Influence of Application Equipment on Protecting Wheat Against Diseases

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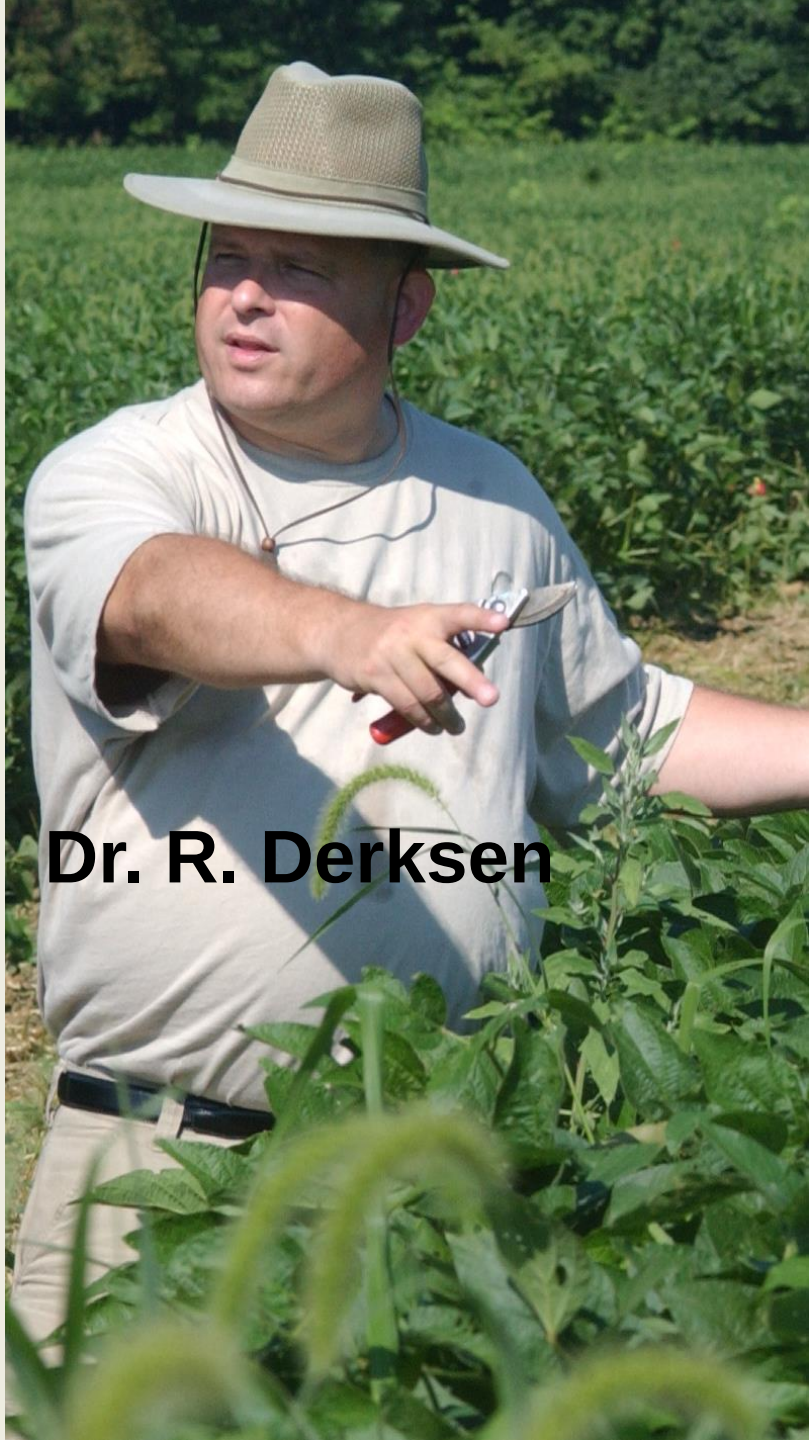
Dr. R. Derksen

Major variables affecting success in pest control in crop protection

- **Choice of pesticide**
- **Choice of application equipment**
- **Proper calibration & operation of equipment**
- **Weather conditions** (before, during and after application)
- **Timing of application**

The most frequently asked question:

"What is the best nozzle I can put on my sprayer?"

BASF

We create chemistry

Group 3 Fungicide

SPECIMEN

Caramba®

Fungicide

For use in disease control in the following crops: barley, corn, oats, rye, sugar beets, sugarcane, triticale, and wheat

Active Ingredient*:	
metconazole: 5-[(4-chlorophenyl)methyl]-2,2-dimethyl-1-(1*H*-1,2,4-triazol-1-ylmethyl)cyclopentanol	8.6%
Other Ingredients:	91.4%
Total:	100.0%

*Equivalent to 0.75 pound of metconazole per gallon.

EPA Reg. No. 7969-246 **EPA Est. No.**

KEEP OUT OF REACH OF CHILDREN

WARNING/AVISO

CARAMBA fungicide label

(fungicide for management of Fusarium Head Blight)

- The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
- Systems must use a metering pump, such as a positive displacement injection pump (e.g. diaphragm pump), effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
- Allow sufficient time for pesticide to be flushed through all lines and all nozzles before turning off irrigation water. A person knowledgeable of the chemigation system and responsible for its operation, or under supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.
- **DO NOT** connect an irrigation system used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.

Specific Instructions for Public Water Systems:

Application Instructions

Apply **Caramba® fungicide** according to the rate, timing, resistance management and adjuvant use instructions in the disease-specific use directions (**Table 2. Caramba® fungicide Crop-specific Instructions**) in this label.

Caramba may be applied by ground sprayer, aerial equipment, or through sprinkler irrigation equipment. Equipment should be checked frequently for calibration.

Ground Application

Apply **Caramba** ≥ 5 gallons/acre. Thorough coverage of foliage, blooms, and fruit is required for optimum disease control. The use of a nonionic surfactant at the lowest labeled rate may be used to improve spray coverage. Refer to the adjuvant product label for specific use directions. For ground application to corn, refer to the **Adjuvant or Crop Oil Use Limitations on Corn**. **DO NOT** use adjuvants that contain methylated seed oil, crop oil concentrate, or crop oil with emulsifier properties.

1/8 of ONE page

CARAMBA fungicide label

(fungicide for management of Fusarium Head Blight)

"**Ground Application**

Apply Caramba in ≥5 gallons/acre. Thorough coverage of foliage, blooms, and fruit is required for optimum disease control. The use of a nonionic surfactant at the lowest labeled rate may be used to improve spray coverage."

CARAMBA fungicide label

(fungicide for management of Fusarium Head Blight)

"**Ground Application**

`16y

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Broadcast application

	HERBICIDES			FUNGICIDES		INSECTICIDES		
	SOIL APPLIED	POST-EMERGENCE CONTACT	POST-EMERGENCE SYSTEMIC	CONTACT	SYSTEMIC	CONTACT	SYSTEMIC	DRIFT MANAGE-MENT
Turbo TeeJet® Reference page 5		VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD
Turbo TeeJet® at pressures below 30 PSI (2.0 bar) Reference page 5	GOOD	GOOD	EXCELLENT	GOOD	EXCELLENT	GOOD	EXCELLENT	VERY GOOD
Turbo TwinJet® Reference page 14	GOOD	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	VERY GOOD
Turbo TwinJet® at pressures below 30 PSI (2.0 bar) Reference page 14	VERY GOOD	VERY GOOD	EXCELLENT	VERY GOOD	EXCELLENT	VERY GOOD	EXCELLENT	EXCELLENT
Turbo TeeJet® *Induction* Reference page 9	EXCELLENT		EXCELLENT		EXCELLENT		EXCELLENT	EXCELLENT
Air Induction Turbo TwinJet® Reference page 15	VERY GOOD	GOOD	EXCELLENT	GOOD	EXCELLENT	GOOD	EXCELLENT	EXCELLENT
XR, XRC TeeJet® Reference pages 10–11		EXCELLENT	GOOD	EXCELLENT	GOOD	EXCELLENT	GOOD	GOOD
XR, XRC TeeJet® at pressures below 30 PSI (2.0 bar) Reference pages 10–11	GOOD	GOOD	VERY GOOD	GOOD	VERY GOOD	GOOD	VERY GOOD	VERY GOOD
AIXR TeeJet® Reference page 6	VERY GOOD	GOOD	EXCELLENT	GOOD	EXCELLENT	GOOD	EXCELLENT	EXCELLENT
AI, AIC TeeJet®	VERY GOOD	GOOD	EXCELLENT	GOOD	EXCELLENT	GOOD	EXCELLENT	EXCELLENT
TwinJet® Reference page 16		EXCELLENT		EXCELLENT		EXCELLENT		
DG TwinJet® Reference page 18	VERY GOOD	VERY GOOD	EXCELLENT	VERY GOOD	EXCELLENT	VERY GOOD	EXCELLENT	VERY GOOD
Turbo FloodJet® Reference page 19	EXCELLENT		VERY GOOD		VERY GOOD		VERY GOOD	EXCELLENT
TurfJet® Reference page 22	EXCELLENT		EXCELLENT		EXCELLENT		EXCELLENT	EXCELLENT
QCTF Turbo FloodJet® Reference page 21	EXCELLENT							EXCELLENT
AirMatic AirJet® Contact your regional sales office for additional information	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT

Note: Consult the chemical manufacturer's product label for specific rate and application recommendations.

Nozzle catalogs indicate the type of nozzle best for a given application type

Says: "EXCELLENT"

Is it excellent for **Wheat Head** Scab?

Is it excellent for **Wheat Stem** Rust ?

Is it excellent for **Aphids** on Soybeans?

Is it excellent for **White Mold or Rust** on soybeans?

Questions not addressed adequately by equipment and pesticide manufacturers:

- How to achieve “uniform coverage”?
- What is the recommended “percent coverage”?
- How much pesticide deposit is required for adequate control of the pest?
- How does target canopy characteristics influence pesticide deposition and coverage on specific parts of the plant?
- Does choice of nozzle or droplet size affect biological efficacy?
- Does spraying with air assistance improve deposition and coverage?

Objectives of Multi-year Wheat Research in Ohio

Overall Goal:

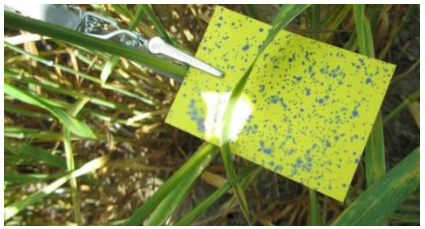
Provide Ohio wheat growers recommendations on selection of application equipment for effective treatment of various wheat diseases.

2 studies conducted

Study 1

Evaluation criteria:

- **Artificial targets**
  (coverage data)

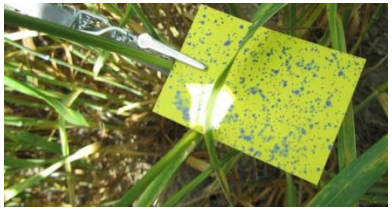


- **Efficacy**

Study 2

Evaluation criteria:

- **Artificial targets**
  (coverage data)



- **Plant samples**
  (deposition data)

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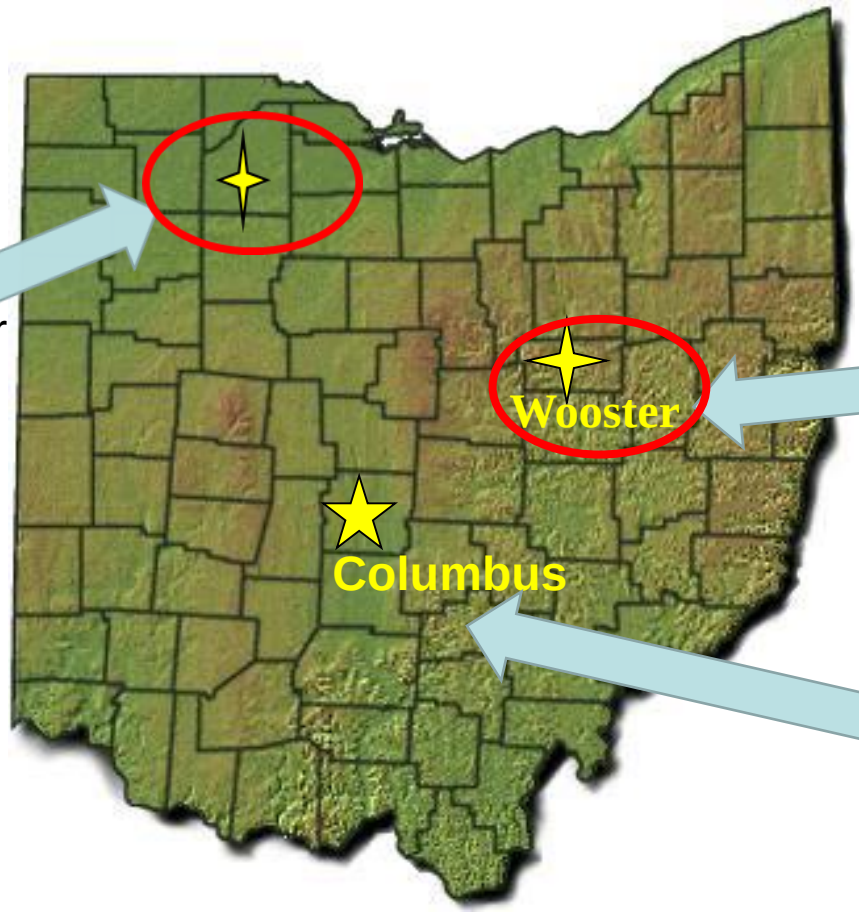
College of Food, Agricultural, and Environmental Sciences

Study 1
Research Center
(Hoytville)



Study 2
Wooster Campus
(OARDC)

Main Campus

Objectives – Study 1

General Objective:

Determine which nozzle(s) will provide the most efficacious delivery of fungicides to wheat head for protection against wheat head scab and other spike diseases.

Specific Objective:

Determine the influence of spray quality, nozzle type, and nozzle configuration on penetration of droplets into wheat canopy, and uniformity of spray distribution on various plant parts.

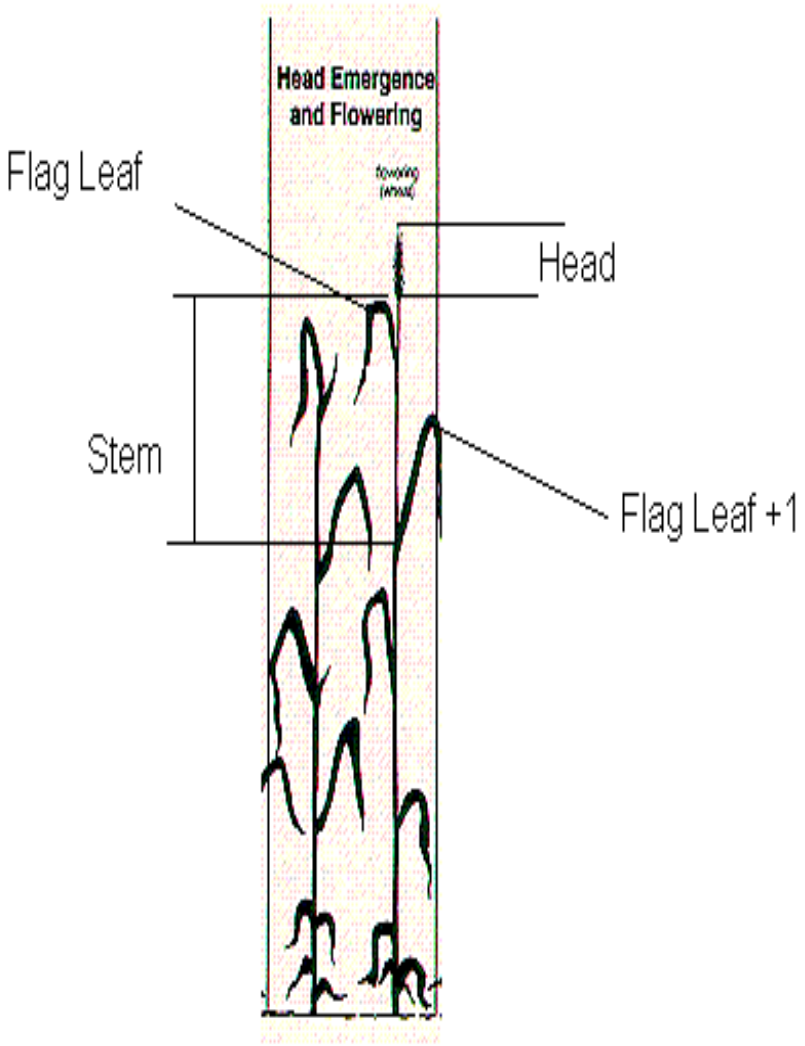
Study 1

Location: **Northwest Ohio (Hoytville)**

Samples: **Water sensitive paper**
Representing coverage on:
Head, Flag leaf, Flag leaf+1

Sprayer: **Conventional Boom**

Treatments: **Select nozzles**
+
Efficacy evaluation



Study 2 Experiments

Experiment #1:

Determine effectiveness of various nozzles and operating conditions using a conventional boom sprayer on spray deposition on wheat plant parts.

Objective is similar to that of Study 1

Except:

- With more treatments (more nozzles)
- Actual plant parts collected in addition to using water sensitive papers
- No efficacy trials

Location: **Northeast Ohio (Wooster)**

Samples: **Water sensitive paper**
(to determine coverage)
&
Actual plant parts
(Flag leaf, Flag leaf+1)
(to determine deposition)

Sprayers: **Conventional Boom**
(No air assistance)

Treatments:
--- Select nozzles

Study 2 Experiments

Experiment # 2:

Determine effectiveness of various nozzles and air assistance on spray deposition on wheat plant parts.

Location: **Northeast Ohio (Wooster)**

Samples: **Water sensitive paper**
(to determine coverage)
&
Actual plant parts
(Flag leaf, Flag leaf+1)
To determine deposition

Sprayers: **Air-assisted sprayer**

Treatments:
--- Select nozzles
--- Air assisted sprayer operations

Study 1 and Experiment 1 of Study 2

Questions to be addressed:

- **Which spray quality is the best ?**
  - Fine ?
  - Medium ?
- **What type of flat-fan nozzle is the best?**
  - Single flow ?
  - Double flow (forward and backward)?
- **If a double flow nozzle is chosen, does spray angle affect coverage and deposition?**

Study 2- Experiment 2

What we wanted to learn:

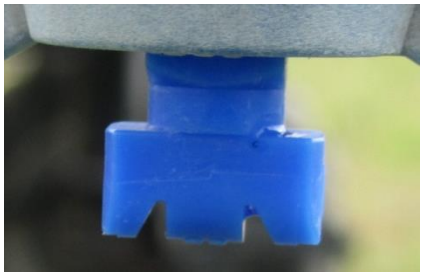
- **Does droplet size matter if we use air assistance** (fine vs. medium)?
- **Does air-flow rate matter** (low, medium, high)?
- **Does angling the boom matter** when using air assistance (straight down vs. 30 deg. forward)
- **Does application rate matter** when there is air assistance? (10 gpa vs. 15 gpa)

Single flow Flat-fan (XR 8003)
Medium spray quality

Single flow Flat-fan (XR 11003)
Fine spray quality

TwinJet (TJ 11003)
(Fine spray quality)

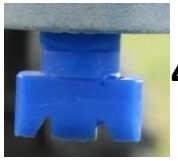
STUDY 1 Treatments



Turbo Twinjet (TTJ 11003)
Coarse spray quality

Turbo Teejet Duo (TT 110015)
Medium spray quality

STUDY 1 Treatments

		Spray Pressure (psi)		Nozzle Height (in)	Droplet size (µm) $D_{V0.1}$	$D_{V0.5}$	$D_{V0.9}$
(1) XR8003 conventional (Medium spray quality)		40		22	90	213	415
(2) XR11003 conventional (Fine spray quality)		40		20	84	183	346
(3) TwinJet 11003 (Fine spray quality)		40		18	77	160	292
(4) Turbo TwinJet TTJ-11003 (Coarse spray)		40		18	124	250	574
(5) Turbo TeeJet Duo (two TT nozzles TT110 015; Medium spray quality)		40		12	104	218	434

Application Rate: 15 gpa **Travel speed: 6 mph**

LOCATION OF TARGET HOLDER STAKES in PLOTS

Total 24 Plots

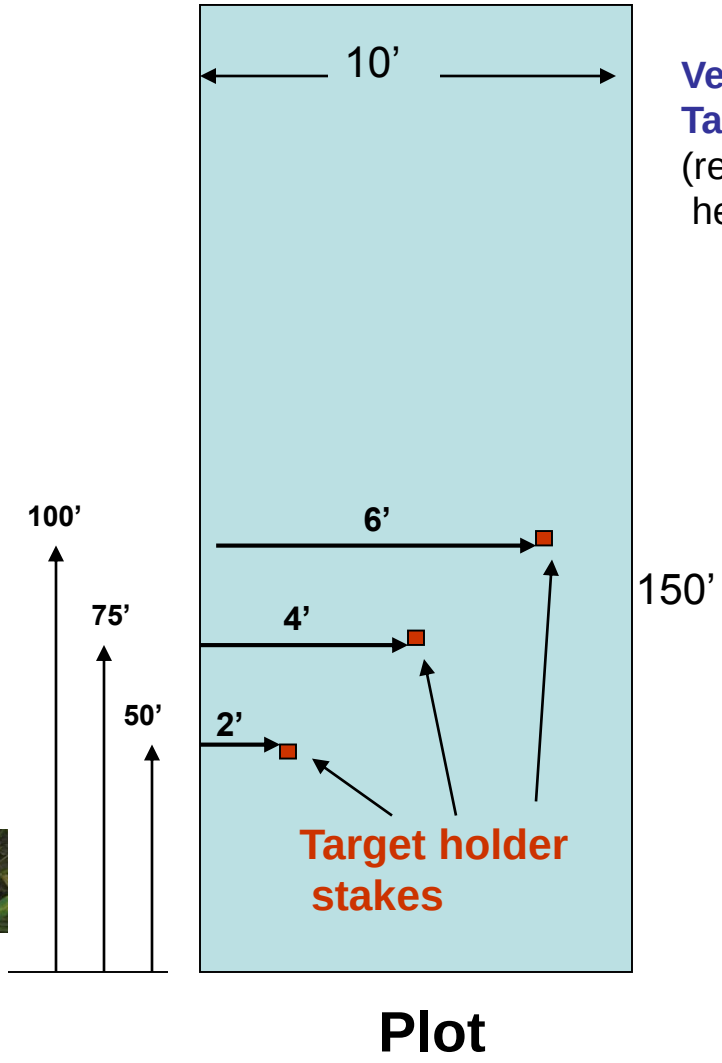
- 5 treatments
- Control
- 4 reps (Blocks)

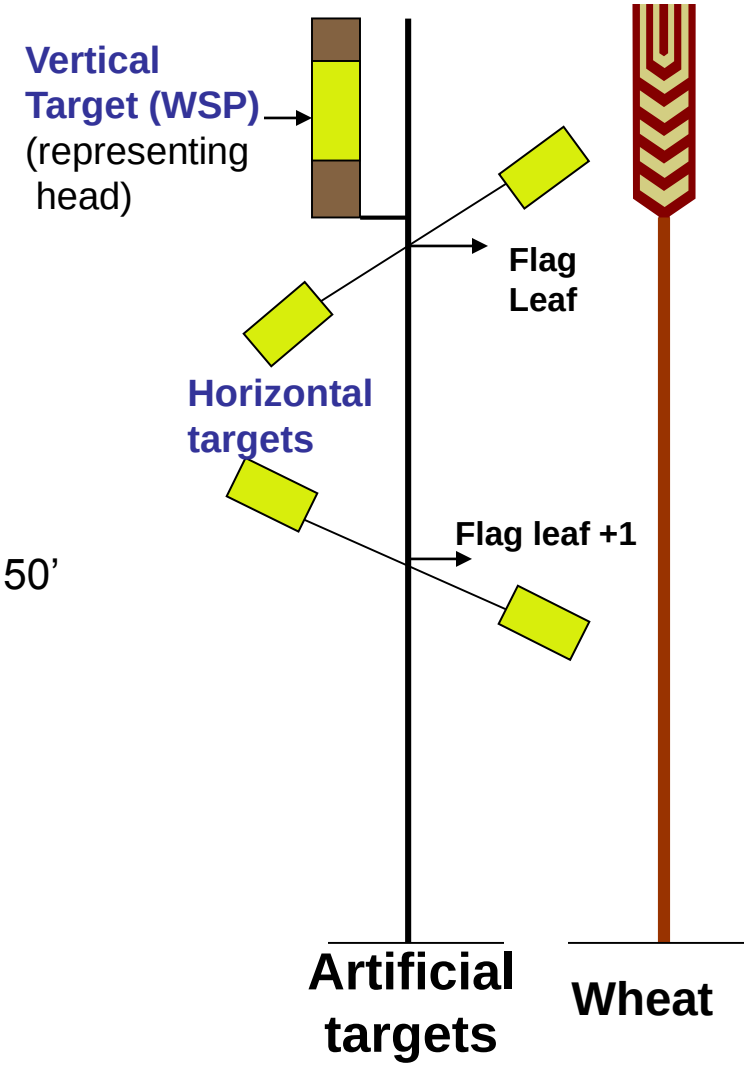
Total 60 stakes

- 5 treatments
- 4 reps (Blocks)
- 3 stakes / plot

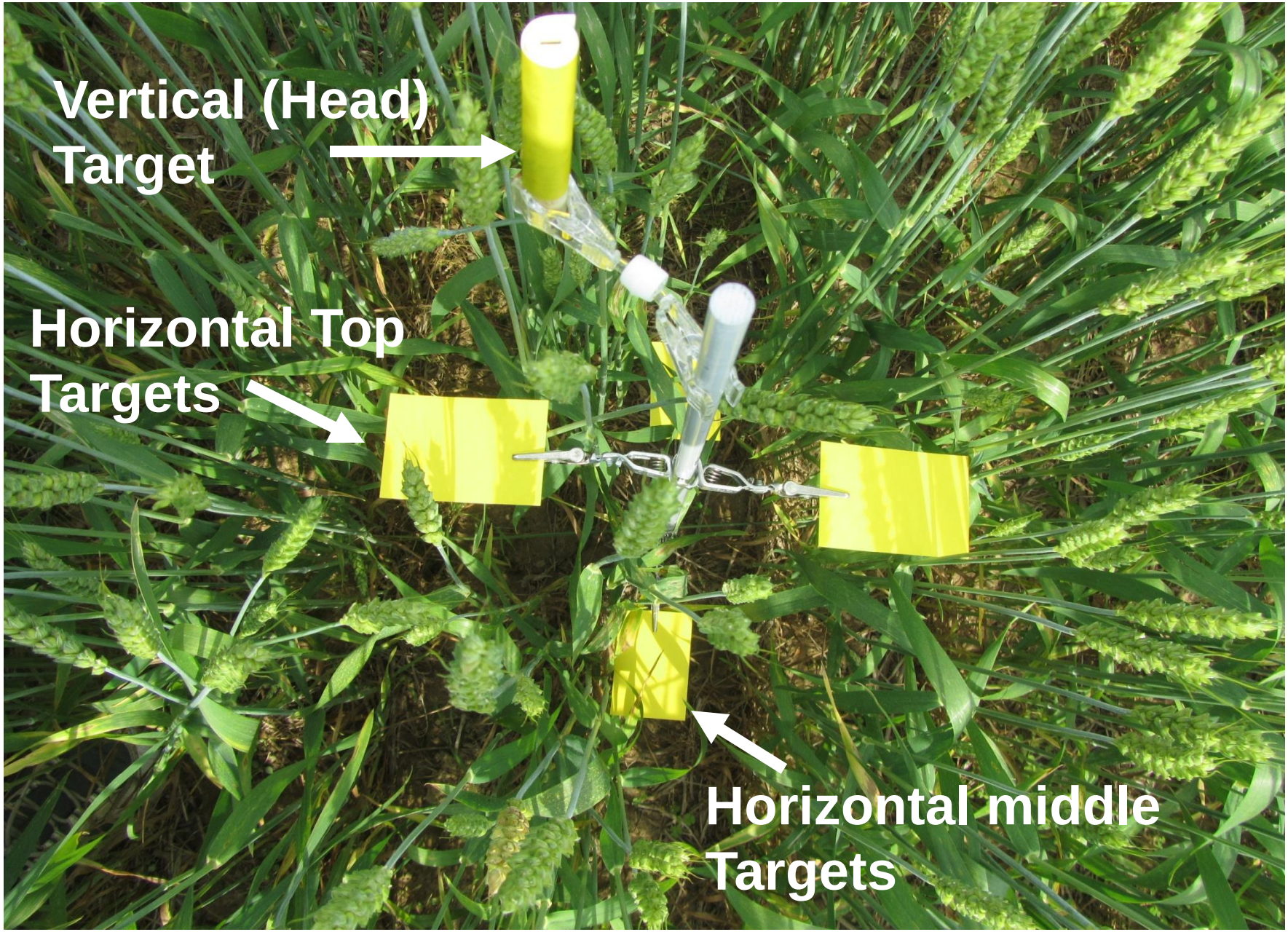
Total 300 cards (WSP)

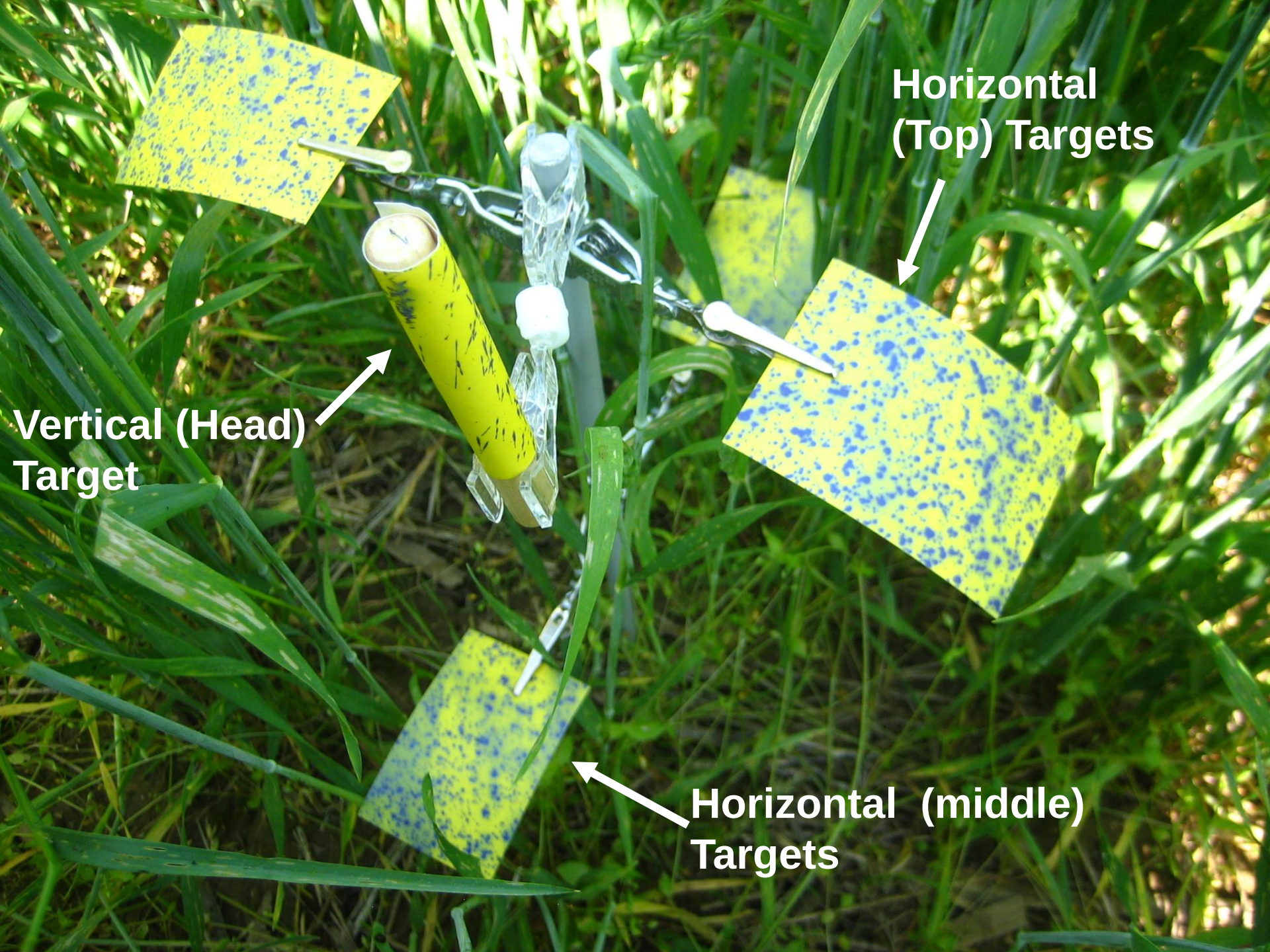
- 60 stakes
- 5 cards per stake






OHIO STATE
PHS
CHEERLEADER


Vertical (Head) Target
Horizontal Top Targets
Horizontal middle Targets


Horizontal
(Top) Targets
Vertical (Head)
Target
Horizontal (middle)
Targets

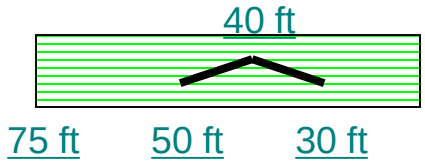

Mycogen


PHS
CHEERLEADER
T5R2

"DepositScan"

http://www.ars.usda.gov/mwa/wooster/atru/depositscan

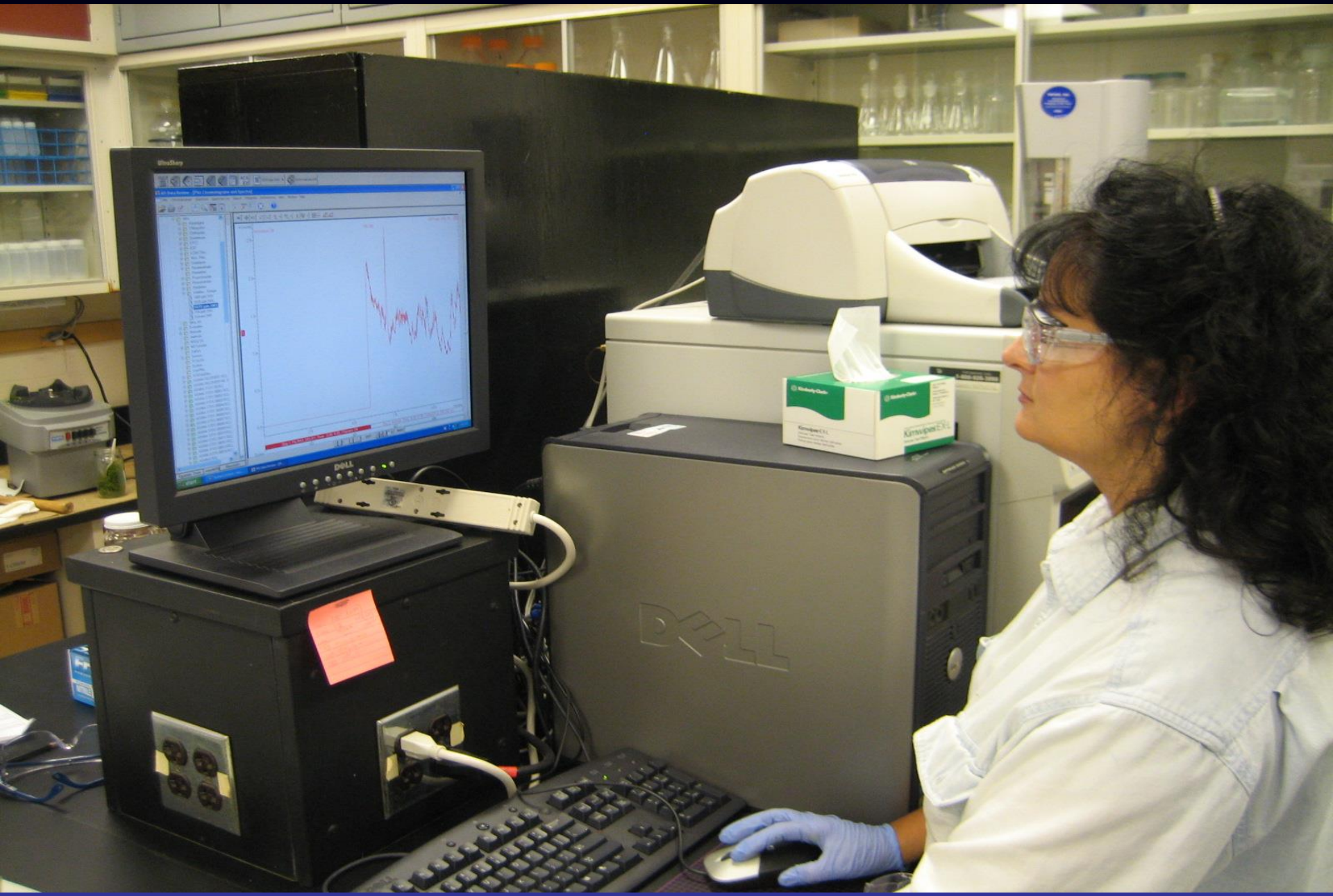
Collection of plant samples– STUDY 2



Collect (Cut) 10 plants per plot
(diagonally, V pattern)
Total: 360 plants

Cut and place following parts in separate jars:

- Heads
- Flag Leaf
- Stem (between flag leaf and flag leaf+1)
- Flag leaf +1


DELL
DELL

Study 2 Experiments

Experiment #1:

Determine effectiveness of various nozzles and operating conditions using a conventional boom sprayer on spray deposition and coverage on wheat canopy.

NO AIR for all Experiment 1 treatments.

Experiment #2:

Comparison of air assisted sprayers with conventional no-air spraying.

- Same sprayer in Experiment 1, but with air assistance on
- All nozzles have single pattern

STUDY 2
Experiment #1 treatments

1) **XR-8002** flat-fan (Fine spray @42 psi; 4 mph, 15 gpa
2) **XR-8004** flat-fan (Medium spray @31 psi; 7 mph, 15 gpa)
3) **XR-8005** flat-fan (Coarse spray @20 psi, 7 mph, 15 gpa)
4) **TJ60-8004** Twin Jet (Medium spray @31 psi; 7 mph, 15 gpa)
5) **TTJ-11004** Turbo TwinJet (Medium spray @31 psi, 7 mph, 15 gpa)
6) **XR-8004** flat-fan (Coarse spray @31 psi; 7 mph, 15 gpa; 30 degree spray
   (same as Treatment #2; with 30 degree spray angle)
7) **XR-8004** flat-fan (Medium spray @31 psi); 7 mph, 15 gpa; 60 degree spray
   (same as Treatment #2; with 60 degree spray angle)
8) **XR-8003** flat-fan (Medium spray @ 24 psi); 7 mph, 10 gpa
9) **XR-8004** flat-fan (Medium spray @ 54 psi); 7 mph, 20 gpa

Experiment 2 treatments

1) **XR8003** (medium drops @24 psi, 7, mph, 10 gpa, **NO AIR**)
2) **XR110025** (Fine drops @34 psi, **Low air flow**, 7 mph, 10 gpa)
3) Same as Experiment 2, except **air flow: Medium**.
4) Same as Experiment 2, except **air flow: High**
5) **XR110025** @34 psi (fine drops) (Treatment #1; except Fine drops);
6) **XR8003** @24 psi (Same as #3; but droplet size is medium)
7) **XR8003** @24 psi (medium drops), Air flow rate: medium; 7 mph, 10 gpa; **Boom angle- 30 degrees forward**
8) **XR8004** @31 psi (medium drops); 7 mph, 15 gpa (same as #2 Except: medium drops, 15 gpa and **NO AIR**)
9) **XR8004** @31 psi (medium drops), Medium air flow, 7 mph; 15 gpa (same as Treatment 2 in Study 1 with air)

RESULTS

Efficacy ?

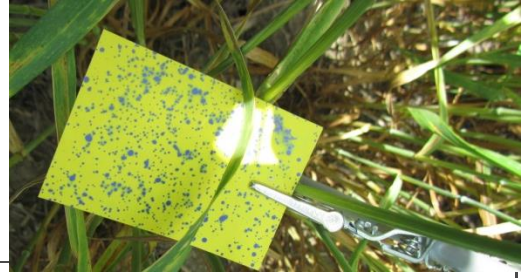
Results-- Coverage

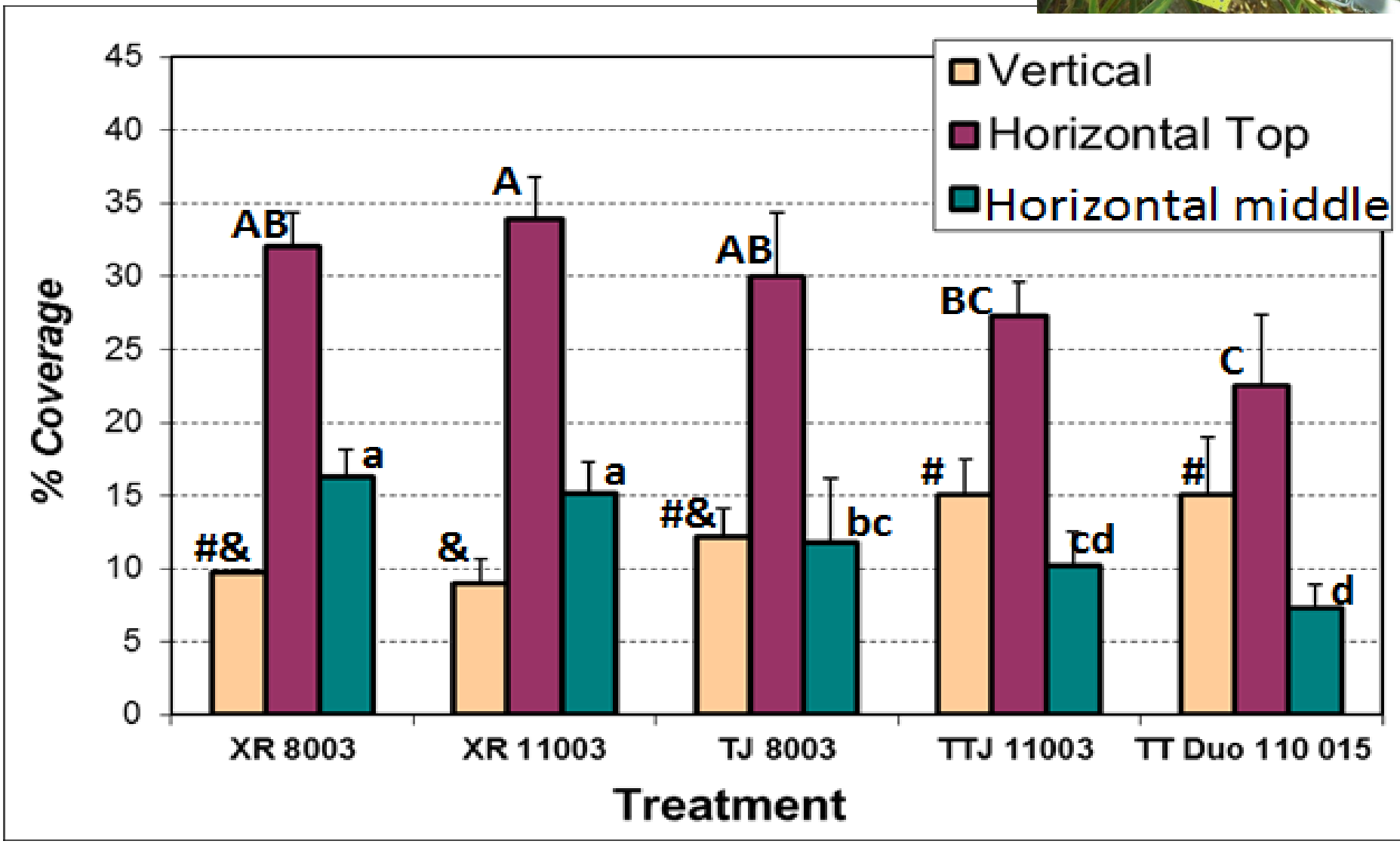
- **Across all treatments, in all three years, the mean percent spray coverage varied :**

5–15%	vertical targets
18–35%	horizontal top
8–28%	horizontal middle

.

% Coverage- 2009



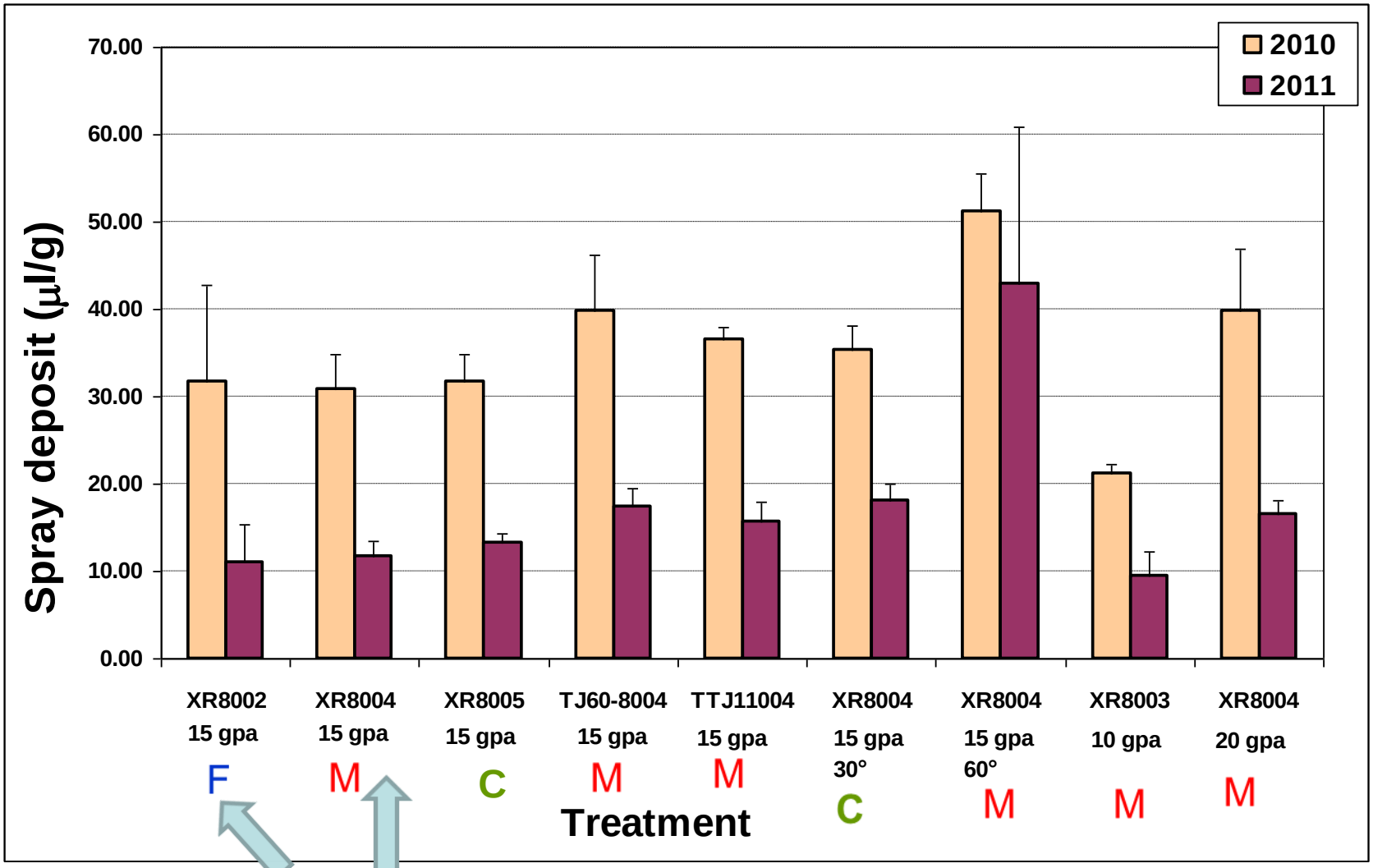


RESULTS– Deposition

(plant parts analyzed for deposition)

Volume of Spray on Heads at stage of growth 10.5

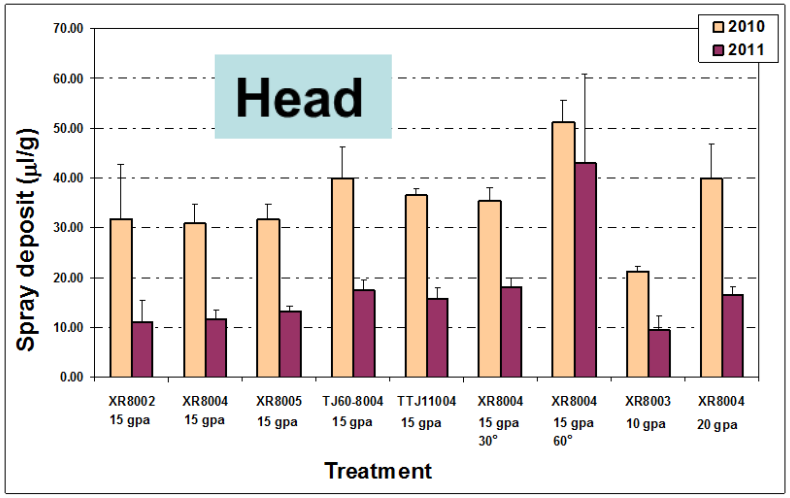
Study 2, **Experiment 1** (No air assistance)



Droplet size class: **M**: Medium, **F**: Fine, **C**: Coarse

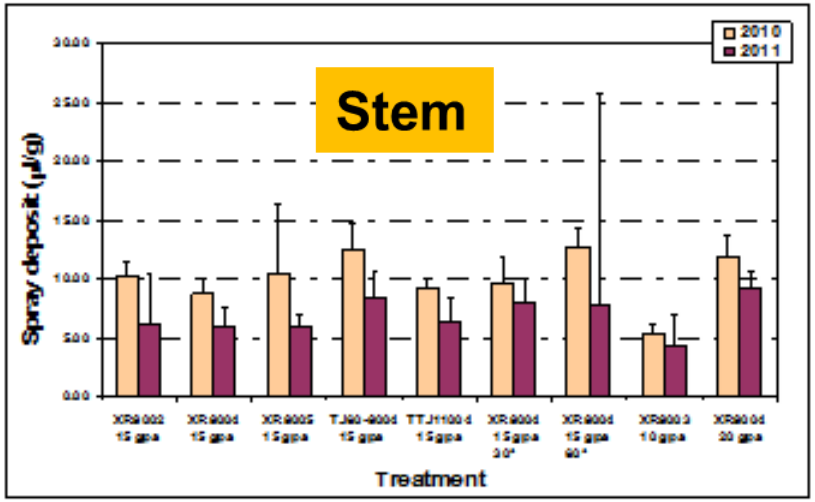
Volume of Spray on Heads at stage of growth 10.5

Experiment 1



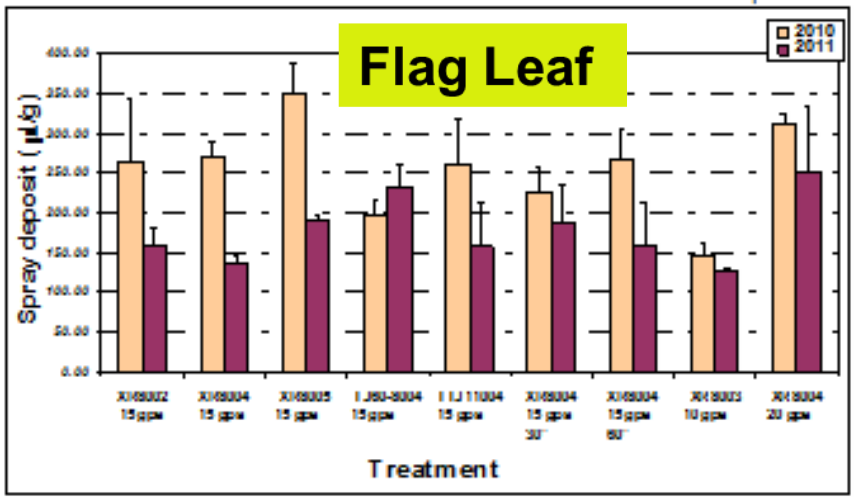
Volume of Spray on Stems at stage of growth 10.5

Experiment 1



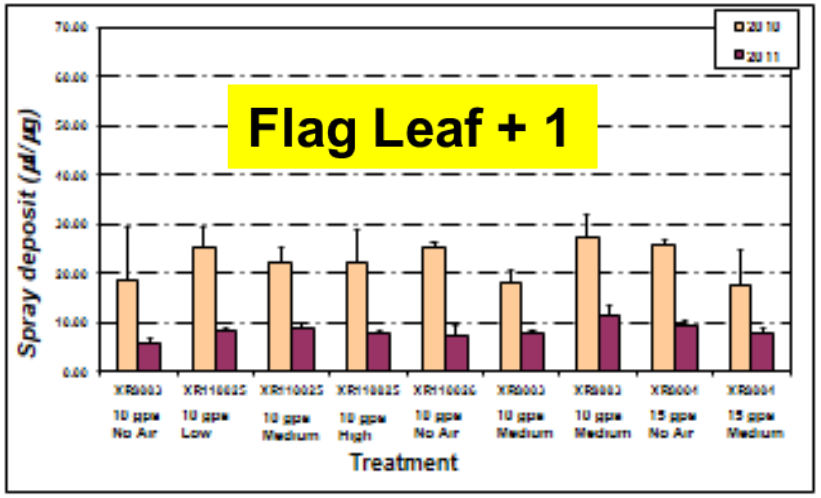
Volume of Spray on Flag leaf at stage of growth 10.5

Experiment 1



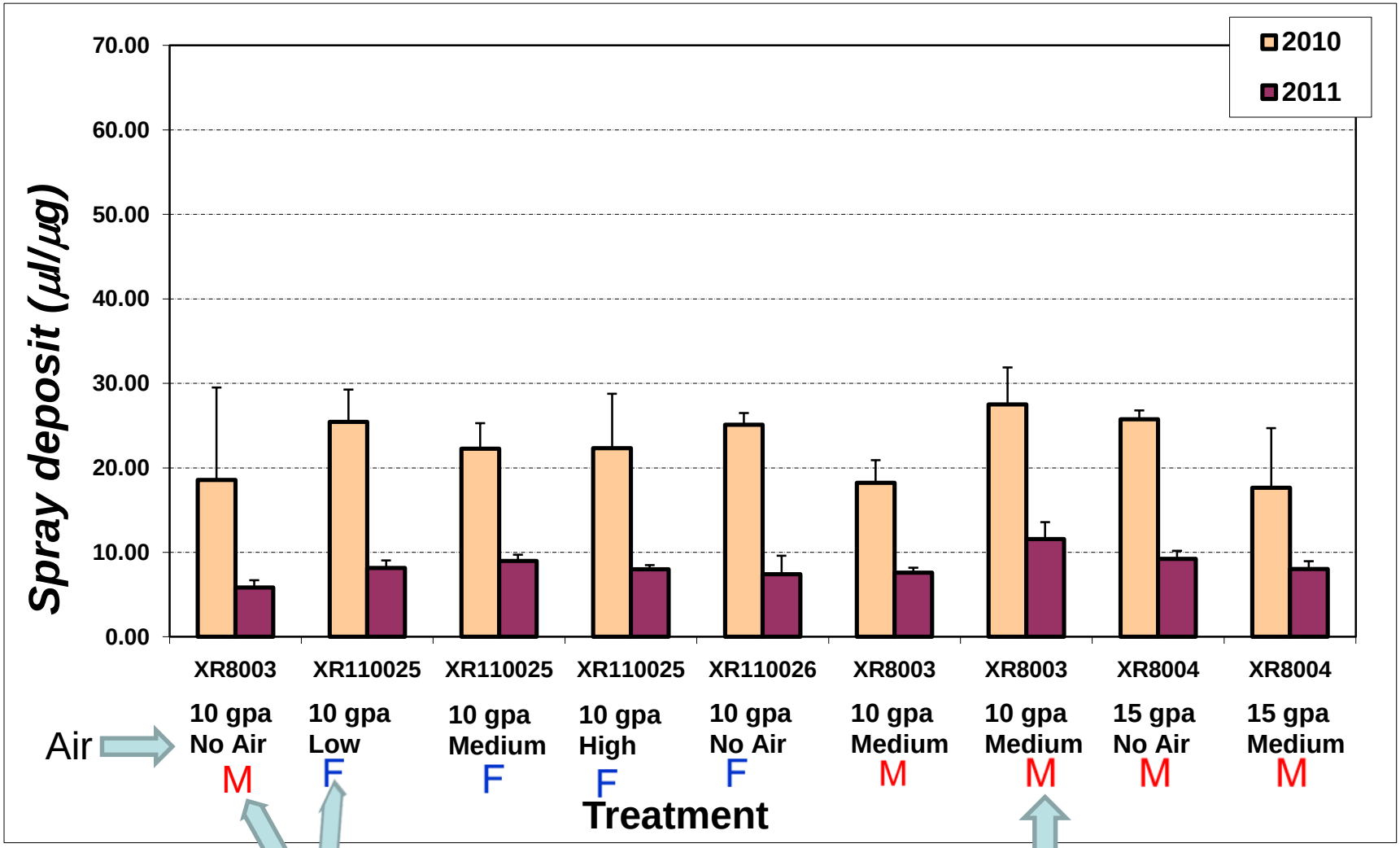
Volume of Spray on Heads at stage of growth 10.5

Experiment 2



Volume of Spray on Heads at stage of growth 10.5

Experiment 2 (With Air assisted sprayer)



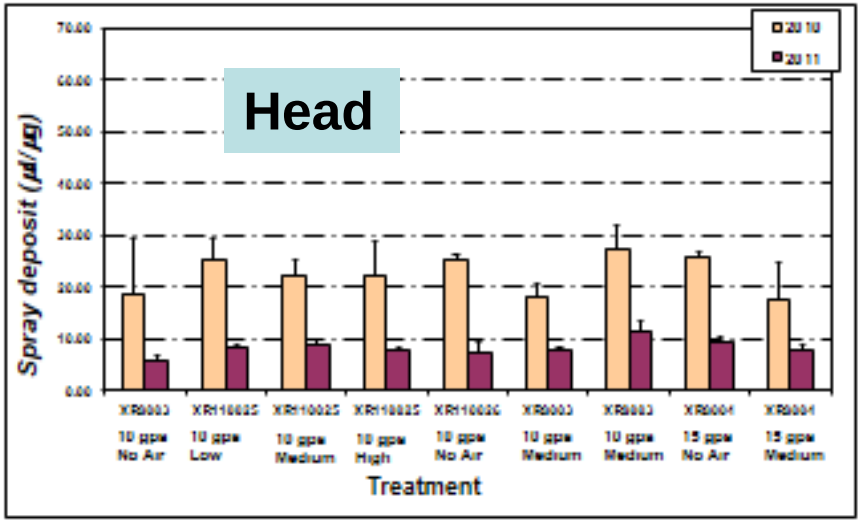
Droplet size class: **M**: Medium, **F**: Fine

Spray angle: 30 degr. forvard

Effect of Air on Deposition of Chemicals

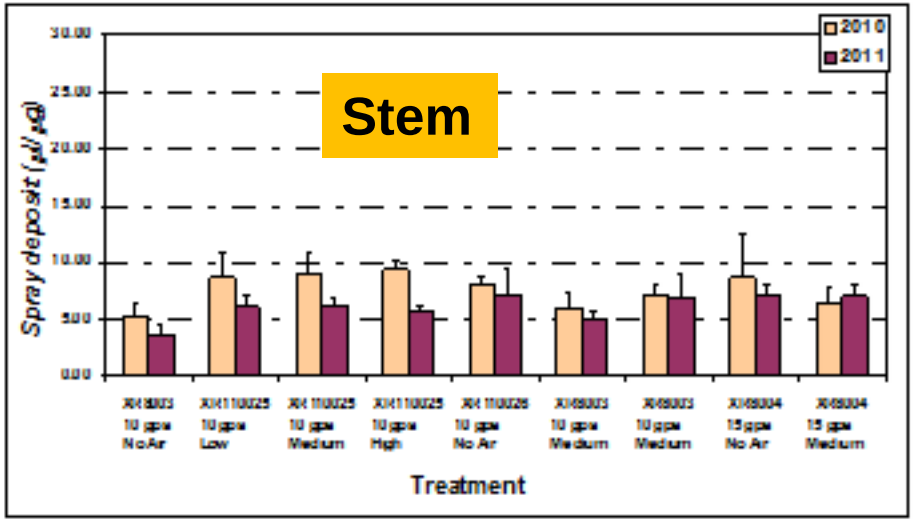
Volume of Spray on Heads at stage of growth 10.5

Experiment 2



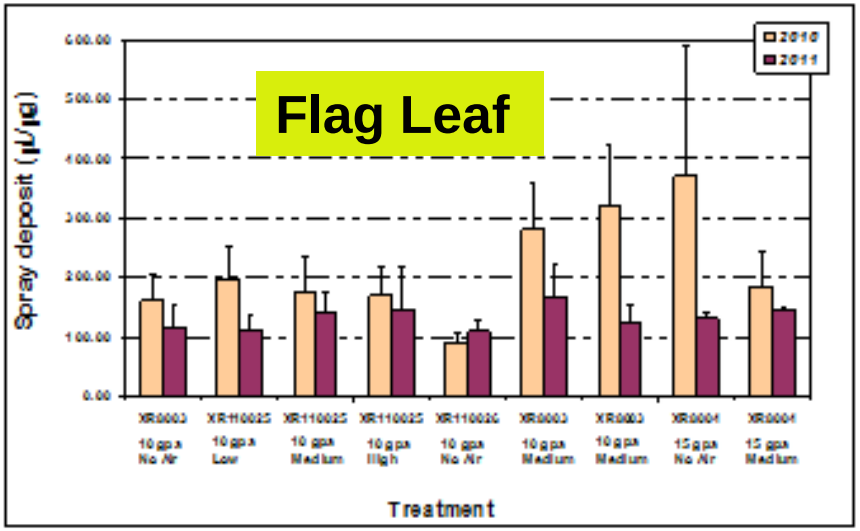
Volume of Spray on Stems at stage of growth 10.5

Experiment 2



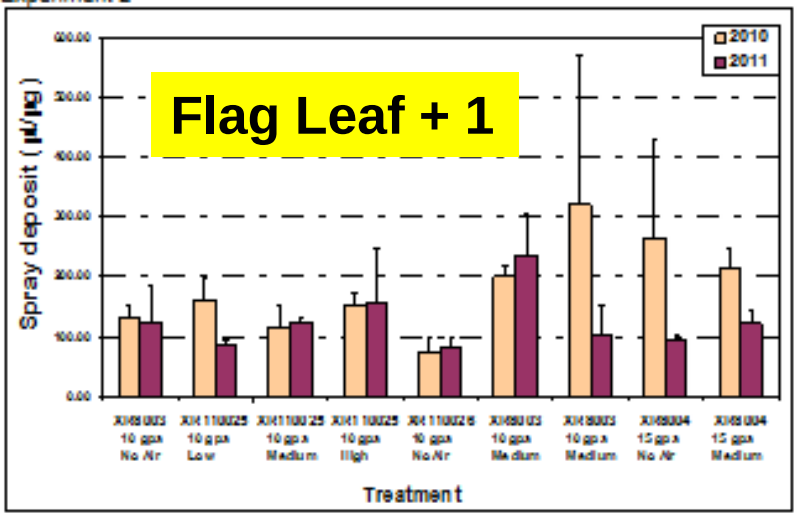
Volume of Spray on Flag leaf at stage of growth 10.5

Experiment 2



Volume of Spray on Flag leaf +1 at stage of growth 10.5

Experiment 2



What did we learn ?

Questions to be addressed:

Which spray quality provides better coverage (single flow nozzles)**?**

- Fine
- Medium

Answer: (3 year comparison)

Head: No significant difference (medium is slightly better)

Horizontal Top (Flag leaf): No significant difference

Horizontal Middle (Flag leaf+1)**:** No significant difference

With Air assistance

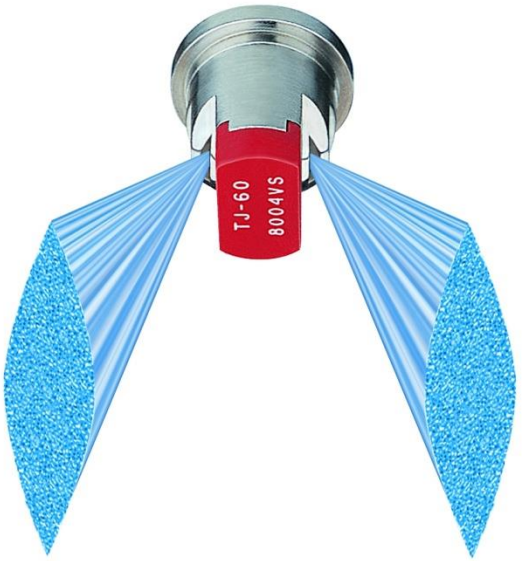
Does spray quality matter in COVERAGE?

(Fine, Medium or Coarse?)

- **YES** - for all plant parts
- **Fine** produced significantly higher coverage than Medium or Coarse regardless of the plant parts.
- No significant difference between Medium or Coarse regardless of the plant parts.

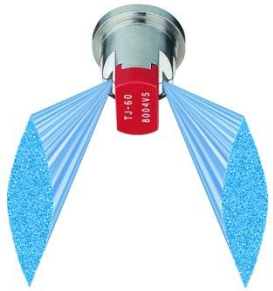
Questions to be addressed:

- **What type of flat-fan nozzle is better for coverage** (No air assistance)?
  - Single flow
  - Double flow (forward and backward)



Results

- Nozzles with twin-fan spray patterns had higher spray coverage than single flow pattern nozzles on **vertical** targets representing wheat head.

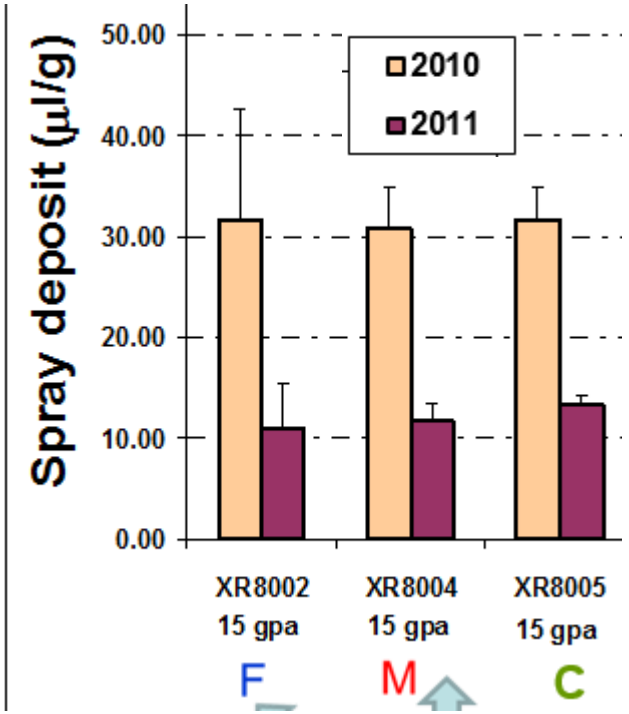


- However, single-flow pattern nozzles produced slightly higher coverage on horizontal **top and middle** targets than the twin-flow nozzles.

Does spray quality matter in DEPOSITION?

(Fine, Medium or Coarse?)

- **No** – if the disease is on the wheat HEAD (such as head scab)



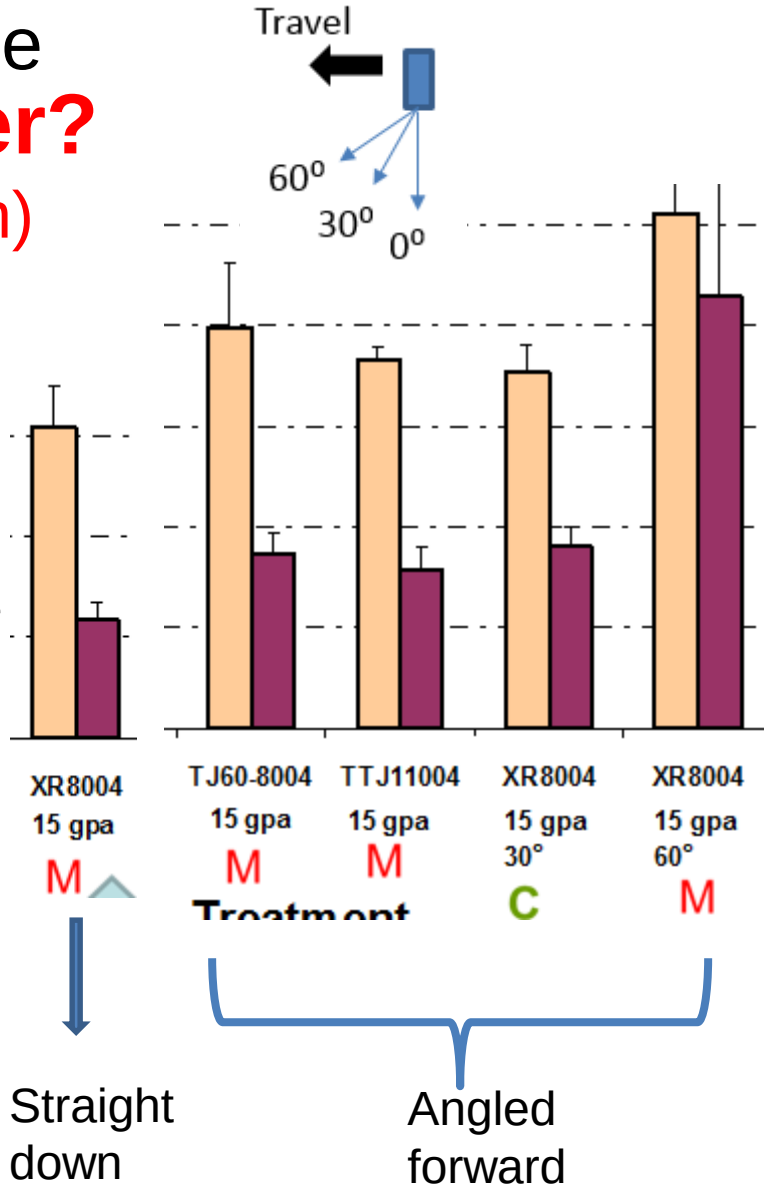
No Air Assistance

Does spray angle matter?

(Vertical vs. Forward Orientation)

- **YES -** Forward orientation is significantly better for HEAD.
  - 60° is significantly better than 30°.

- Generally lower deposition and coverage on other plant parts when using angled spray.
  - Greater the angle, the lower the coverage and deposition on leaves.

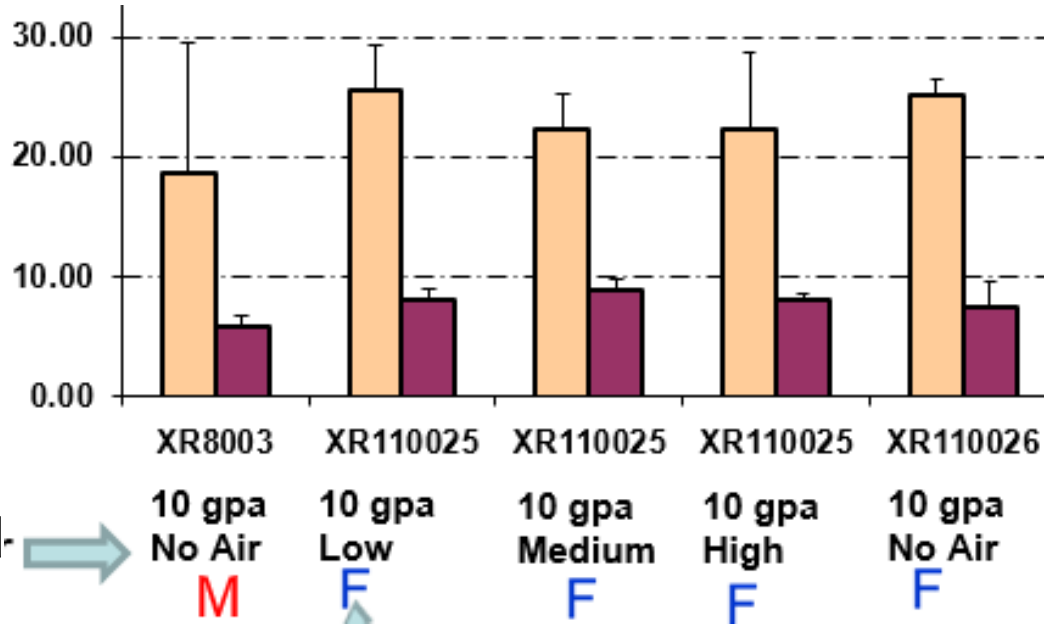


Does fan speed setting matter in COVERAGE?
(NO AIR vs. AIR – Low, Medium, High)

- **YES** - if the disease is on the wheat Head (such as Head scab) or on Flag Leaf.
- Faster fan speeds tended to produce higher coverage on the Head and Flag Leaf targets.
- No statistical difference between Air and No-Air for Flag Leaf+1.

Does fan speed setting matter in DEPOSITION?
(NO AIR vs. AIR – Low, Medium, High)

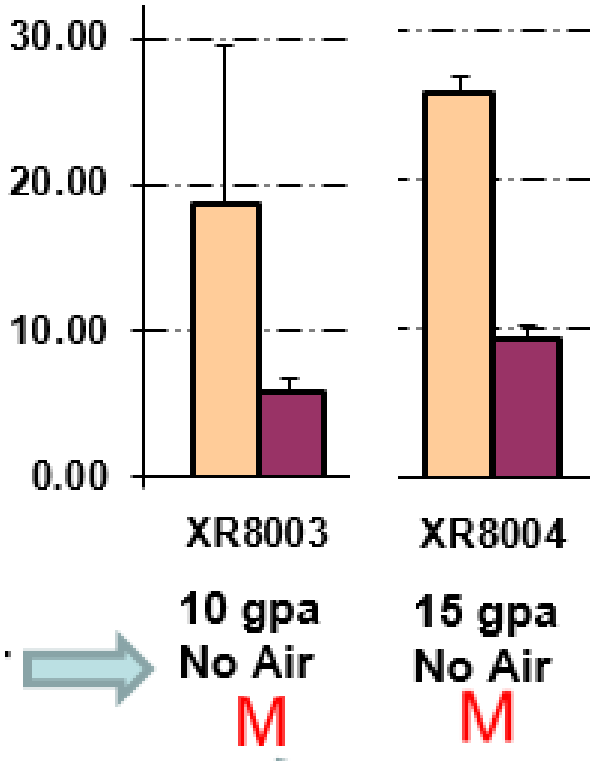
- **No** – if the disease is on the wheat HEAD (such as head scab)
- **YES** - for all other plant parts.
- No statistical difference between Low, Medium, and High fan speed, but to treat Flag Leaf, Low-air seems to be the best choice.



Without air assistance

Does application rate matter in DEPOSITION on wheat head?

Increased deposition with higher gallonage



Overall Conclusions

- **Different pathogens tend to cause infection on different plant parts (head, leaves, or stem) .**

Conclusions

- Different pathogens tend to cause infection on different plant parts (head, leaves, or stem) .

- **Effective spray delivery to a specific part of the plant where the disease is located, is the key to protecting wheat from that particular disease.**

Conclusions

- **Application equipment (sprayer type, nozzle, spray quality) best suited to control one type of wheat disease may not be the best to control another type.**

Conclusions

- Application equipment (sprayer type, nozzle, spray quality) best suited to control one type of wheat disease may not be the best to control another type.
- **Nozzles with twin-fan spray patterns should be chosen to control diseases that occur on upper parts of the plant, while the single flow pattern nozzles should be chosen to control diseases on lower parts of the plant.**

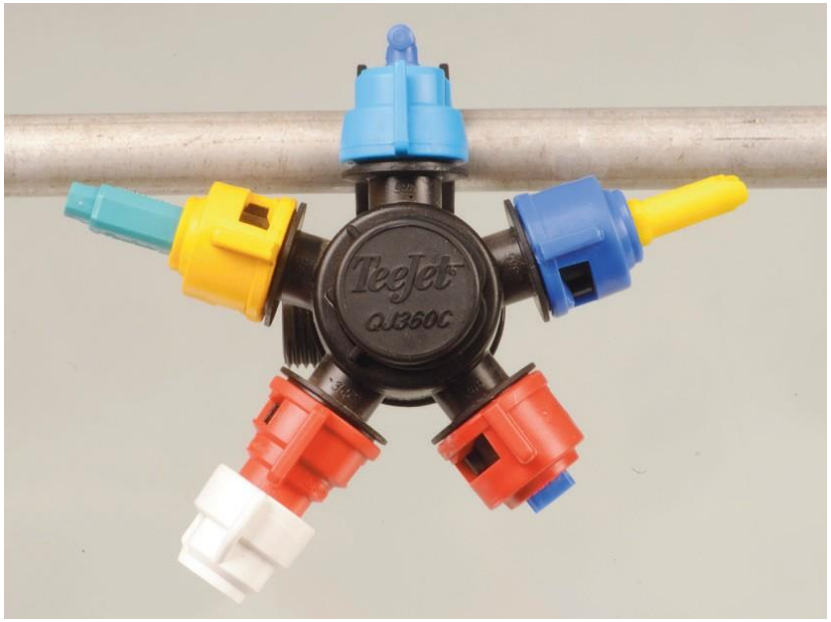
This is what droplets would “see” when they are landing:

Conclusions

- Since there seems to be no clear advantage of using **fine** spray quality, nozzles producing **medium** spray quality should be used, especially when spray drift is a concern.

Final recommendation:

- **Have plenty of nozzle types and sizes on the boom**
- **Switch to the nozzle that is best for the application conditions and target canopy characteristics**

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