Understanding Herbicide Efficacy, Movement, and Crop Response

Mandeep Singh
Agronomy Advisor
Sacramento, Solano, and Yolo Counties
University of California, Agriculture and Natural Resources
Email: mdpsingh@ucanr.edu
Phone: (530) 376-7895
Office: (530) 666-8704

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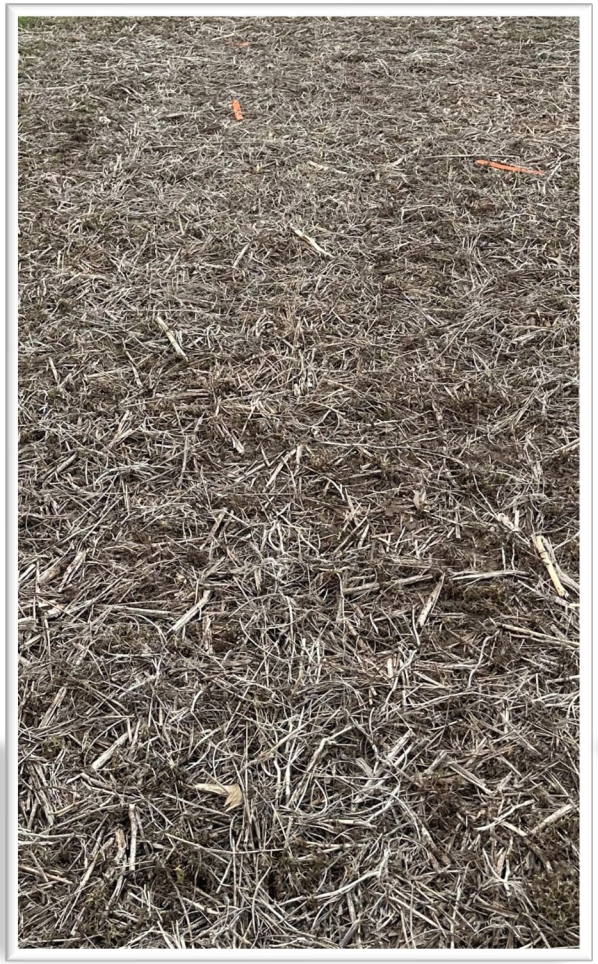
Herbicide Efficacy

Proper application

- Accurate, Uniform
- Effective weed control
- No/minimal crop injury



Herbicide Movement

PESTICIDE MOVEMENT IN THE ENVIRONMENT

Pesticides have the potential to move after they are first applied. Where they go and how long they may last can depend on many factors. The combination of the following factors influences pesticide movement.

AIR

Increasing temperature, sunlight, and rain may increase pesticide breakdown. This and other weather conditions affect the potential for pesticide movement.

ENVIRONMENTAL CONDITIONS

PLANTS

Some pesticides are not easily taken up by plants, and some plant types take up pesticides more than others.

PLANT UPTAKE

SOIL BINDING

PESTICIDE USED

PLANT TYPE

DROPLET SIZE

SMALL DROPLETS CARRY FURTHER BUT DISSIPATE FASTER

LARGE DROPLETS FALL FASTER BUT STAY ON TARGET BETTER

SOIL

Some soils hold onto pesticides more easily, or collect water so pesticides don't move as far. Bacteria, fungi, and other microbes vary across locations and soils, which can also affect pesticide breakdown.

TYPE OF PESTICIDE

SOIL TYPE

SOIL CHEMISTRY

MICROBIAL COMMUNITY

NATURAL WATER

If a pesticide does reach water, it may not move as much as you think. Some pesticides bind tightly to sediment where they settle out.

WATER TABLE HEIGHT

When the water table is shallow, pesticides may be more likely to reach it.

LAND PROFILE

SEDIMENT BINDING

WATER MOVEMENT

For more information about pesticides or their movement in the environment, contact us M-F 8am-12pm PST at 800-858-7378.

npic NATIONAL PESTICIDE INFORMATION CENTER

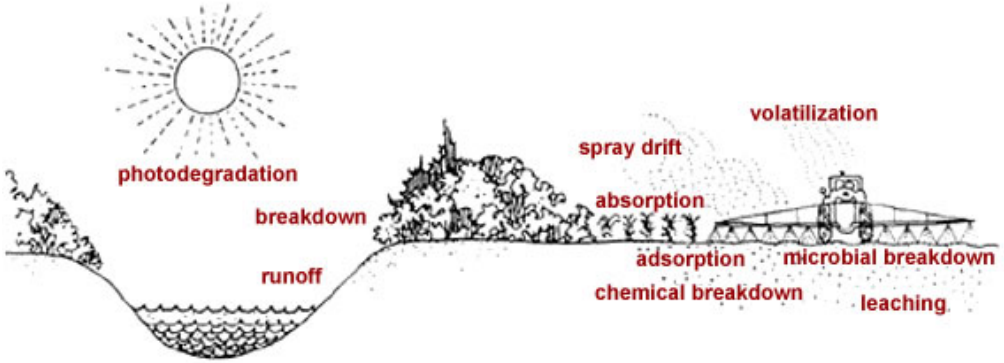


Photo Credits: Npic.orst.edu, Uku.edu

Herbicide Drift

What is it?

Physical movement of herbicide through the air during or after application, to any other unintended site

- Unintentional/unintended exposure
- Humans, animals, crops/plants, and broader environment

Photo: Pixabay.com

Herbicide Drift

Can Cost…

- Reduced weed control, waste of herbicide/money
- Injury/damage to non-target plants
- Environmental and/or food contamination, water pollution
- Unacceptable/illegal herbicide residues
- Health risks to people, animals, wildlife
- Litigation concerns, fines, administrative action

Al-Khatib (2024)

Herbicide Drift

Types

1. Particle Drift: Physical movement of **spray droplets** or dust particles
2. Vapor Drift: Movement of **vapors** (gas, fumes)

Photo: Pexels.com

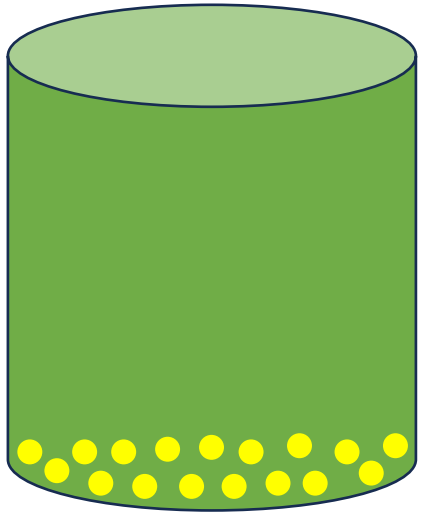
Herbicide Drift

Vapor Drift

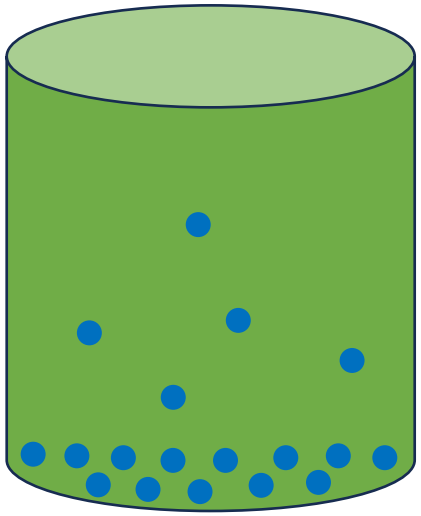
Vapor pressure

Herbicide	~Vapor Pressure (mmHg at 77F)
Clomazone (e.g., Command)	0.000144
Trifluralin (e.g., Treflan)	0.00011
Dicamba	0.0000338
2,4-D	0.000000147
Glyphosate (e.g., Roundup)	0.000000000975
Saflufenacil (e.g., Sharpen)	0.00000000000000015

Water 23.8



Saflufenacil
0.00000000000000015 mmHg
Low vapor pressure
Less volatile



Water
23.8 mmHg
High Vapor Pressure
More volatile

Credits: NPIC.orst.edu, NPIC

Herbicide Drift

Vapor Drift

Formulations

2,4-D

- 2-ethylhexyl *ester*; 0.000002 mmHg
- dimethyl*amine* salt; 0.00000000079 mmHg (less volatility)

	5 ft	10 ft	20 ft	40 ft	79 ft	157 ft
ester	64%	57%	48%	29%	13%	2%
amine	<2%	<2%	-	-	-	-
choline	<1%	-	-	-	-	-

choline salt: 0.00000014 mmHg

Data: Sysnoskie et al. (2017)

Image: Pat.unl.edu

Dicamba

- DMA salt – dimethylamine salt of dicamba
- DGA salt – diglycolamine salt of 3,6-dichloro-o-anisic acid

Credits: NPIC.orst.edu

Spray Drift

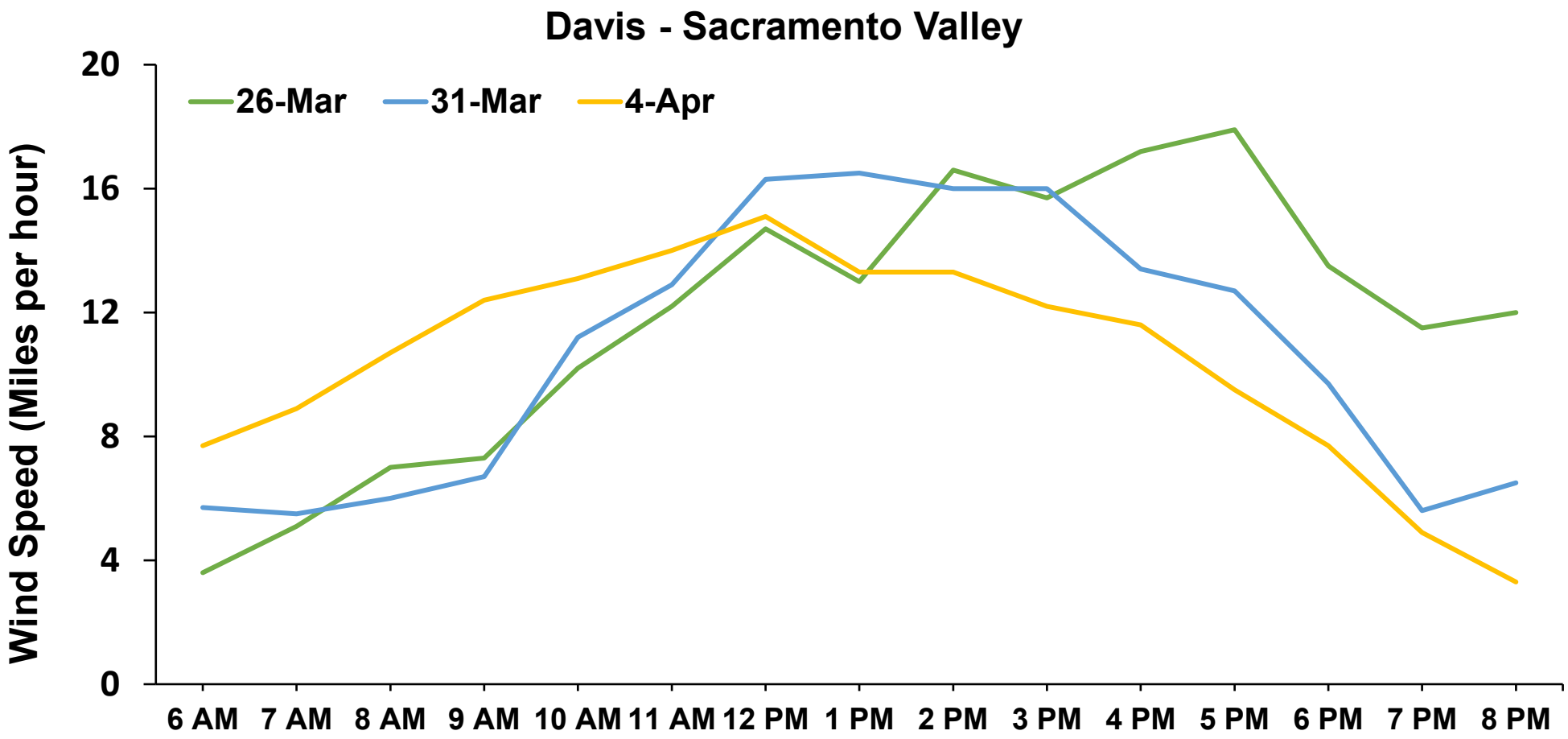
Important Factors

1. Wind Speed
2. Boom height
3. Distance from Susceptible Vegetation
4. Spray Droplet Size

Epa.gov, Kruger (2018)

Spray Drift

Wind Speed



Data: cimis.water.ca.gov

Herbicide Drift

Particle drift; Spray Droplet Size; Standard Measure; Micron

One micron = 1/1000 millimeter
= 1/25,400 inch

Degree of Atomization	Drop size (microns)	Common object comparison
Fog	Up to 20	Point of needle (25 microns)
Fine mist	20-100	Human hair (100 microns)
Fine drizzle	100-250	Sewing thread (150 microns)
Light rain	250-1000	Staple (420 microns)
T-storm rain	1000-4000	Pencil lead (2000 microns)

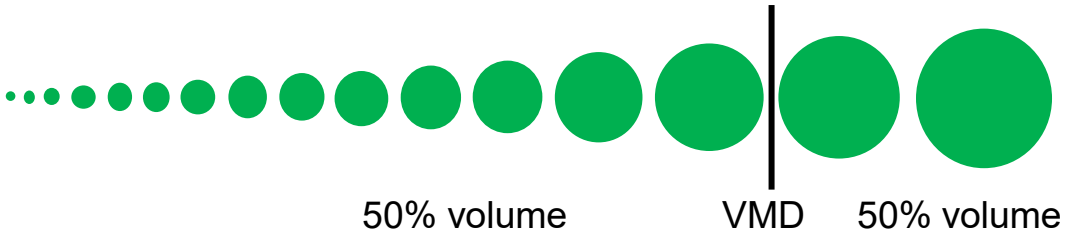
Credits: Ag.Purdue.Com

Droplet Size

Volume Median Diameter (VMD), microns (µm)

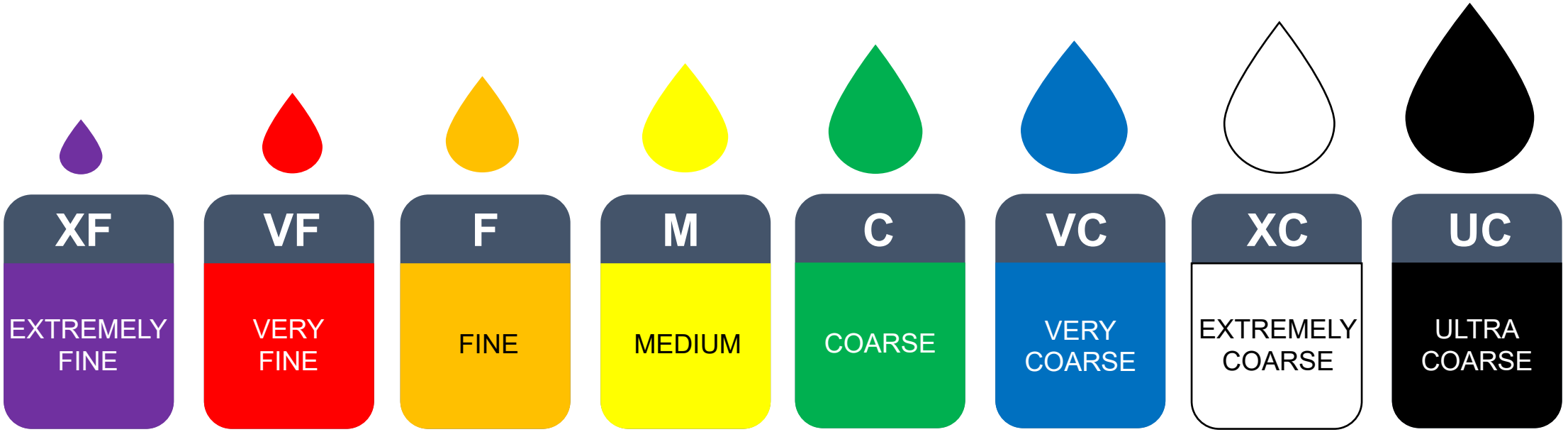
50% of the total spray volume consists of droplets **smaller** than the VMD

50% of the total spray volume consists of droplets **larger** than the VMD



Droplet Size Classification

Standard Classification



XF	VF	F	M	C	VC	XC	UC
up to 99 µm	100 µm or greater	150 µm or greater	195 µm or greater	270 µm or greater	350 µm or greater	485 µm or greater	665 µm or greater

ASABE S572.3 / ISO25358

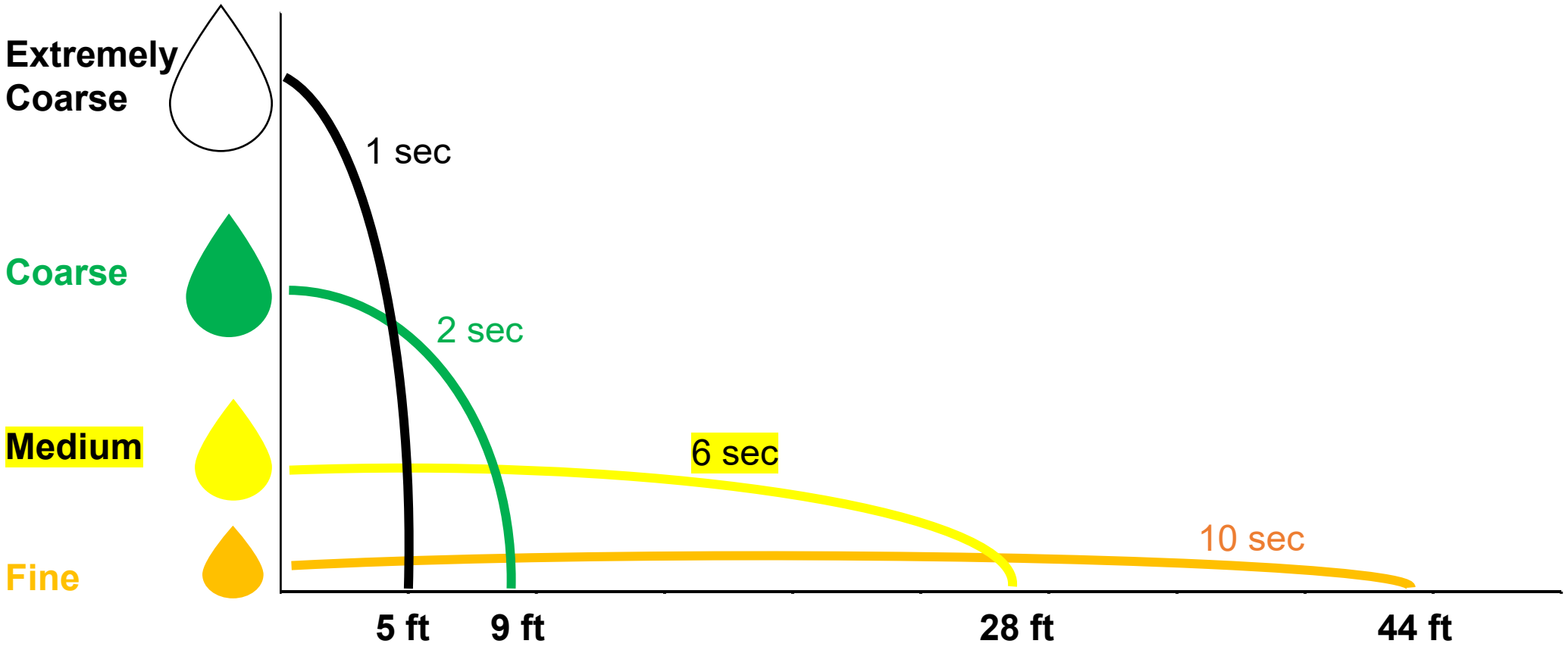
Herbicide Drift

How long will it take to fall? How far will it go?

Droplet	Width (µm)	Time to Fall 10 Feet	Travel Distance in 3mph Wind
Fog	5	66 minutes	3 miles
Very Fine	20	4 minutes	1,100 feet
Fine	100	10 seconds	44 feet
Medium	240	6 seconds	28 feet
Coarse	400	2 seconds	8.5 feet
Extremely Coarse	1,000	1 second	4.7 feet

Herbicide Drift

How long will it take to fall? How far will it go?



Montana.edu

Coverage

Droplet size, spray volume, and coverage

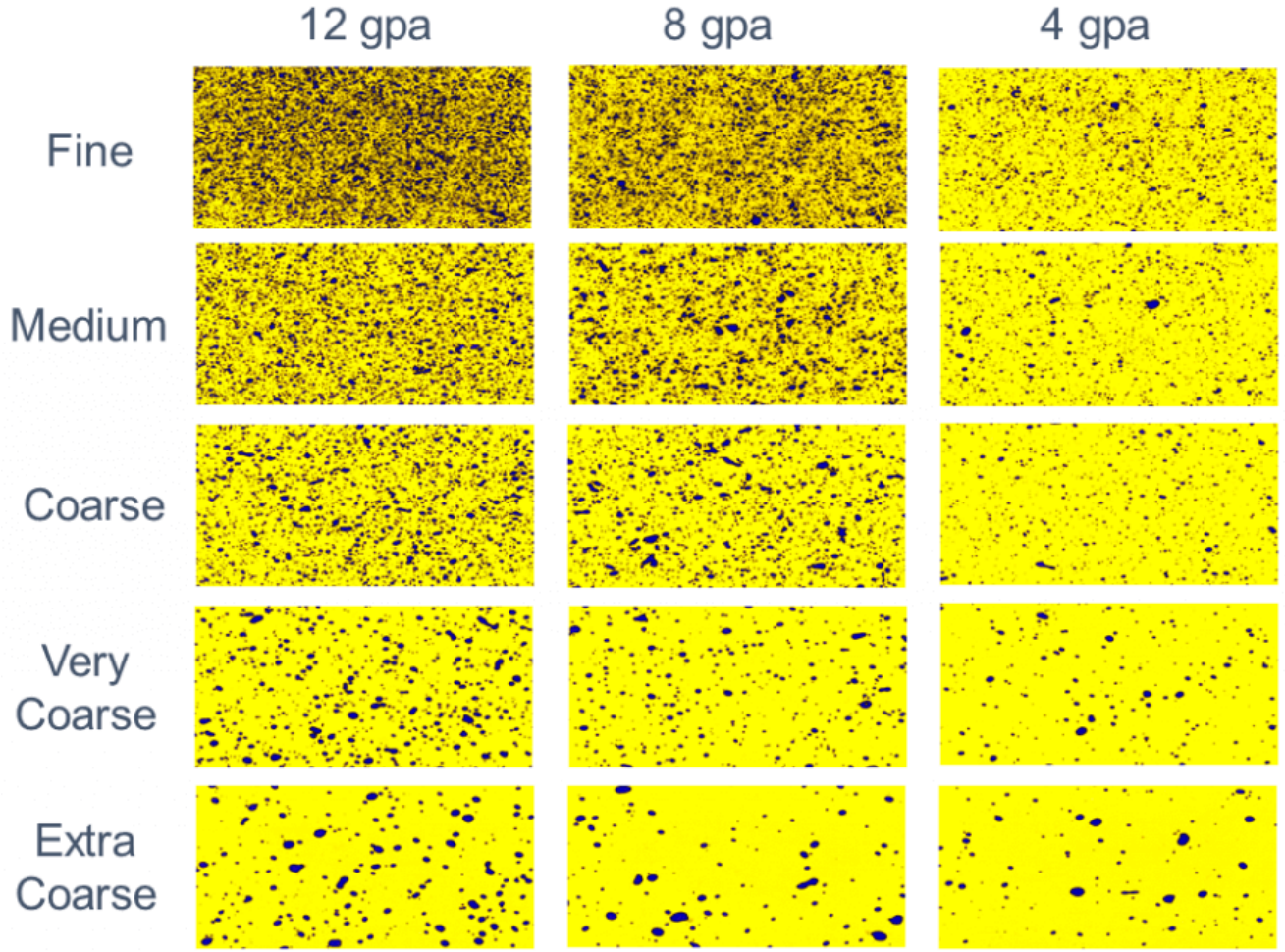
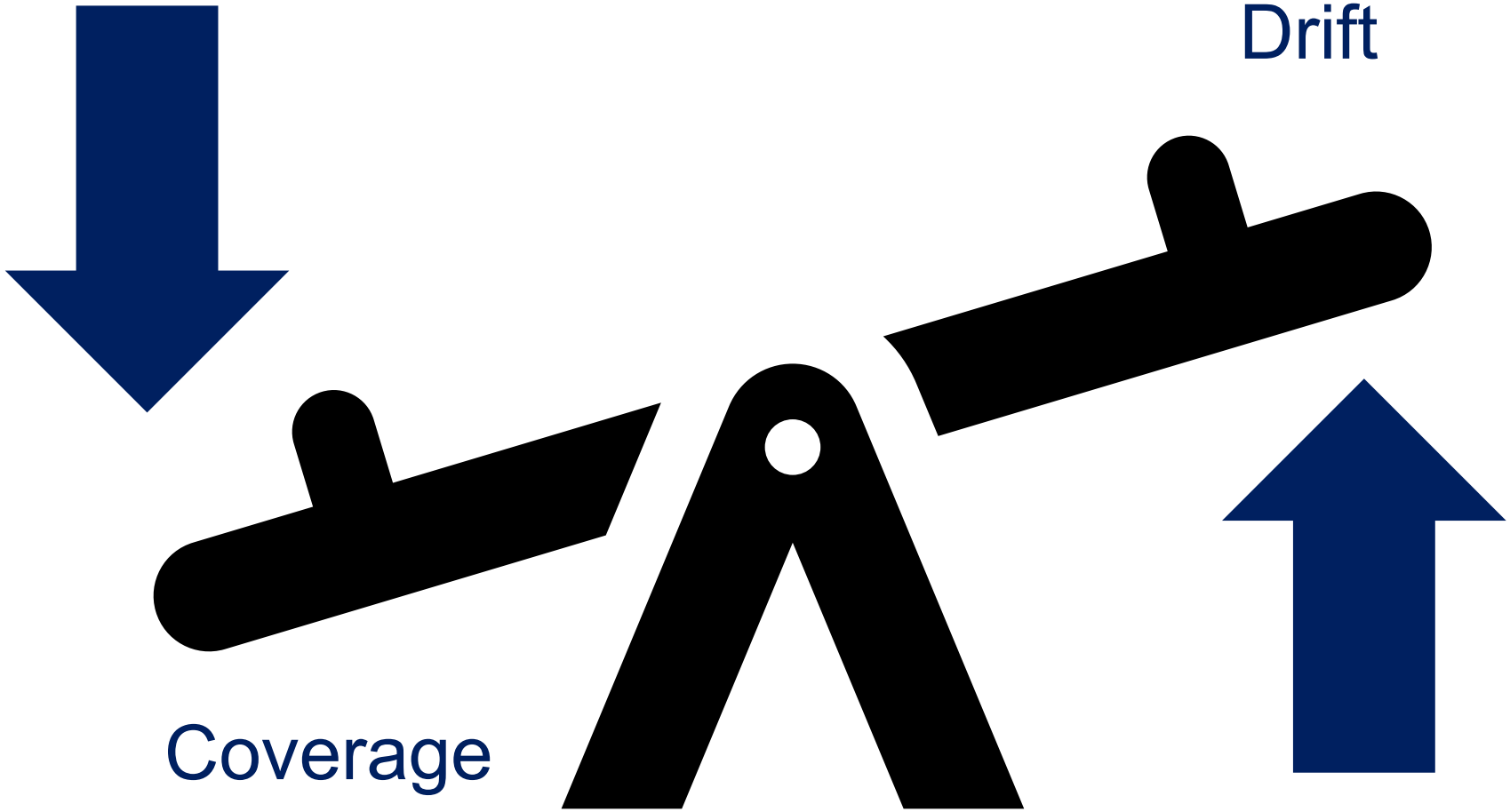


Photo: Sprayers101.com

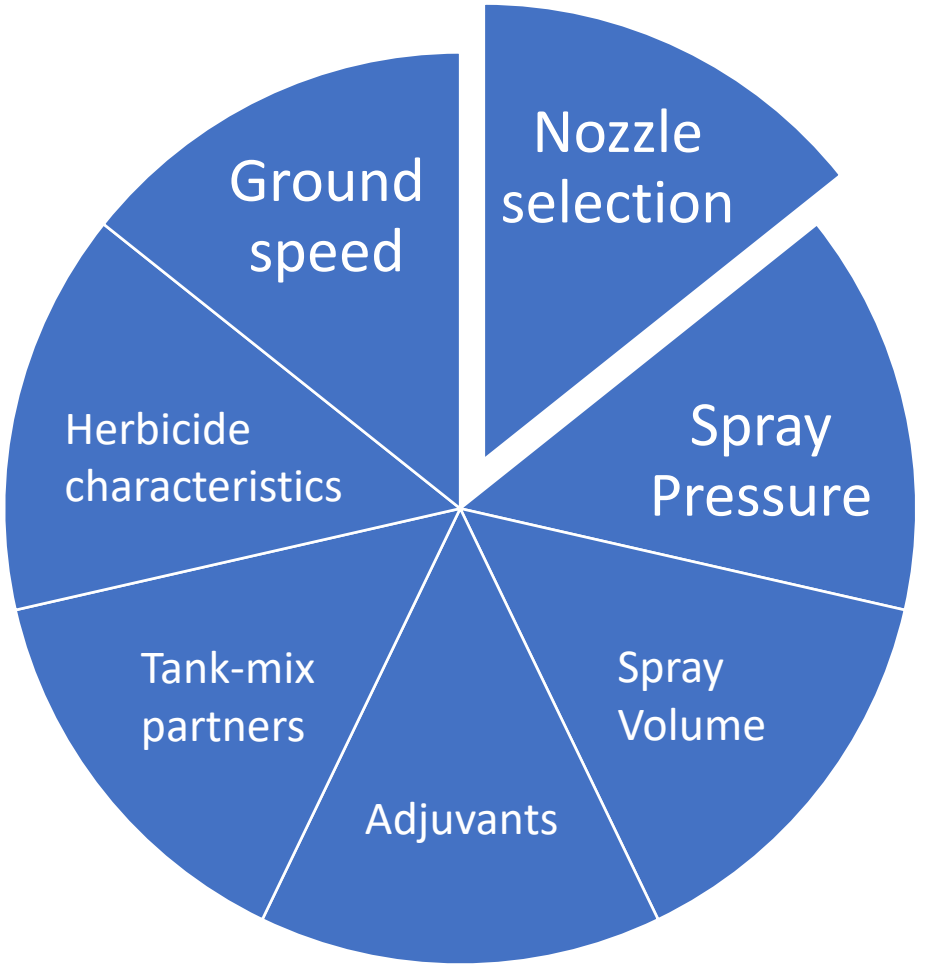
The Balancing Act



Herbicide Efficacy

Nozzle selection is important!

- Droplet Size
- Drift Potential
- Flow Rate
- Spray Pattern
- Spray Coverage/Penetration



Nozzle Information

Nomenclature

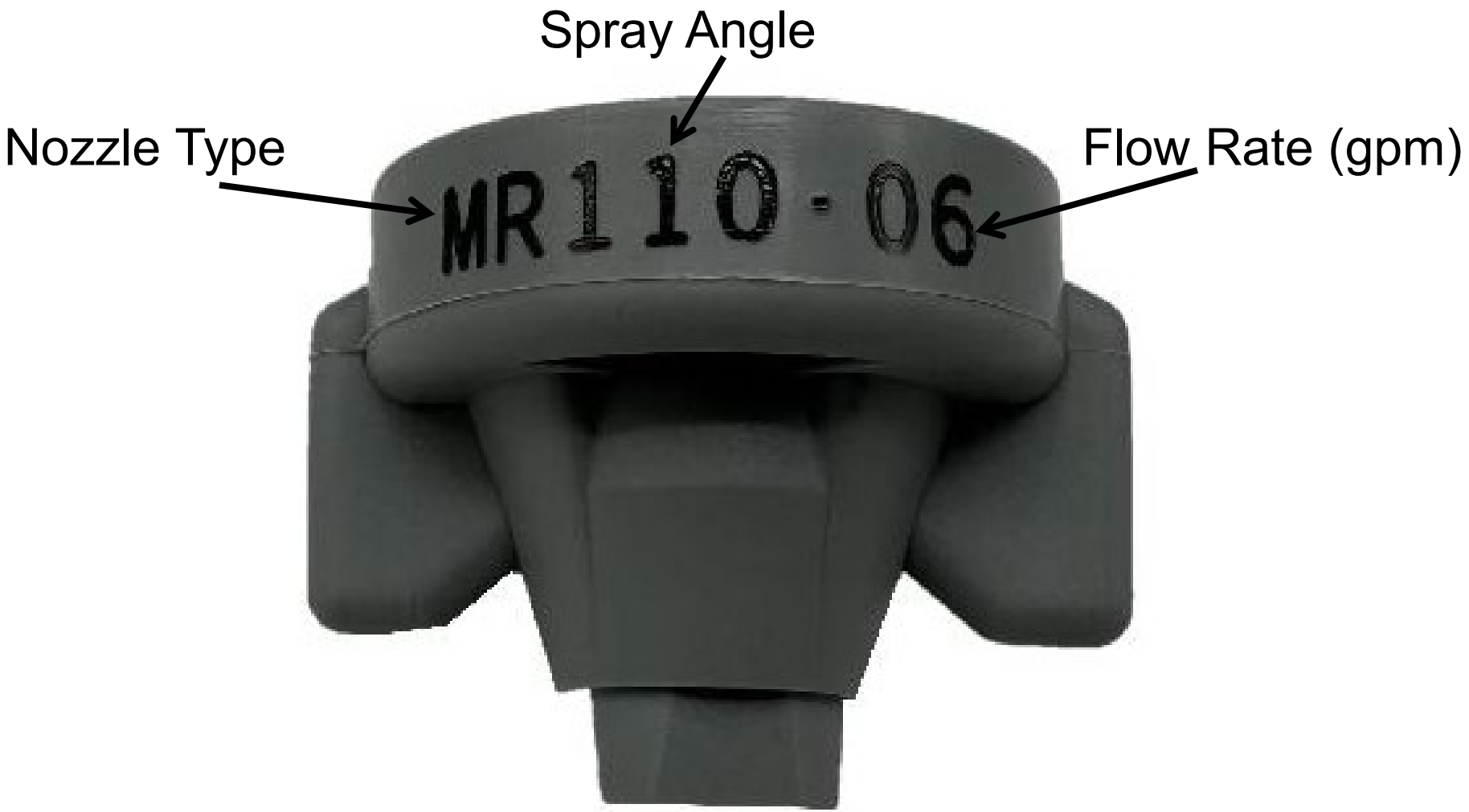


Photo: AgSpray.Com

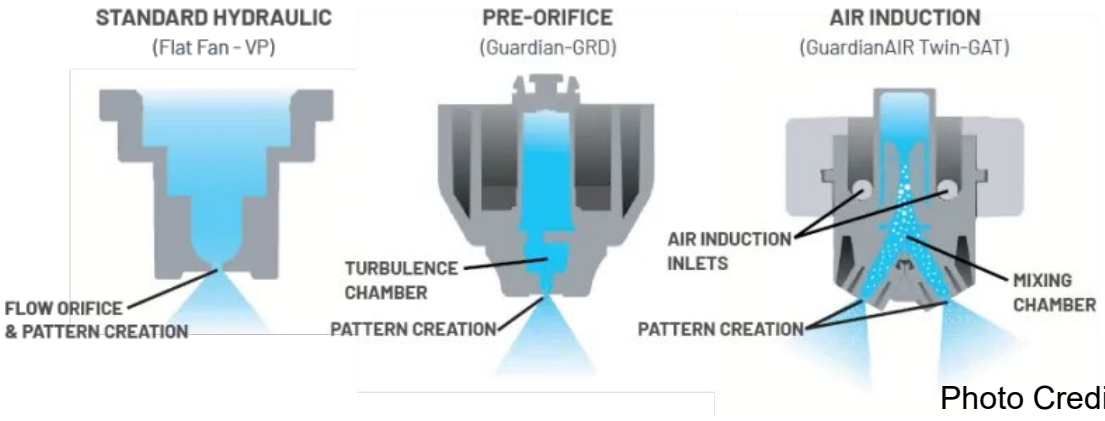
Nozzle Technology

XR
Simple flat fan

TT
Turbo flat fan

TTJ60
Turbo twin flat fan

AIXR
Air induction
flat fan



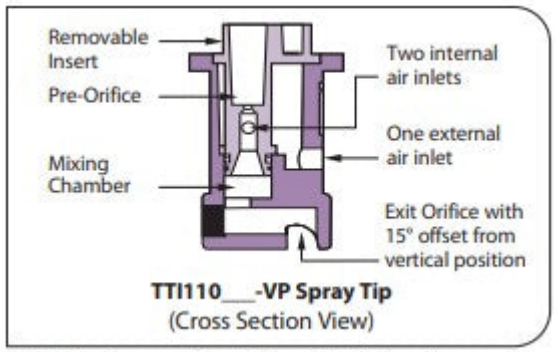
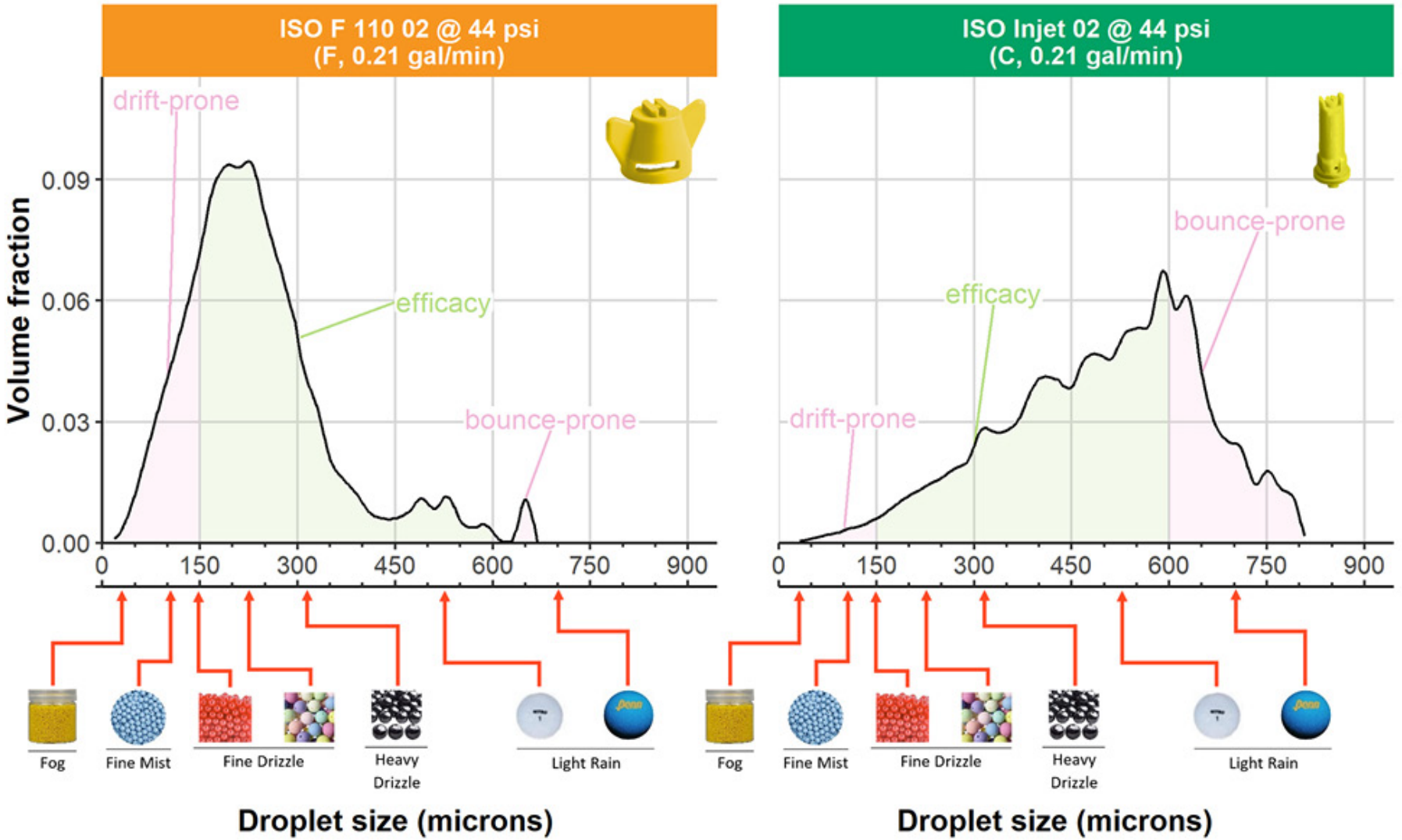


Photo Credits: Thompson (2025) extension.uga.edu, Proulx et al. (2024) NDSU.edu, and Teejet

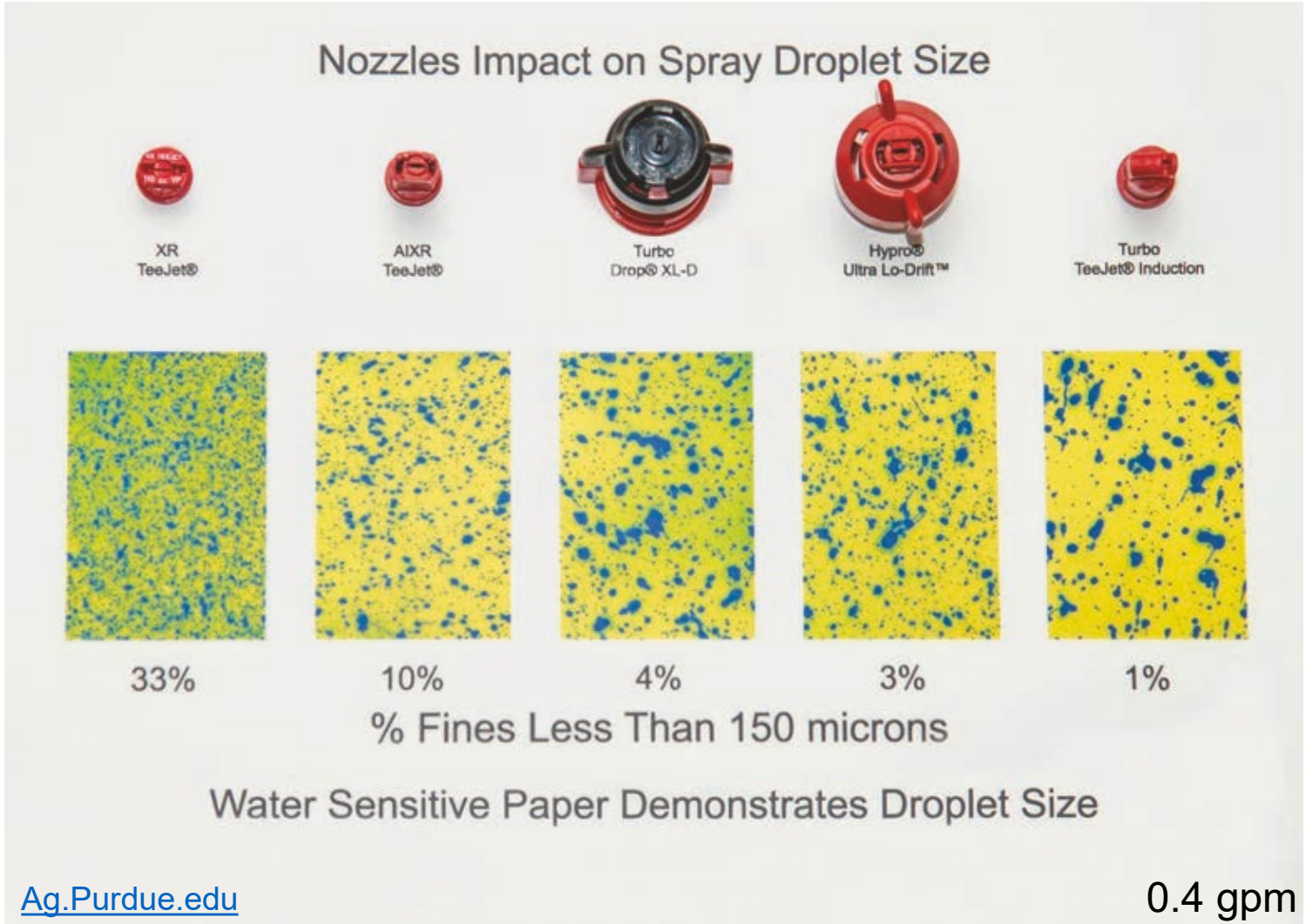
Herbicide Drift



Nyuttens et al. (2007)

Photo/Graph: Rob Proulx, NDSU

Herbicide Drift



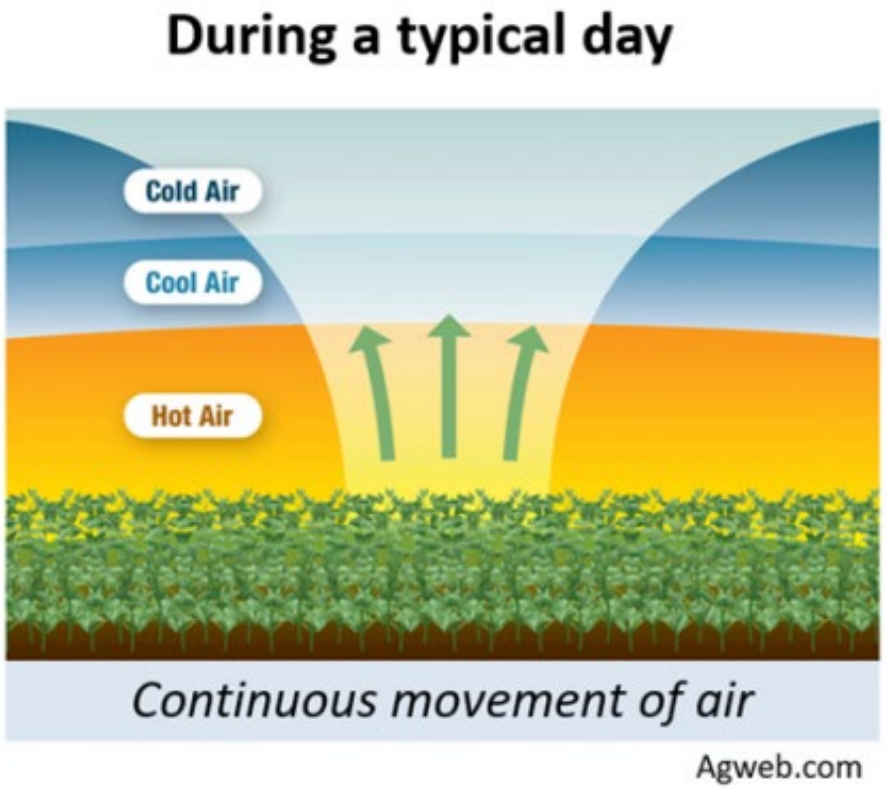
Ag.Purdue.edu

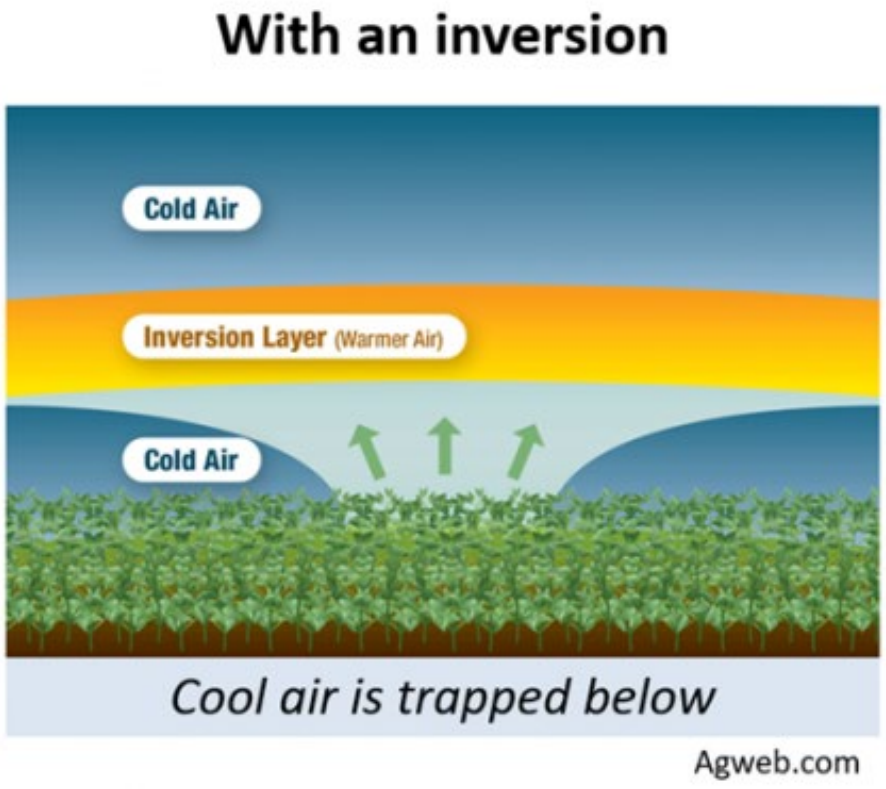
0.4 gpm

Photo: Ag.Purdue.edu

Environmental conditions

Temperature Inversion

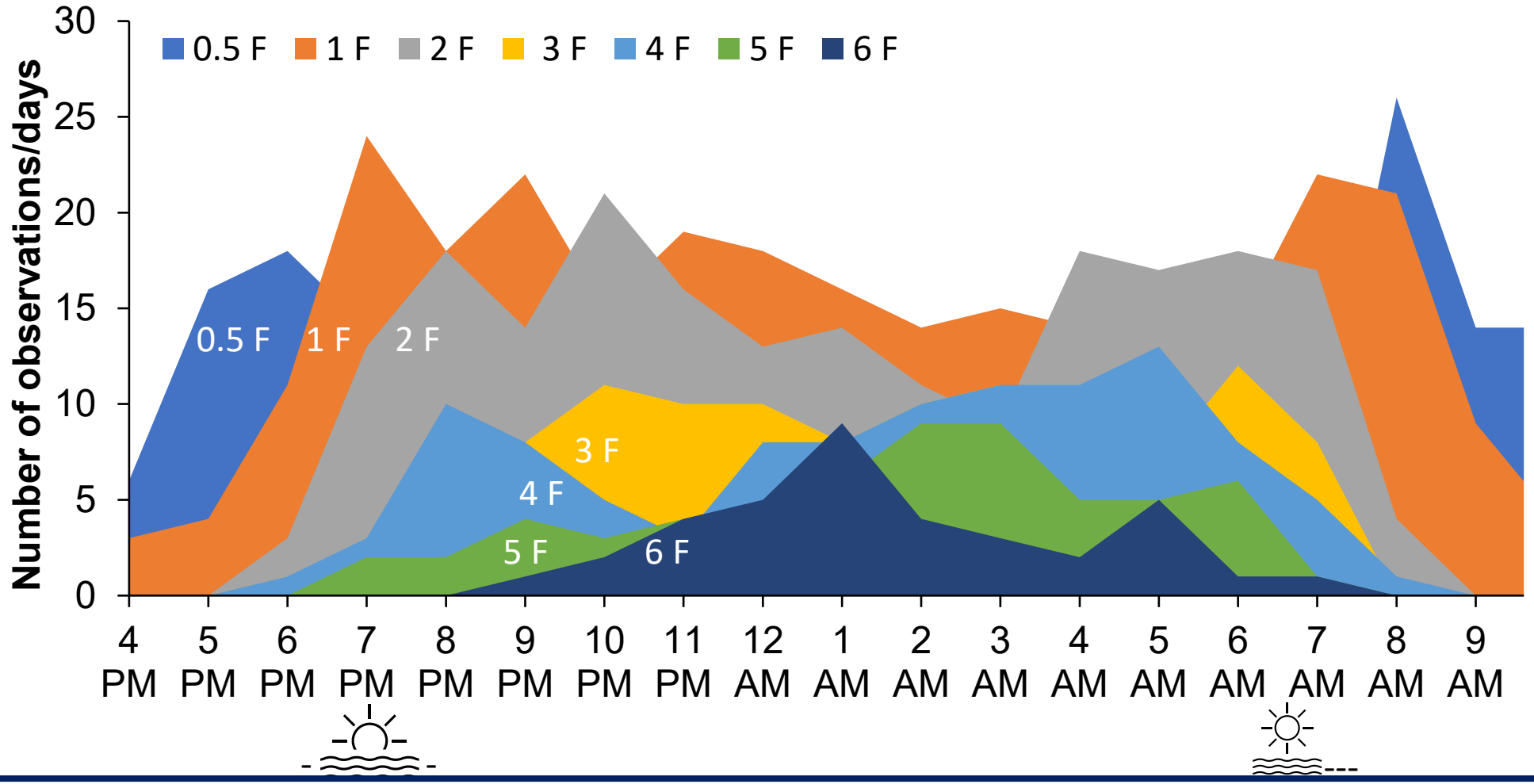




Photos: Agweb.com & Angie Rieck-Hinz

Environmental conditions

Temperature Inversion



March-April (2025)
Russell Ranch
Davis, CA

Data: atm.ucdavis.edu

Herbicide Injury

Diagnostics

- Symptomology
- Spatial Patterns
- Selectivity
- Site History
- Require Training
- Abiotic factors? (e.g., Drought/Nutrients stress)
- Biotic factors? (e.g., Insects/Diseases)

Photo: Freepik.com

Herbicide Injury

Examples

Group 4
- Broadleaves
- Epinasty/Twisting
- Leaf malformations (crinkling, cupping, strapping)

Group 1
- Grasses
- Chlorosis
- Rotten growing point

Photos: Patricia Lazicki, UC Weed School, UC IPM, herbicide-symptoms.ipm.ucanr.edu

Herbicide Injury

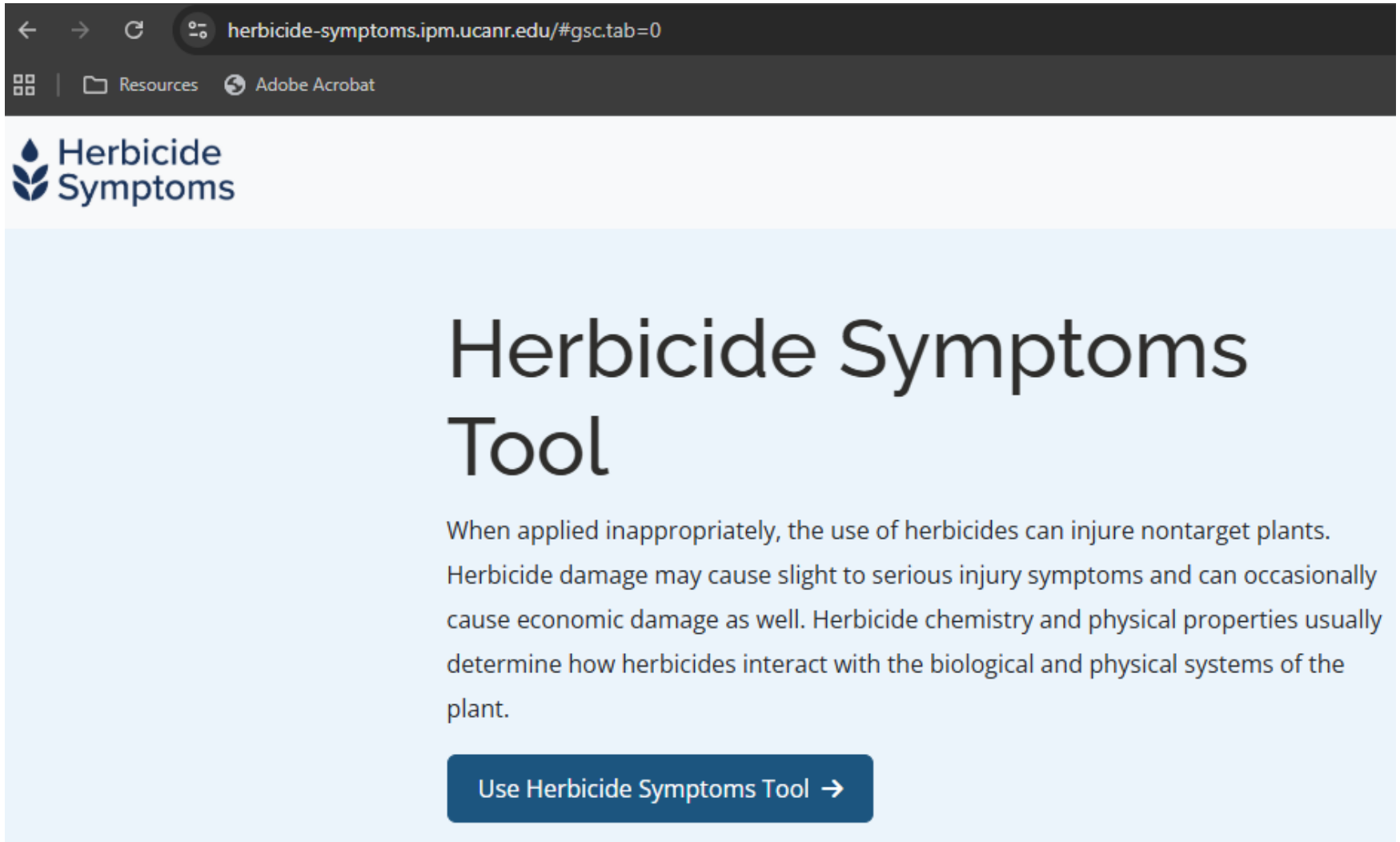
Examples

Group 9
- Systematic
- Yellowing/chlorosis
- New to old growth

Group 14
- Contact
- Bronzing/browning
- Necrotic spots/lesions

Photos: Patricia Lazicki, UC Weed School, UC IPM, herbicide-symptoms.ipm.ucanr.edu

Herbicide Injury



Conclusions

Practices to reduce herbicide drift

- ALWAYS FOLLOW the herbicide product LABEL
- Consider the location of sensitive vegetation
- Check wind (3-10 mph)
- Large size droplets
- Wide-angle nozzles
- Stable low boom height
- Avoid high/variable travel speeds
- Low volatility formulations
- Avoid temperature inversions
- Consider/use buffer
- Consider new technology:
  - Drift reducing nozzles
  - Drift reducing adjuvants
  - Shielded booms

AGRONOMY CROPS SURVEY