & right hand are doubles

VMD for Different Nozzle Types

FIELD TRIAL



515 - 472 microns (NS), LSD – 64.3 microns

Calibrated Droplet Spectra – 200-300 microns

Summary and Findings

- **Percentage Coverage Area**
  - Lab trials = 5.1 - 1.6% (TT 11006 & TDXR 11006)
  - Field trials = 10 – 6% (TT 11005 & ER 8006)
  - No significant differences in top 15 nozzles – lab
  - No significant differences in top 9 nozzles - field
  - On average the single nozzle configurations gave more PAC than the double nozzle configurations
  - Venturi designs at high pressures did not perform well as the conventional nozzles at lower pressures

Summary and Findings

- **Droplets per Square Centimeter**
  - Lab trials – D/SC ranged from 145.5 – 75.5 (TT 11004)
  - Field trials - D/SC ranged from 43 – 12 (TT 11004)
  - Lab trails – No significant differences in the top 5 nozzle configurations
  - Field trails - No significant difference in top 10 nozzle configurations
  - Lab trials – highest coverage did not necessarily have the highest number of D/SC
  - Field trials - The top three for the coverage also provided high number of D/SC

Summary and Findings

- **Volume Mean Diameter (VMD)**
  - Lab trials – VMD ranged from 434 – 260.5 microns
  - Field trials - VMD ranged from 515 to 329 microns
  - Calibrated VMD was 200 – 300 microns
  - The twin nozzle configurations more closely matched the calibrated VMD requirements
  - None of the single nozzle configurations came near the calibrated VMD requirements
  - Spread factor coefficients have not been determined to date.

Conclusions

- Twin nozzle configurations for improved canopy penetration is not supported from this study
- Conventional nozzles performed well provided that smaller orifice sizes and high pressures were selected
- Conventional Turbo and Extended range nozzles performed well in this study
- In addition to calibrating increased GPA’s for fungicide applications, an additional step to calibrate for proper D/SC is essential.

Thank You