AN INDUSTRY PERSPECTIVE ON ADJUVANT DEVELOPMENT AND TESTING PRACTICES

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FUNCTIONS OF ADJUVANTS

Wetting/Spreading

Reduces surface tension and allows droplet to spread on leaf surface.

Absorption/Penetration

Ability to penetrate or cross leaf surface layers.

Deposition

Aids droplets in reaching target and remaining there.

Water Quality

Buffer pH or reduce ions that bind and inactivate a.i.

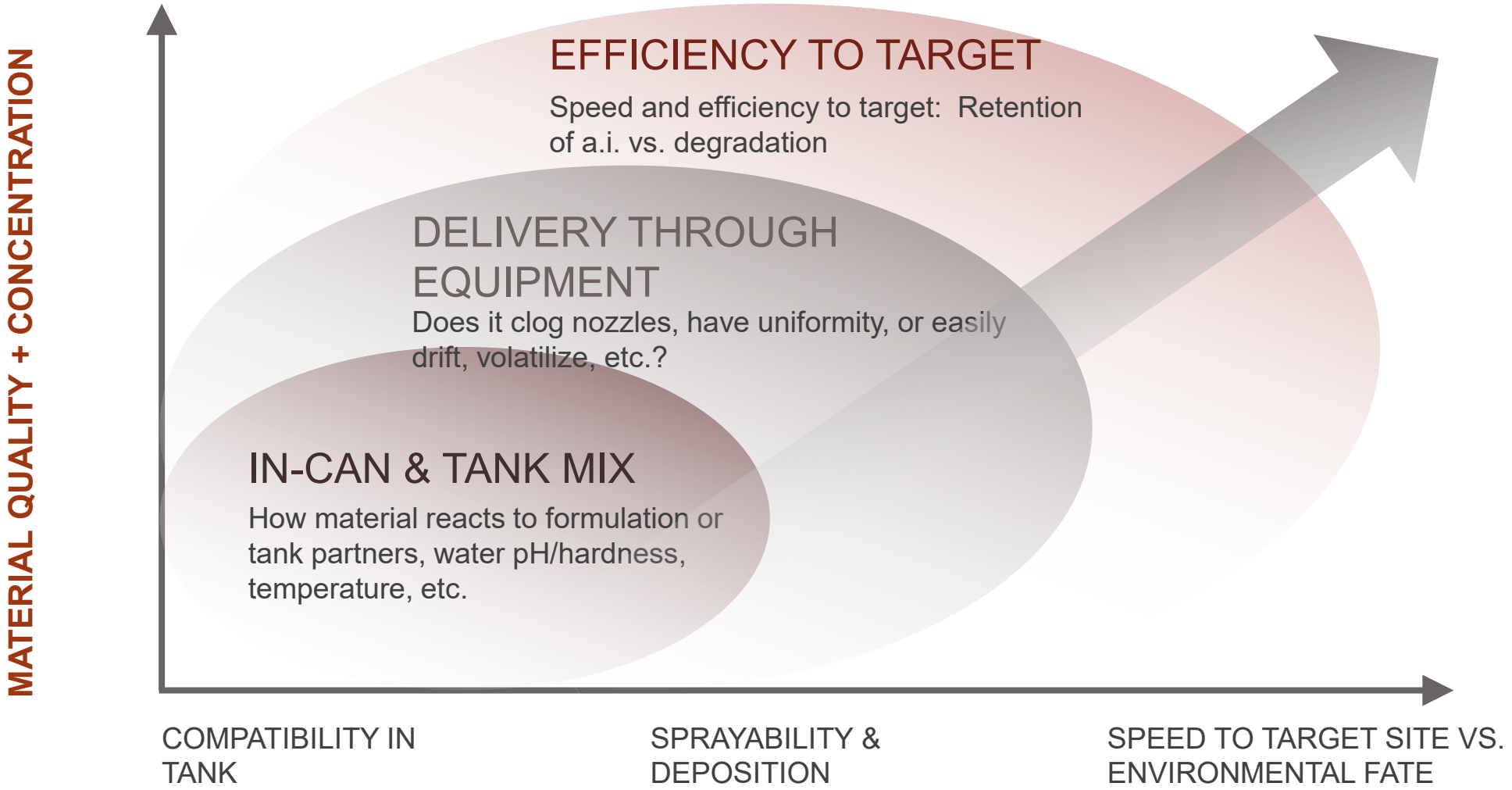
Compatibility

Enhance solubility and interactions with formulation or tank-mix partners.

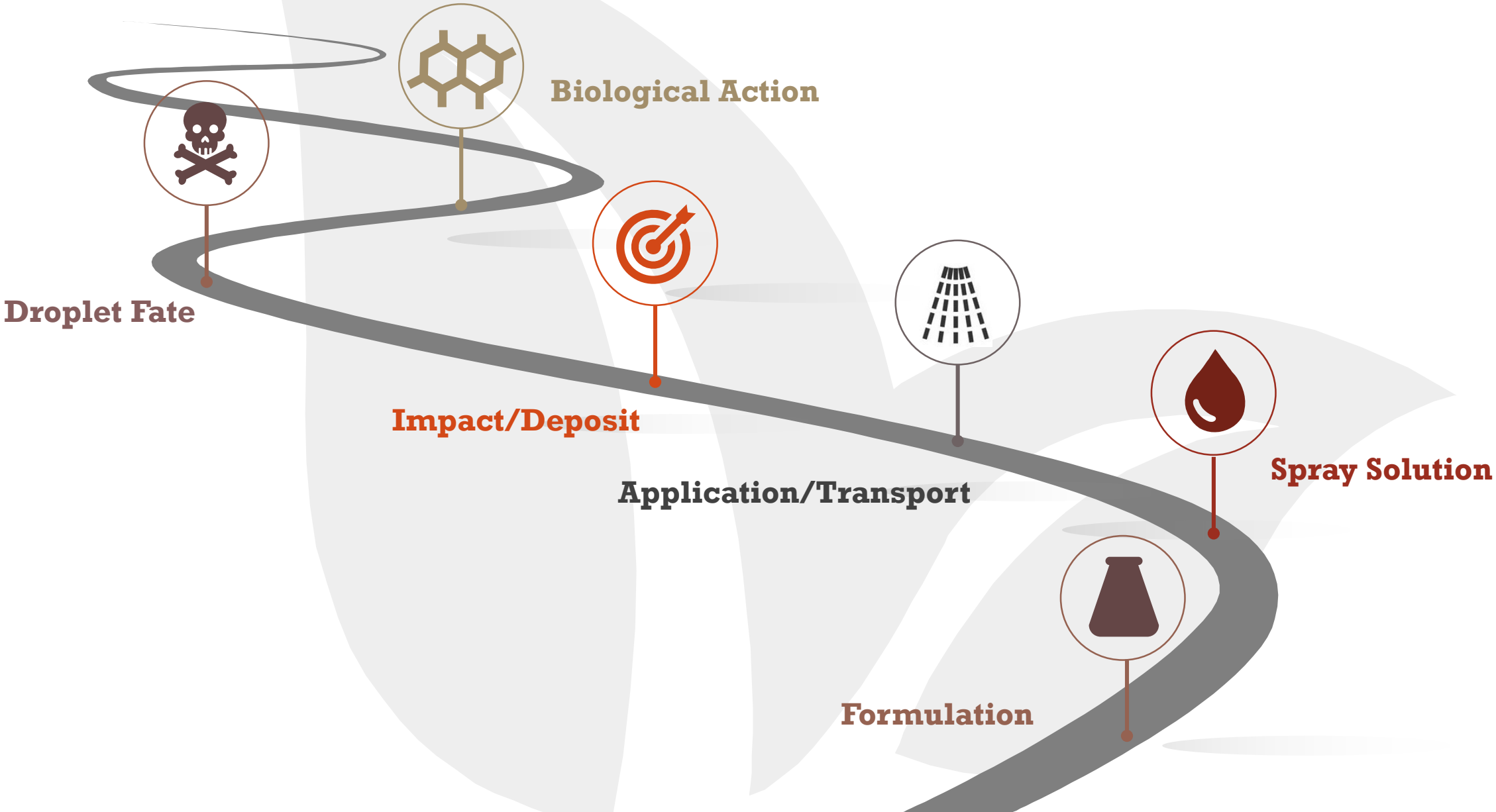
Drift Reduction

Reduce driftable fines in spray solution by enlarging or increasing weight of droplets.

ADJUVANT EFFECT ON A.I. PERFORMANCE



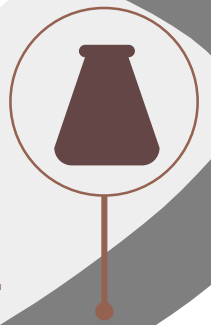
LIFE CYCLE OF A SPRAY DROPLET



FORMULATION DEVELOPMENT

“In-can Formulation”

What is the formulation? How soluble in water, oil, solvents, etc. is it? What are the physical and chemical properties of the active molecule? How compatible with other formulations, fertilizers, pesticides, etc. is it?



Formulation

“In-can”

Physicochemical properties of molecule; SL, SC, EC, WP, WDG, ME, OD, etc.

COMPATIBILITY

"Spray Solution"

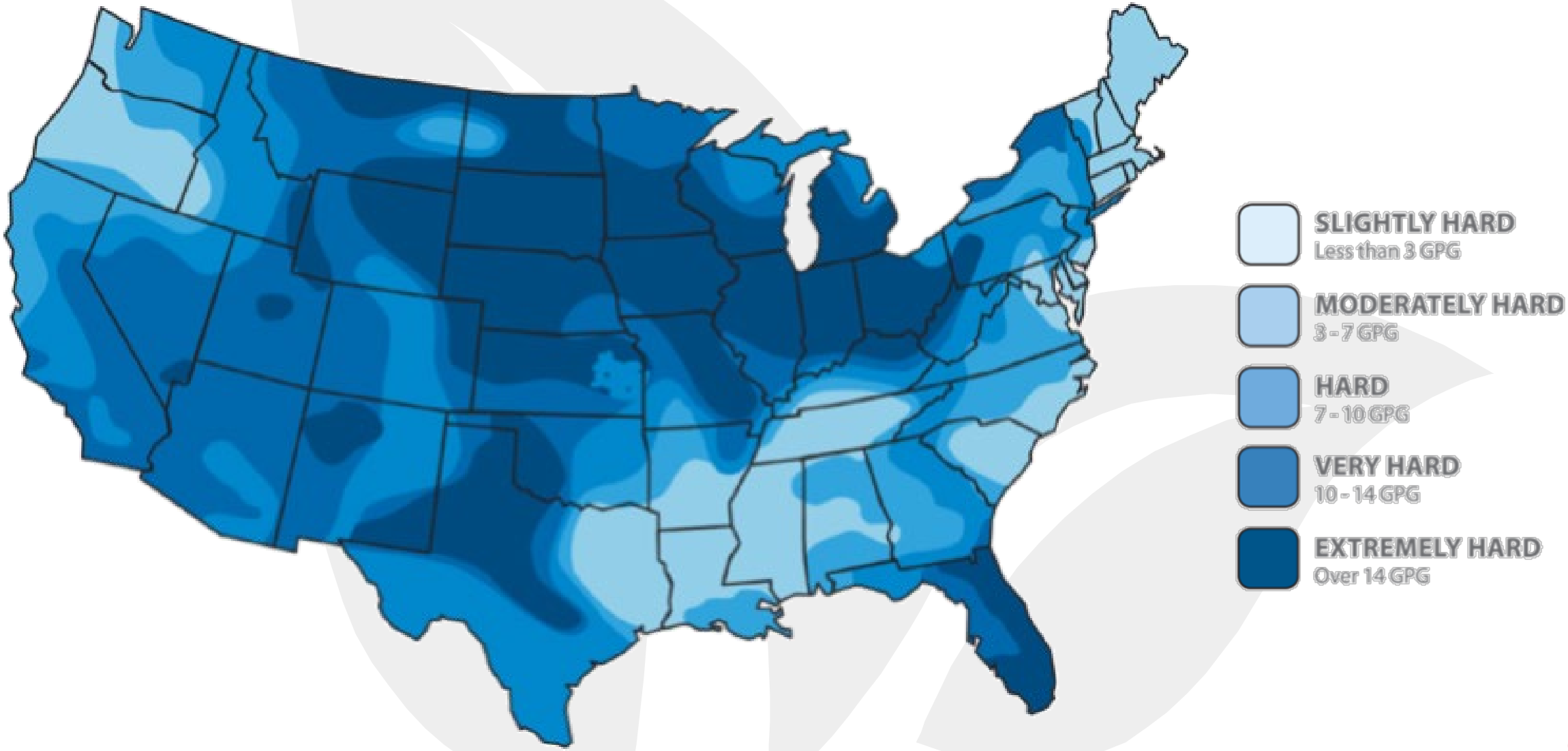
How compatible is it with other tank-mix partners? How much agitation is required to keep in homogenous solution? Is pH buffering or water-conditioning required?

Tank-mixed with water and/or other products

Water solubility, agitation requirements, water pH, ion ppm, etc.

Spray Solution

WATER HARDNESS IN THE U.S.

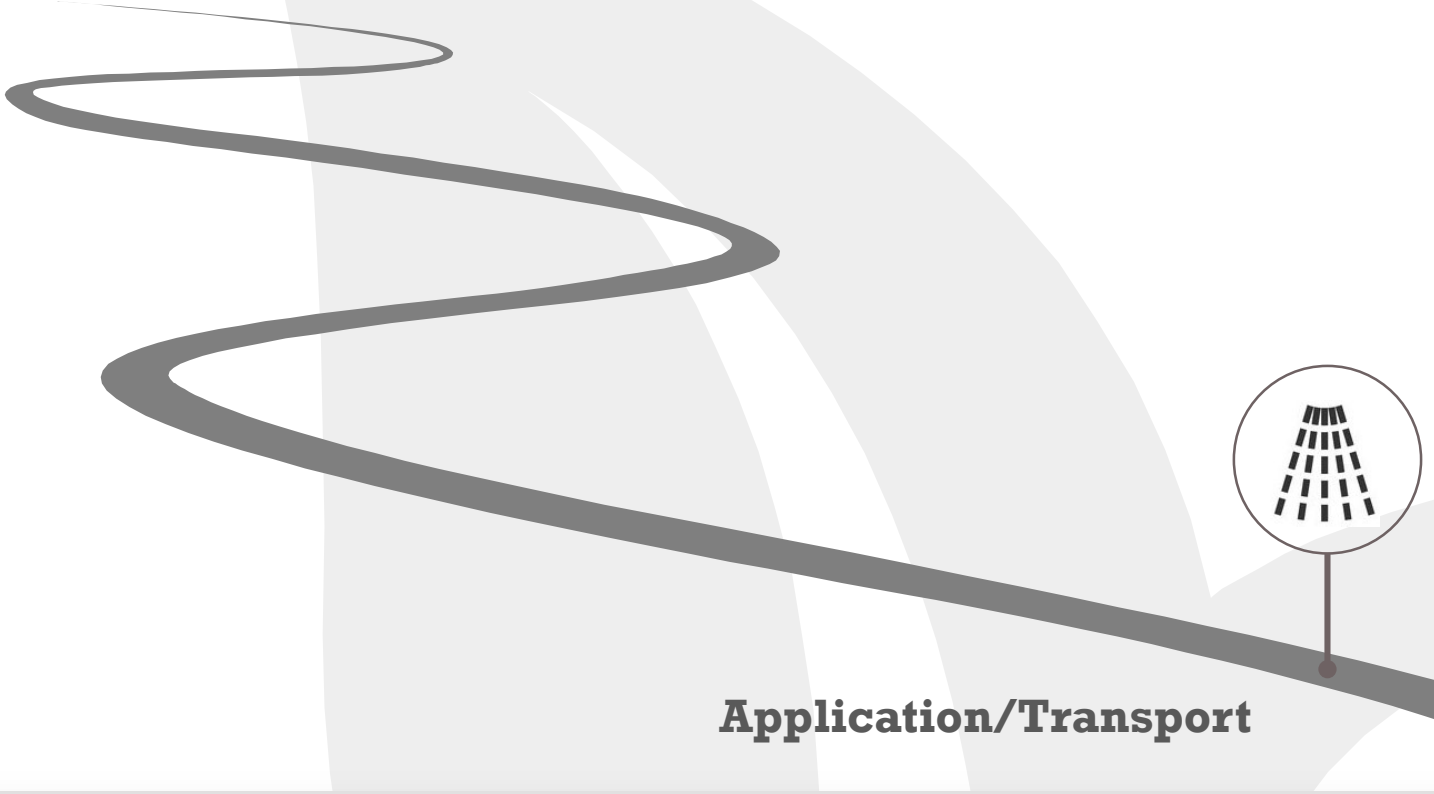


http://personal.psu.edu/bja5191/assignment6.html

SPRAYABILITY

Delivery System

Nozzle type, pressure, speed, GPA, environmental conditions, etc.



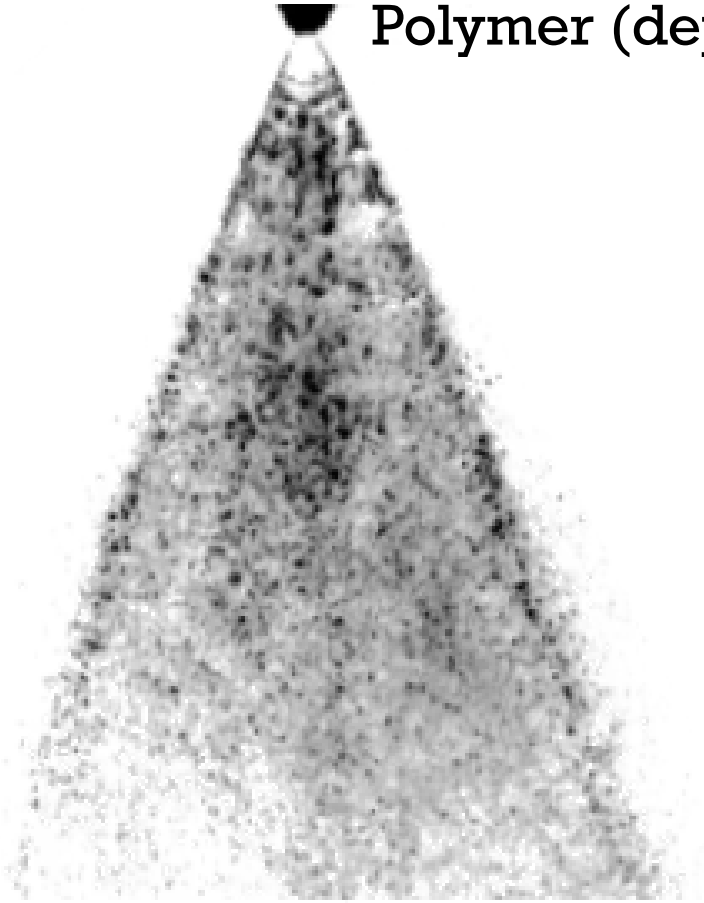
Application/Transport

“Application”

What nozzle/orifice is required for application? How much water is applied per unit area with product? What is the temperature, humidity, wind speed and direction, etc.?

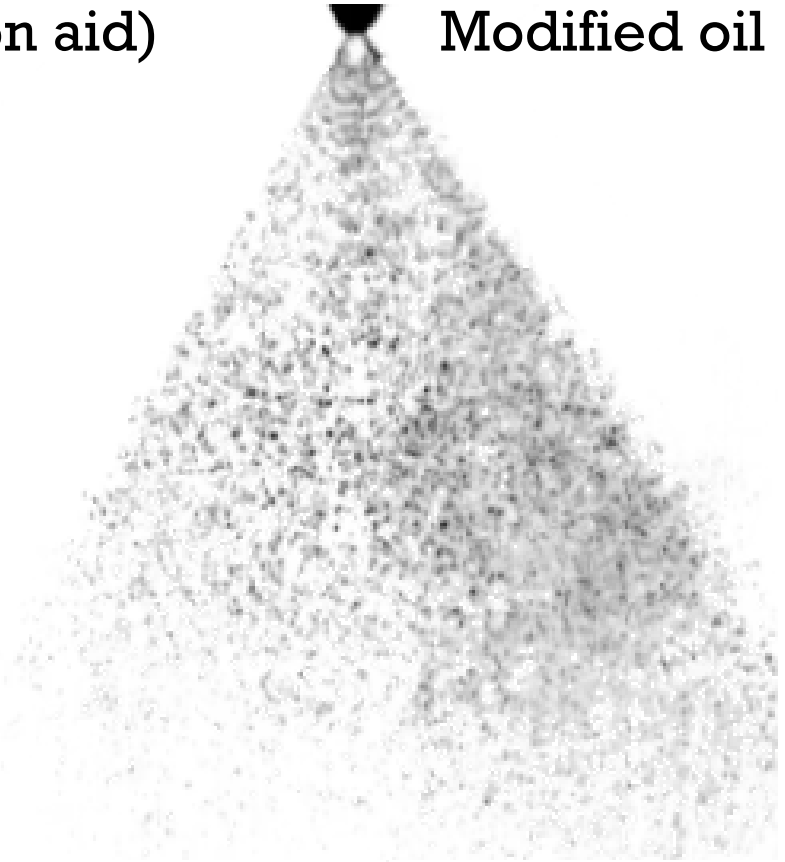
SPRAYABILITY

Polymer (deposition aid)



FF 8002

Modified oil (deposition aid)



FF 8002

DROPLET PERFORMANCE

“What happens to the droplet?”

Does the spray droplet bounce off surface, roll off, stick, spread, break into particulates and scatter, etc.?

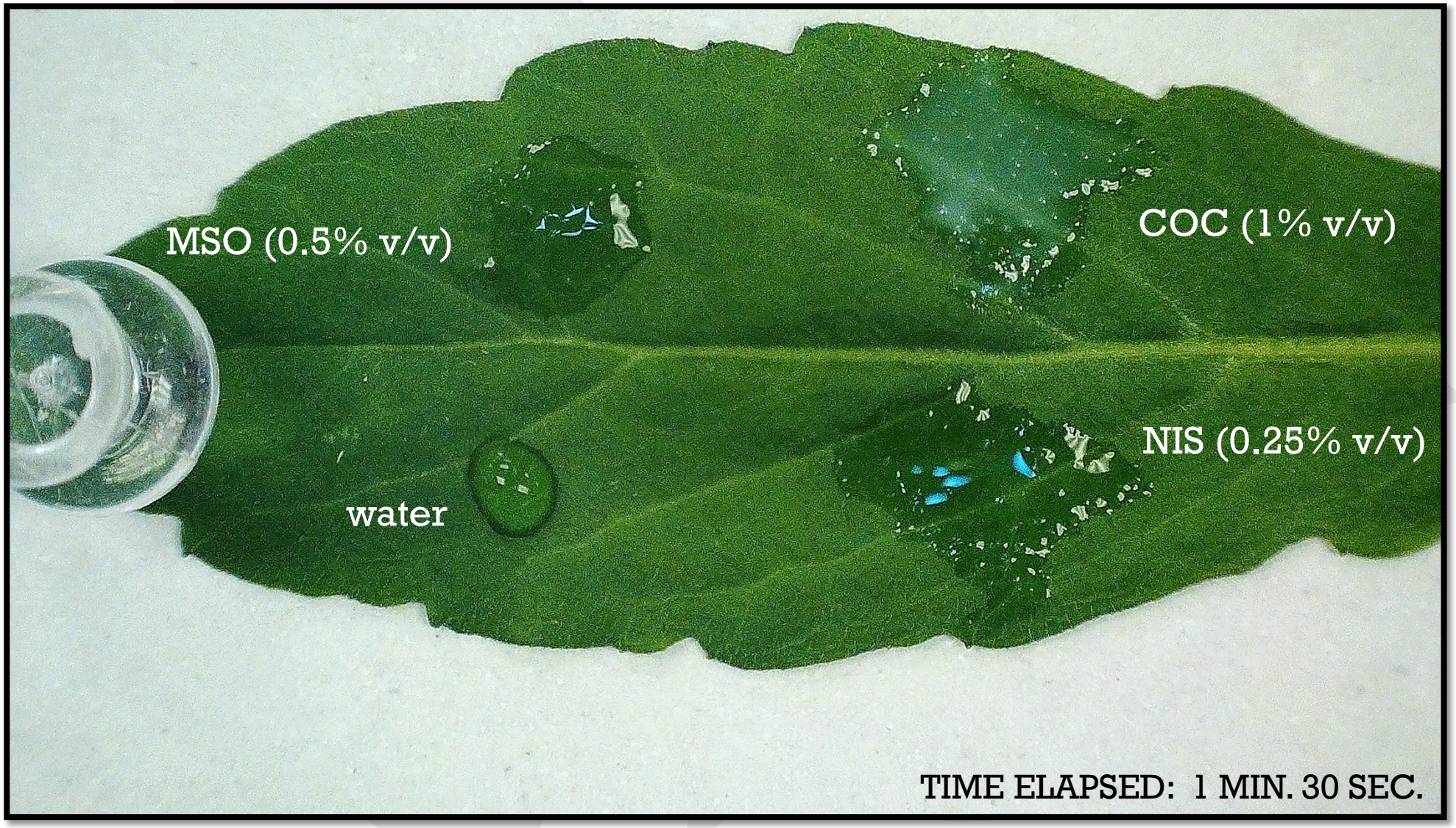
Impact/Deposit

Droplet:surface interface

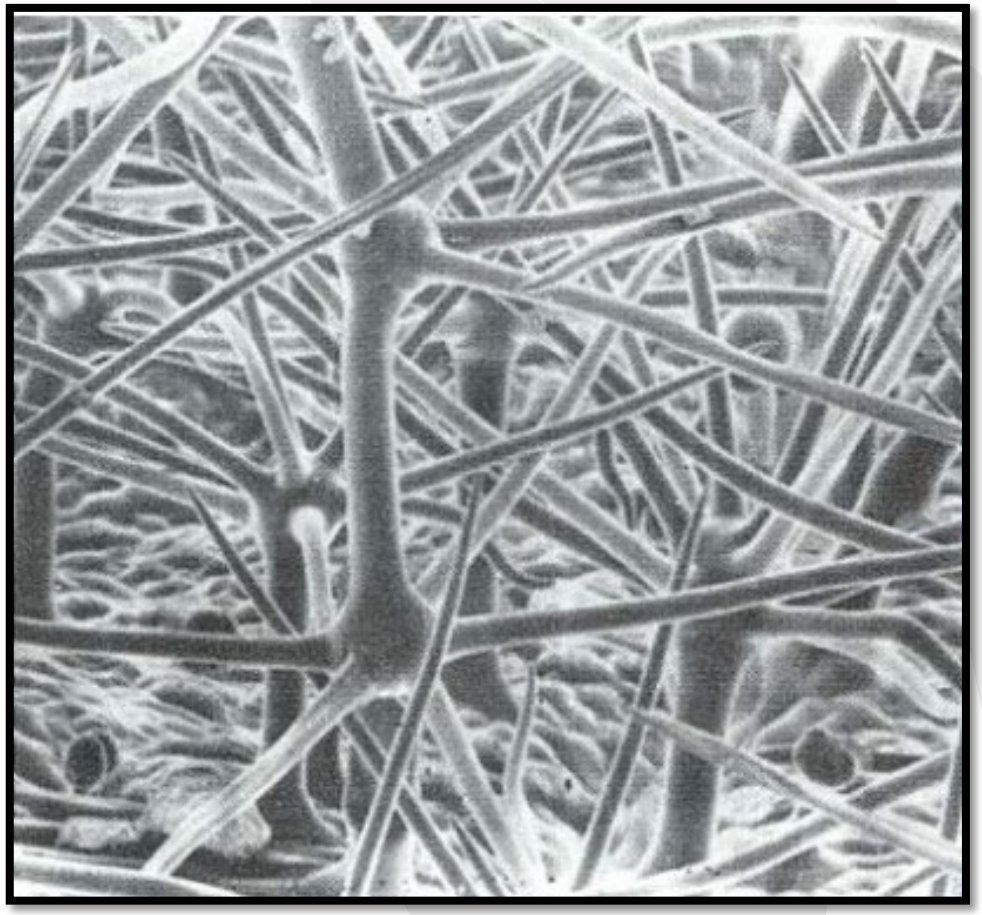
What happens at impact of droplet on pest or soil surface? Sticks, spreads, bounces, rolls off, etc.

ADJUVANT EFFECT

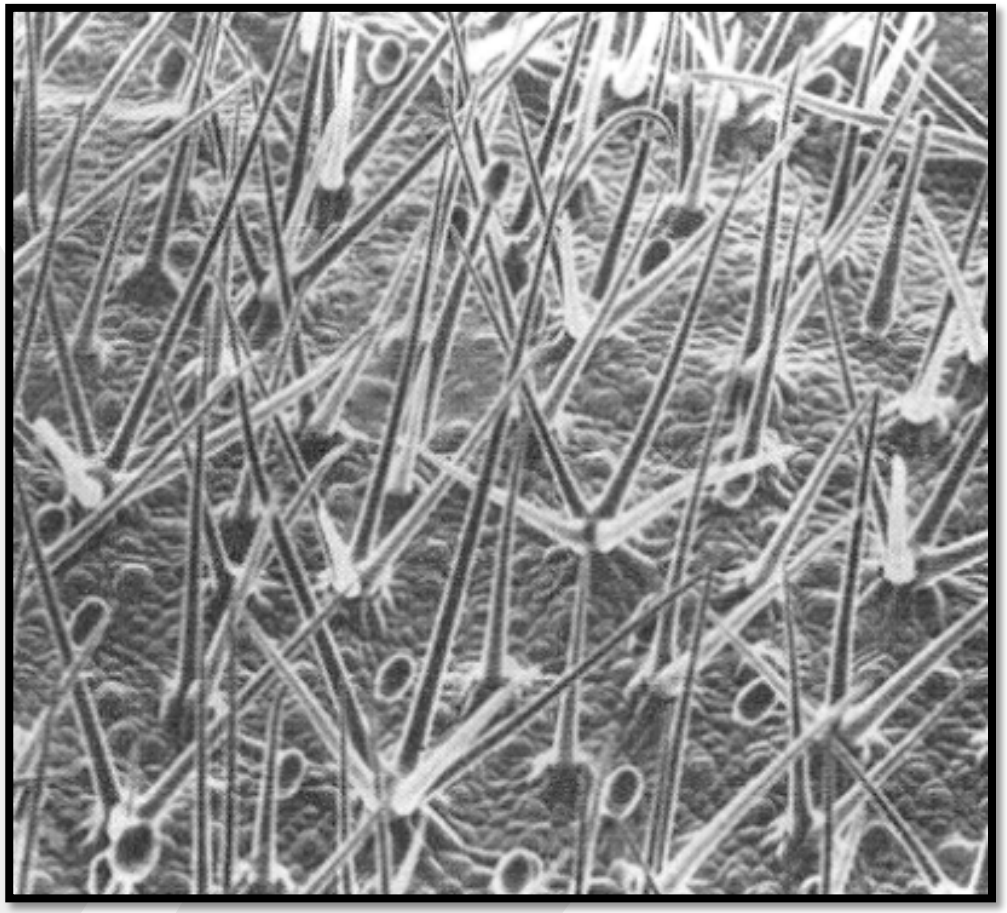
Marestail/horseweed leaf



PLANT DEFENSE MECHANISMS- TRICHOMES



Trichomes on common mullein

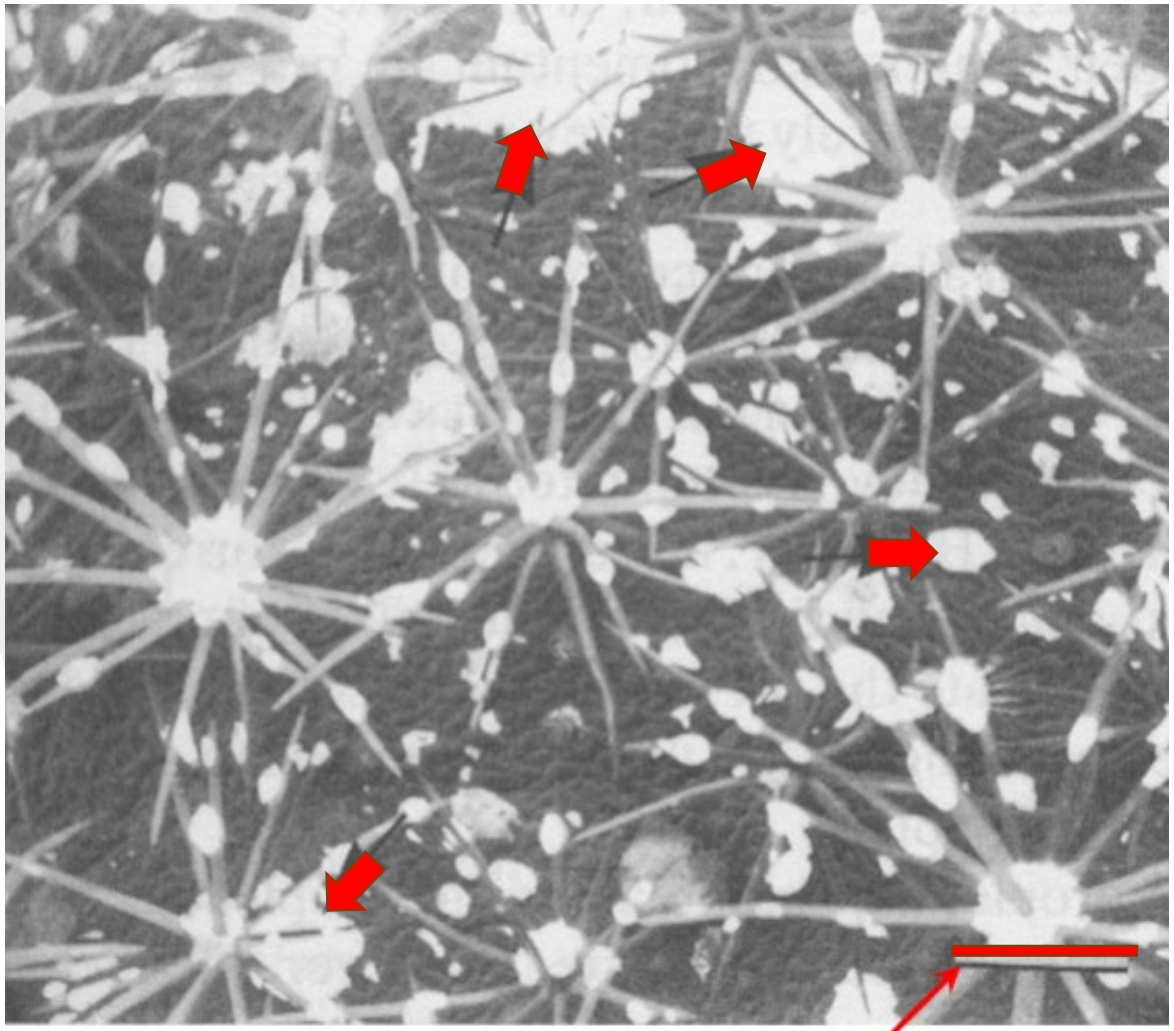


Trichomes on velvetleaf

https://cals.arizona.edu/crop/presentations/2003/mccloskey092403.pdf

PLANT DEFENSE MECHANISMS- TRICHOMES

MCPA (Na salt) deposits on turkey mullein (*Eremocarpus setigerus*) leaves. Red arrows indicate herbicide droplets that have penetrated through the leaf hairs and reached the epidermal surface.



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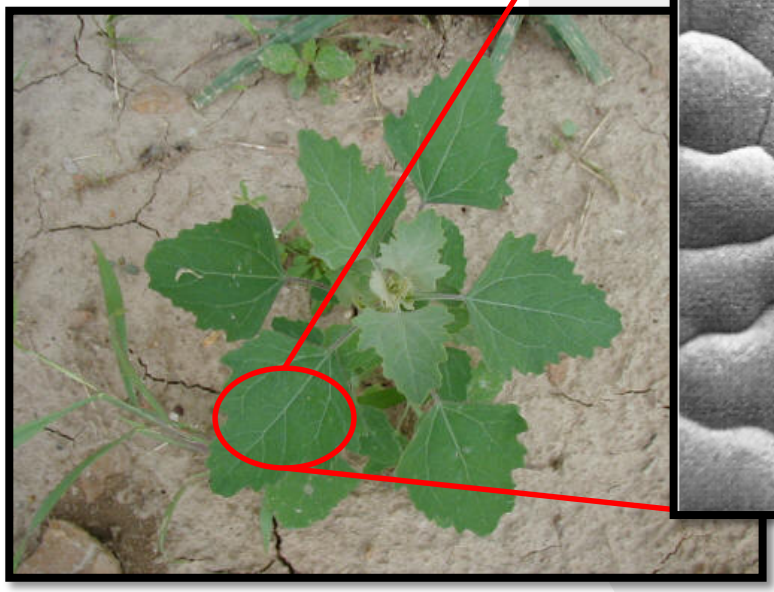
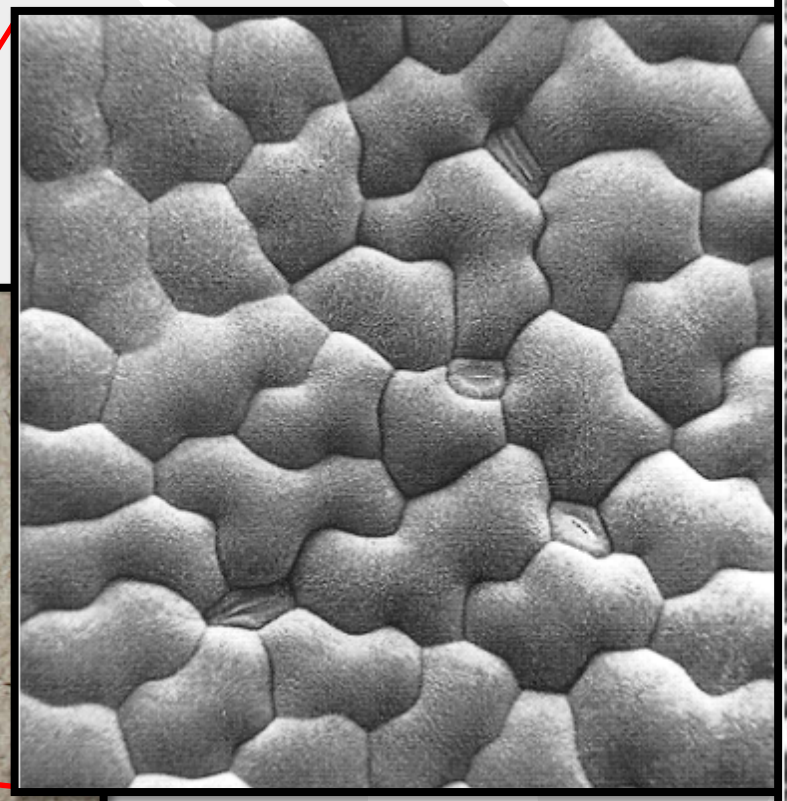
PLANT DEFENSE MECHANISMS - WAXY CUTICLE



Chenopodium album

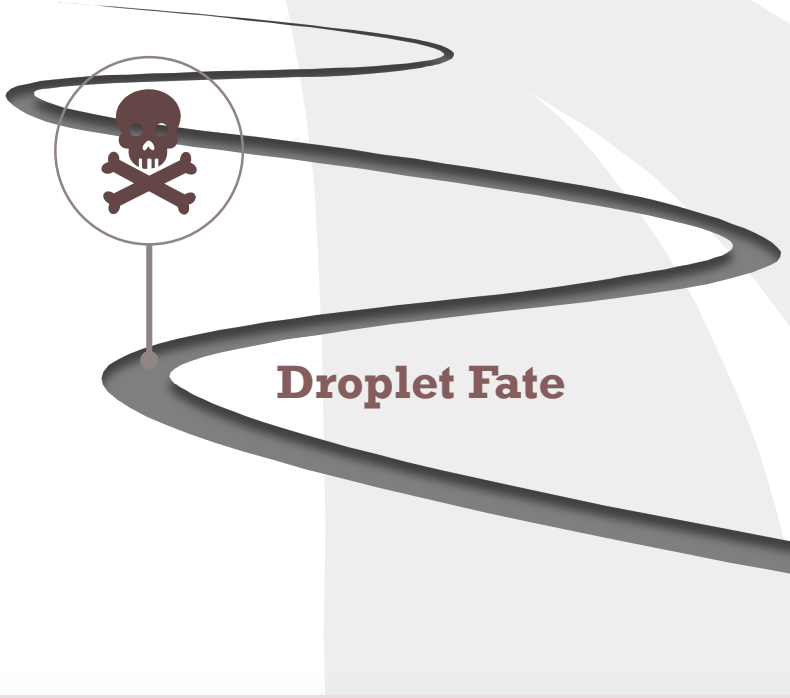


SEM image at 350X
of leaf surface

SEM image at 3500X
showing epicuticular wax

https://cals.arizona.edu/crop/presentations/2003/mccloskey092403.pdf

FATE OF SPRAY DROPLET



Droplet Fate

Post-spray impact

Penetration, absorption, evaporation, photolysis, etc. Largely determined by architecture of plant, wax layers, pubescence, cuticular lining, surface tension, etc.

“Metabolism or Degradation”

After settling at destination from application, does the active ingredient-containing droplet degrade by hydrolysis, photolysis, or microbes, evaporate, volatilize, absorb or diffuse into plant, adsorb to soil, etc.?

EFFECT ON ACTIVE INGREDIENT

Biological Action

Contact or Systemic

Enhances coverage of “burn” or “protectant” for contacts and absorption and translocation for systemics.

“How does it affect the a.i.?”

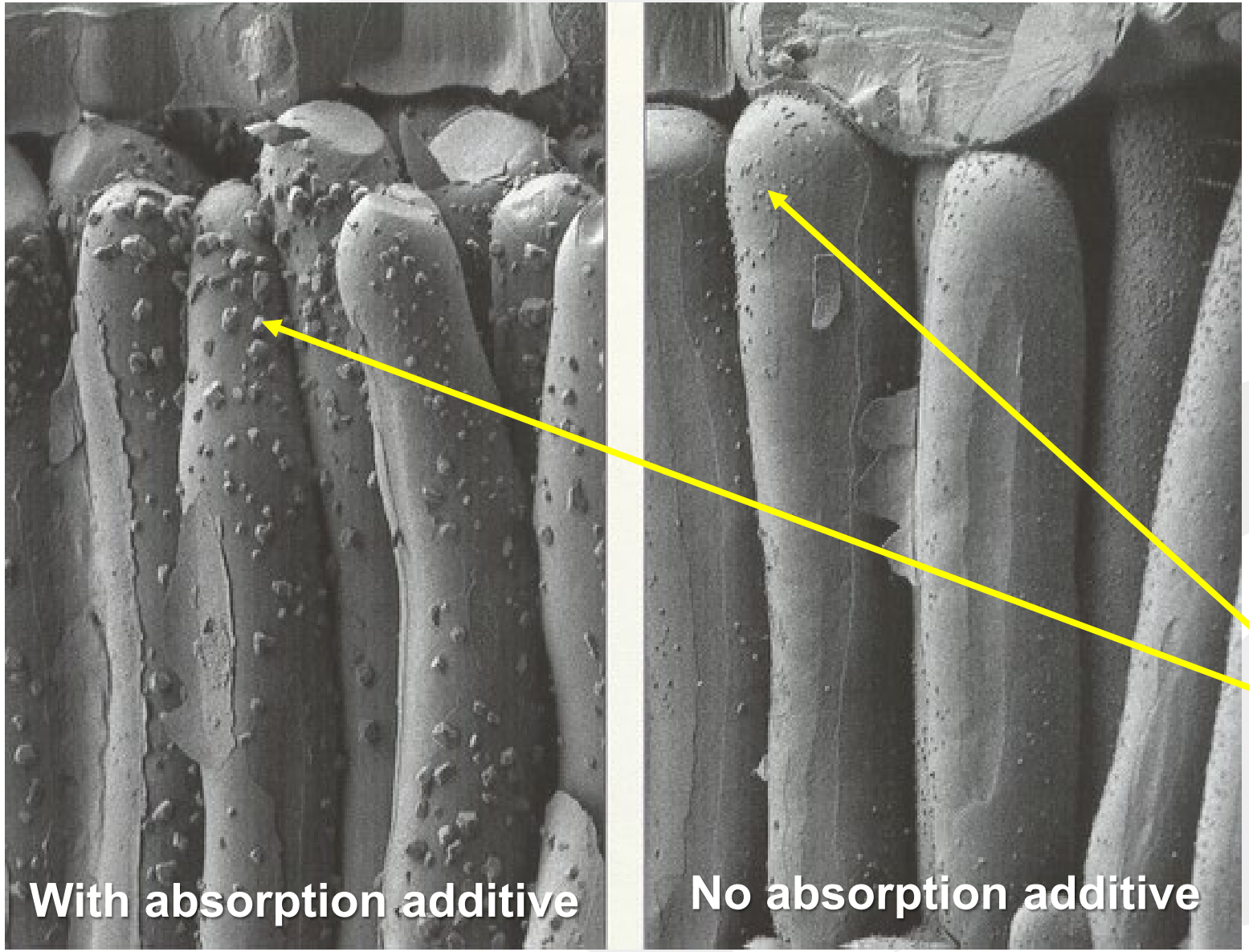
Contact pesticides are directly dependent upon coverage, so spreading is key. Systemics are dependent upon absorption and translocation, thus it is imperative to keep the a.i. in a plant-available form as long as possible for maximum absorption and translocation to the site of action.

CONTACT VS. SYSTEMIC CONTROL

glufosinate on Palmer amaranth

graminicide on johnsongrass

EFFECT ON ABSORPTION = ↑ EFFICACY



Absorbed and translocated Glyphosate particles

FIELD TESTING

How do you test for adjuvant efficacy or determine proper use rate?

2 options…

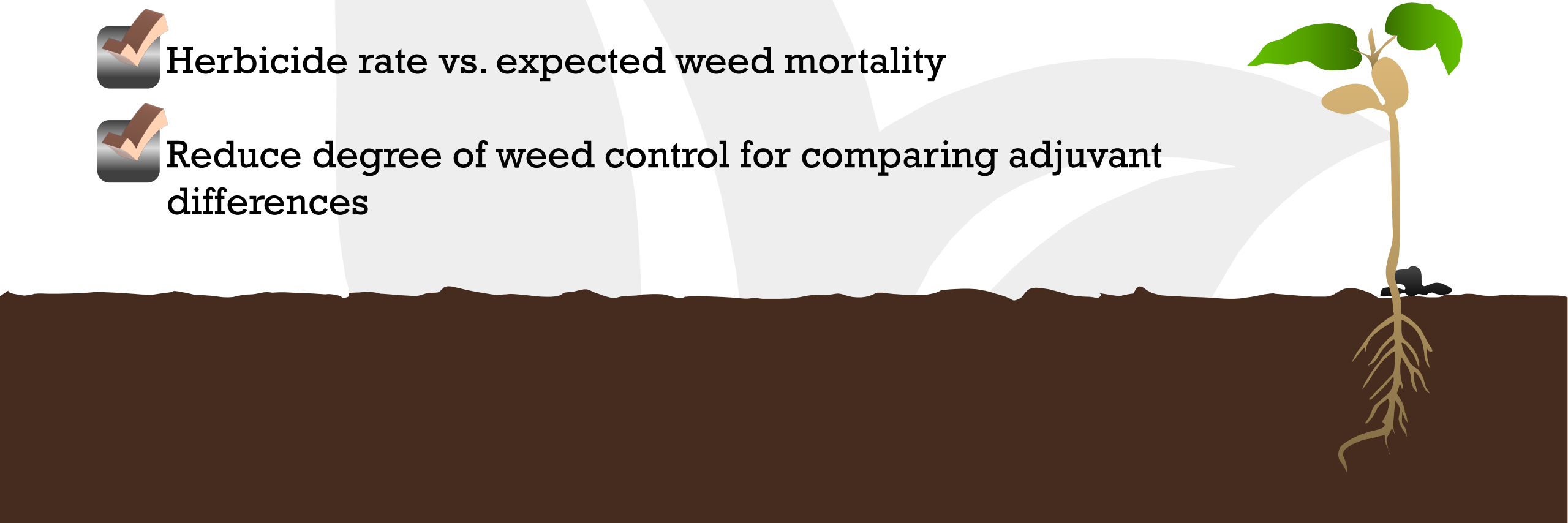
1. Manipulate the pesticide dose/spray mixture.

OR

2. Manipulate the pest stage of growth/maturity.

POINTS TO KEEP IN MIND…

- Determining efficacy of adjuvant, not herbicide
- Weed growth stage and maturity
- Herbicide rate vs. expected weed mortality
- Reduce degree of weed control for comparing adjuvant differences



GROWTH STAGE AFFECTS CONTROL

Control of musk thistle at different growth stages.

Herbicide	Rate	Growth stage at treatment	% of control
2,4-D amine	2 qt/A	rosette	96
		bolting	92
		bud	73
		early flower	75

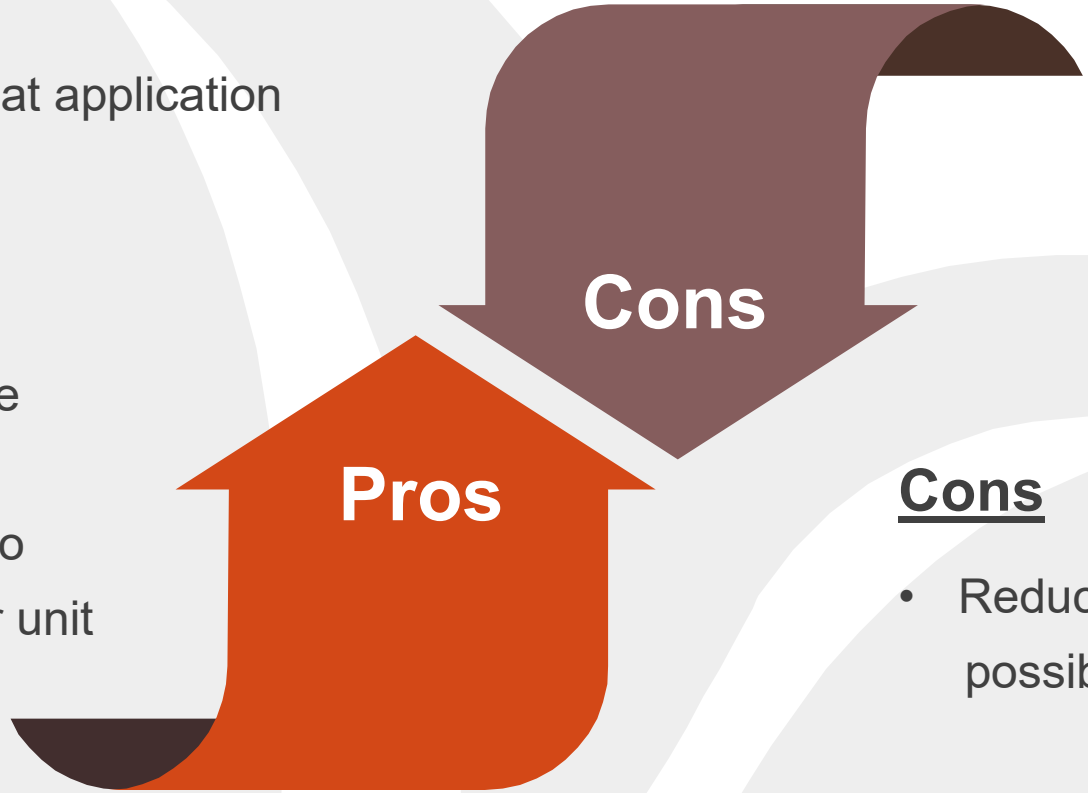
*Wilson et al. NebGuide G92-1109. University of Nebraska Cooperative Extension.

Control decreases as plant matures.

SCENARIO 1– YOUNG WEEDS, REDUCED HERBICIDE RATE

Pros

- Agrees with labeled weed size at application timing
- Weed physiology optimal for herbicide/adjuvant performance
- Higher surface area : mass ratio = more herbicide absorbed per unit mass of plant
- Promotes herbicide stewardship and lower field dose with aid of adjuvant



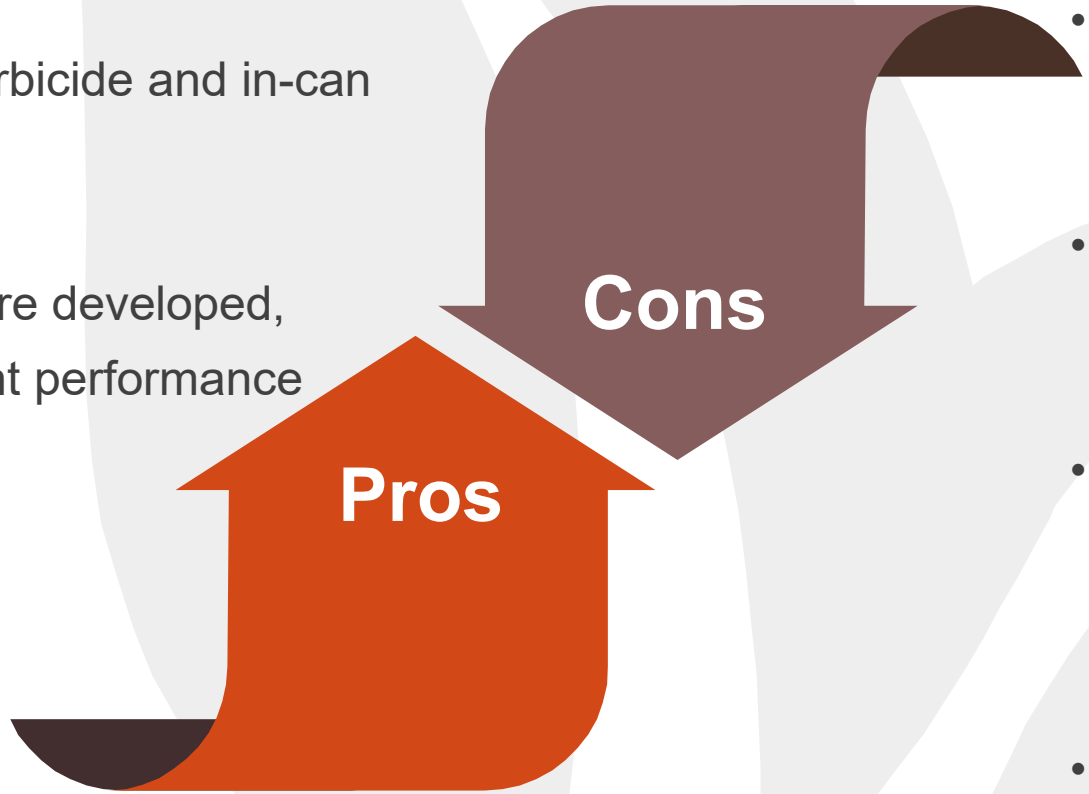
Cons

- Reduced loading of herbicide—possibly sublethal or unlabeled dose
- Reduced loading of in-can adjuvant system in herbicide formulation

SCENARIO 2– LARGE MATURE WEEDS, FULL HERBICIDE RATE

Pros

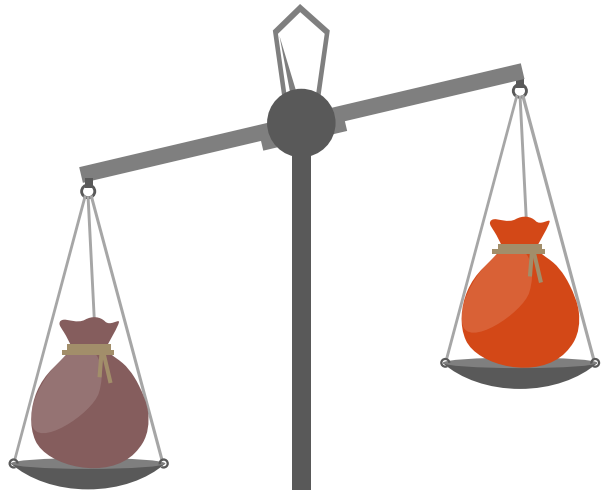
- Full loading of herbicide and in-can adjuvant system
- Cuticular wax more developed, stressing adjuvant performance



Cons

- Off-label weed size – mimics “rescue” treatment and lack of stewardship
- Weed physiology not conducive or favorable for herbicide/adjuvant performance
- Lower surface area : mass ratio = less herbicide absorbed per unit mass of plant
- Plant may translocate herbicide to sink instead of source

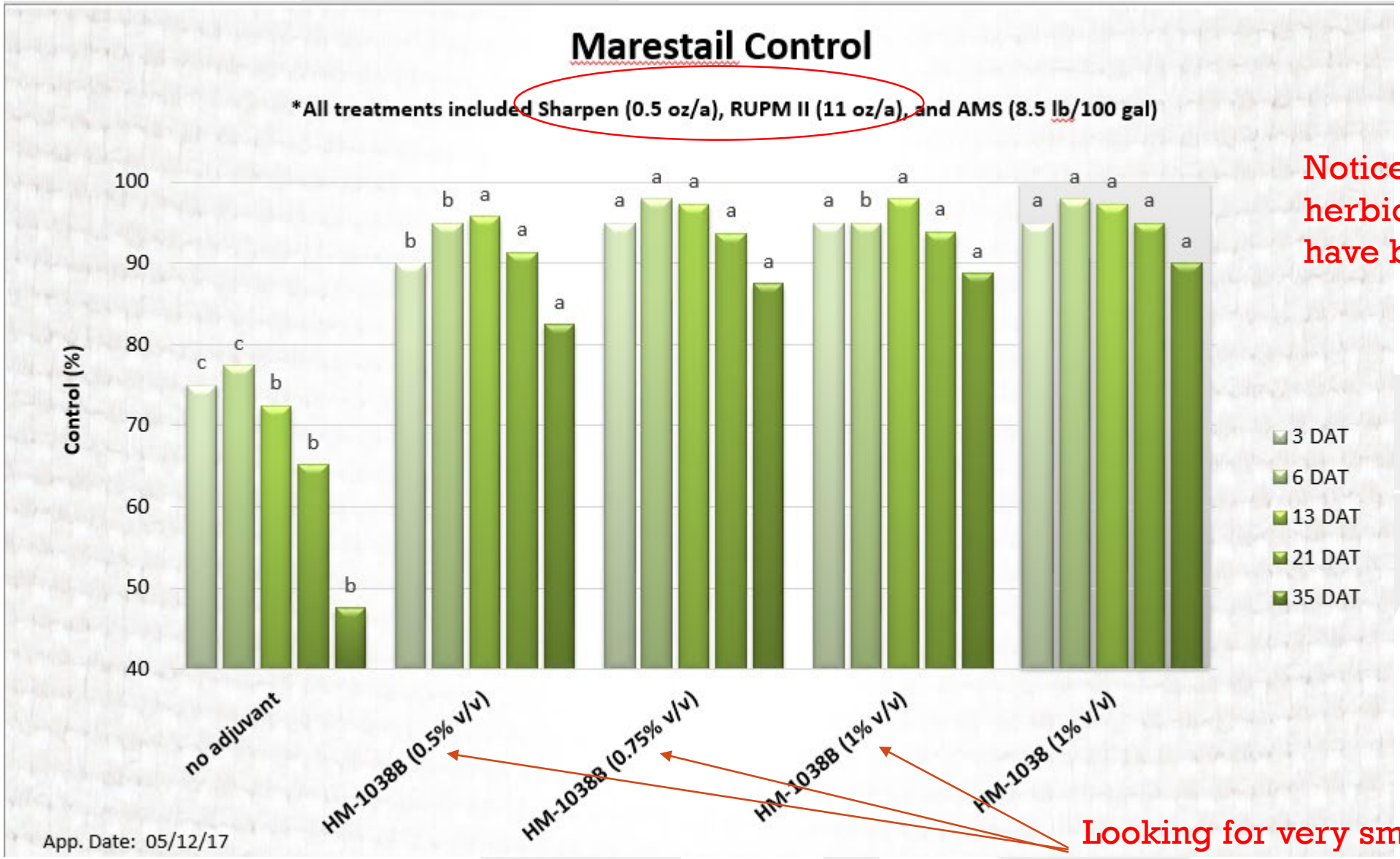
WHICH METHOD IS BEST AND WHY?



SCENARIO 1 – YOUNG WEEDS, REDUCED HERBICIDE RATE

- Test product to fit label spray application recommendations
- Reduces false negative or misleading results
- Doesn't promote "rescue" or overly late spray applications
- Follows herbicide stewardship and resistance mgt. principles
- May allow for less environmental footprint with herbicide dose if adjuvant increases herbicide efficacy

FIELD TRIAL DATA

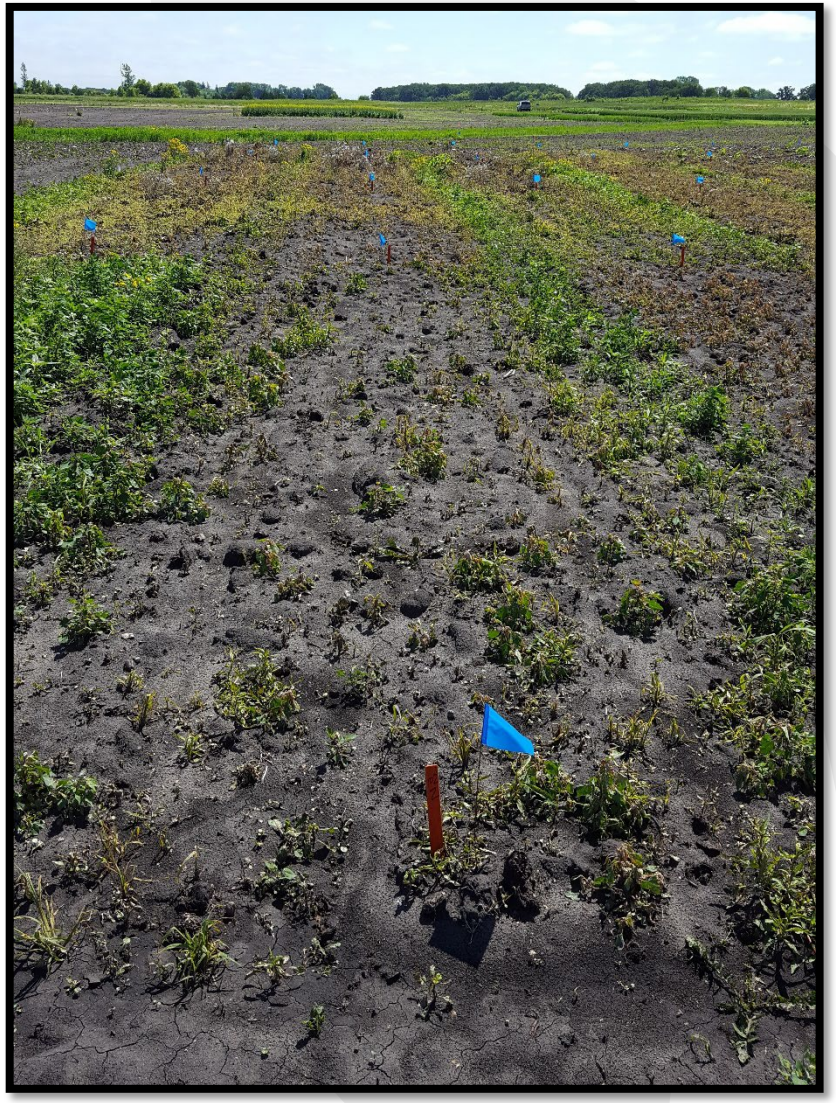


Notice % control values. If 1X herbicide rate, control would have been almost 100%.

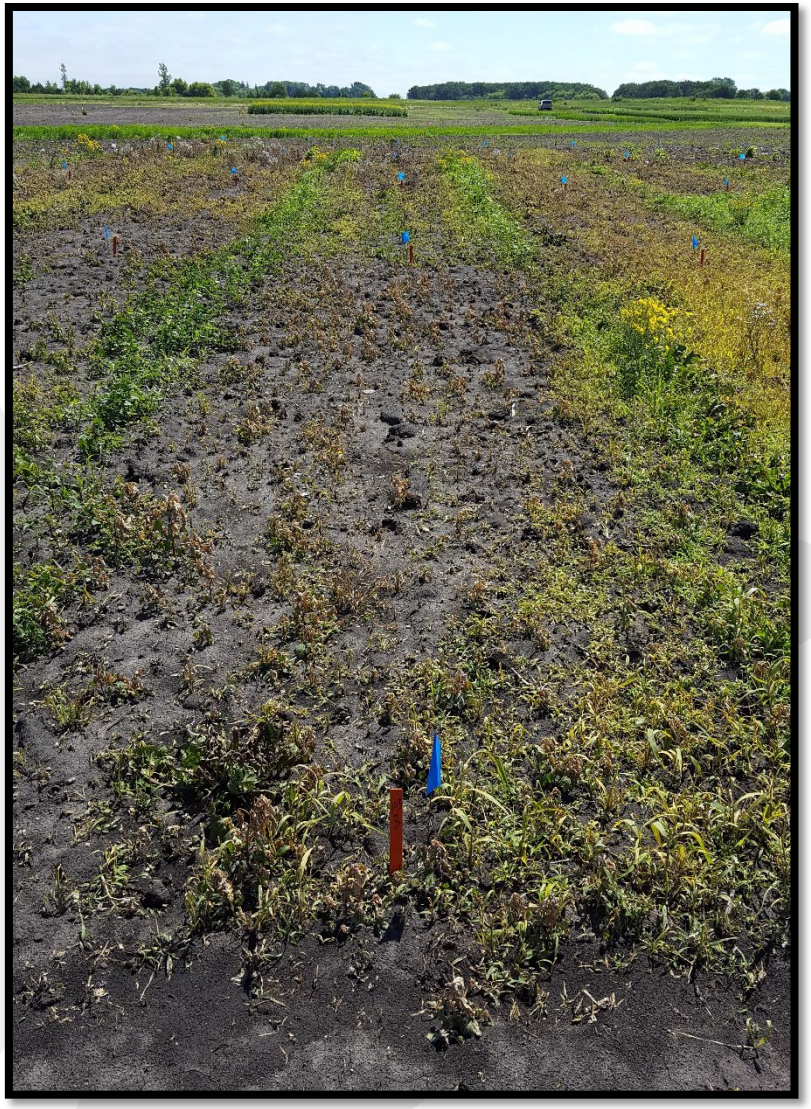
Looking for very small differences across similar formulations!!!

ADJUVANT BENEFIT

Preplant burndown trial in MN, 2016
3 DAT



Sharpen + RUPM II + AMS



Sharpen + RUPM II + AMS + MSO-based surfactant

OTHER PRODUCT CHARACTERISTICS TO COMPARE OR CONSIDER

- SIGNAL WORD
- USE RATE
- COST OF INGREDIENTS
- LABEL REQUIREMENTS (I.E. NON-AMMONIACAL)
- SHELF-LIFE/STORAGE STABILITY PROPERTIES
- ALL PESTICIDE FORMULATIONS ARE NOT EQUAL (I.E. LOADED VS. UNLOADED)

THANK YOU!

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