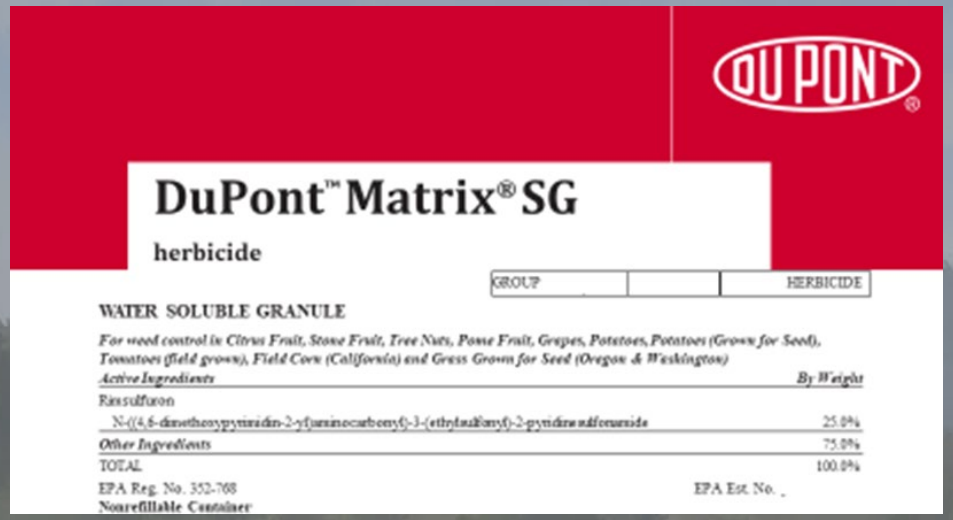
Vineyard Weed Management: Highlights and Take Homes from My Career

John Roncoroni,
UC Cooperative Extension
North Coast Weed Science Advisor

Foothill Grape Day 2020
Tuesday, March 31 - 11:00 – 11:45 am

Optimizing Herbicide Applications



- Start with a clean field, using either a burndown herbicide application or tillage

- Reduced residual weed control may occur when burndown applications are made to fields where heavy crop and/or weed residue

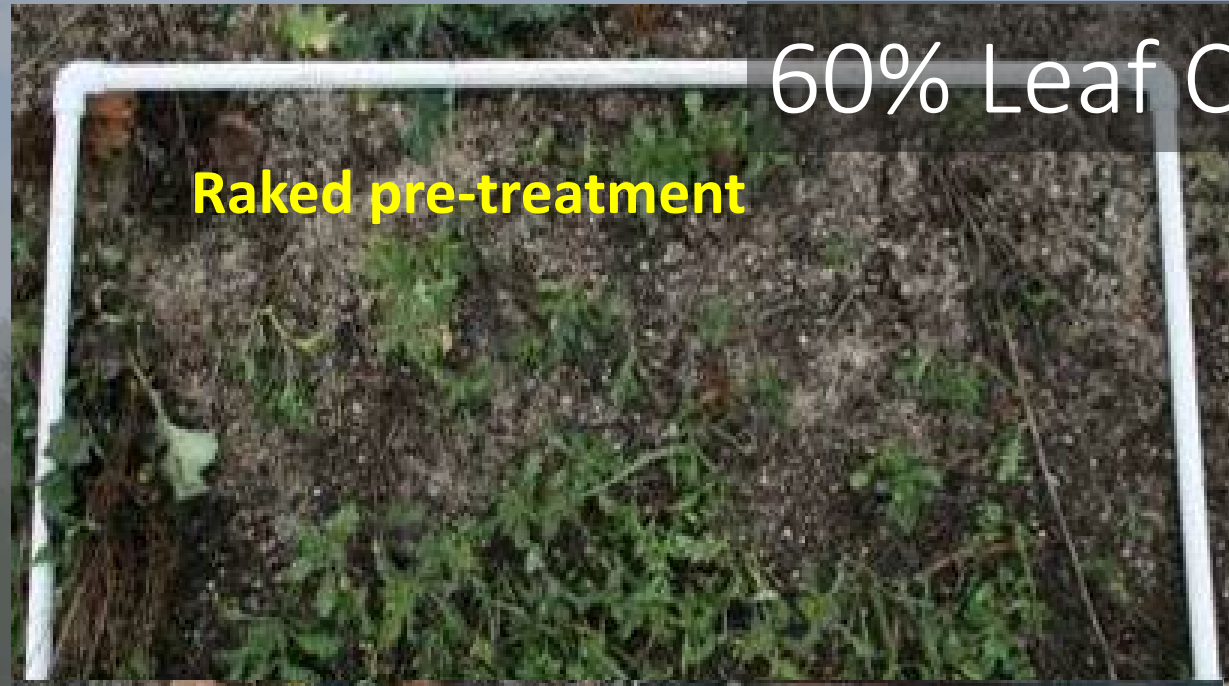
Remove leaves and debris

Plots raked and treated with 10 oz Chateau +24 oz Roundup

Raking Study

- 8 sets of paired treatments- either leaves raked or leaves left.
- Plots raked at 11:30 AM 12/19/07
- Plots treated 12:30 PM 12/19/07
- Treated with 10 oz Chateau +24 oz Roundup with OC nozzles sprayed from both sides of row.
- Each plot 4 vines (24 feet) long
- Merlot grapes

60% Leaf Cover



	March 1 (75 DAT)	
% Leaf Cover	% Fillaree Cover	
	Raked	Not
60	5	50
50	7	30
50	15	40
40	3	20
40	5	10
33	1	15
25	5	20
Ave	8.30%	28%

	March 1 (75 DAT)		June 12 (180 DAT)	
% Leaf Cover	% Fillaree Cover		% Willowherb control	
	Raked	Not	Raked	Not
60	5	50	100	70
50	7	30	100	50
50	15	40	90	40
40	3	20	90	50
40	5	10	100	70
33	1	15	90	70
25	5	20	100	70
Ave	8.30%	28%	96%	60%

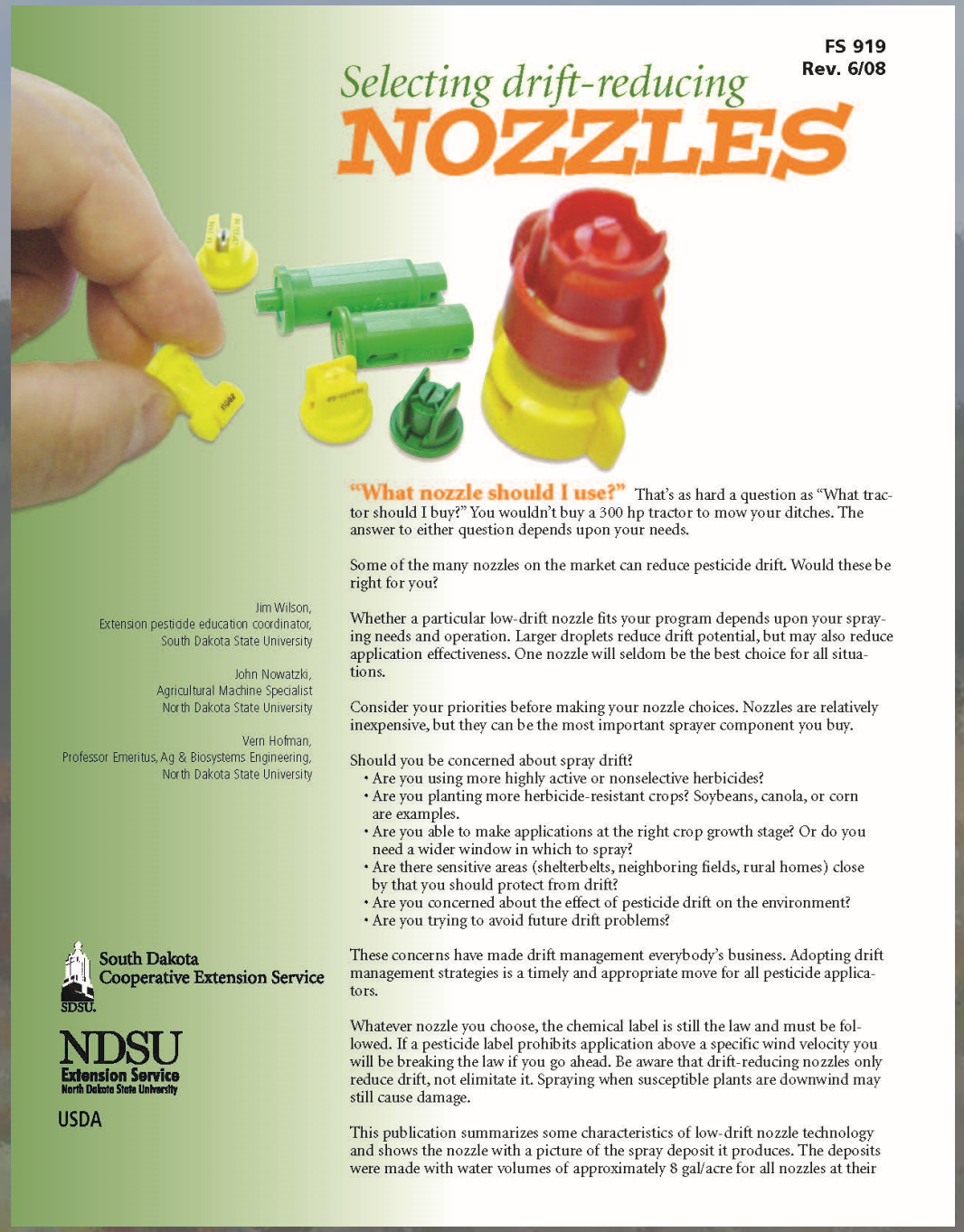

Willowherb

Average 25% leaf cover- worth it?

A single well-timed preemergence herbicide treatment can improve weed control for several years

Spray nozzles are the least expensive part of any spray job, but are often the most overlooked!

Nozzles have been engineered to produce spray droplets of a given size for a given pattern.



FS 919
Rev. 6/08

Selecting drift-reducing NOZZLES

Jim Wilson,
Extension pesticide education coordinator,
South Dakota State University

John Nowatzki,
Agricultural Machine Specialist
North Dakota State University

Vern Hofman,
Professor Emeritus, Ag & Biosystems Engineering,
North Dakota State University

"What nozzle should I use?" That's as hard a question as "What tractor should I buy?" You wouldn't buy a 300 hp tractor to mow your ditches. The answer to either question depends upon your needs.

Some of the many nozzles on the market can reduce pesticide drift. Would these be right for you?

Whether a particular low-drift nozzle fits your program depends upon your spraying needs and operation. Larger droplets reduce drift potential, but may also reduce application effectiveness. One nozzle will seldom be the best choice for all situations.

Consider your priorities before making your nozzle choices. Nozzles are relatively inexpensive, but they can be the most important sprayer component you buy.

Should you be concerned about spray drift?

- Are you using more highly active or nonselective herbicides?
- Are you planting more herbicide-resistant crops? Soybeans, canola, or corn are examples.
- Are you able to make applications at the right crop growth stage? Or do you need a wider window in which to spray?
- Are there sensitive areas (shelterbelts, neighboring fields, rural homes) close by that you should protect from drift?
- Are you concerned about the effect of pesticide drift on the environment?
- Are you trying to avoid future drift problems?

These concerns have made drift management everybody's business. Adopting drift management strategies is a timely and appropriate move for all pesticide applicators.

Whatever nozzle you choose, the chemical label is still the law and must be followed. If a pesticide label prohibits application above a specific wind velocity you will be breaking the law if you go ahead. Be aware that drift-reducing nozzles only reduce drift, not elimitate it. Spraying when susceptible plants are downwind may still cause damage.

This publication summarizes some characteristics of low-drift nozzle technology and shows the nozzle with a picture of the spray deposit it produces. The deposits were made with water volumes of approximately 8 gal/acre for all nozzles at their

South Dakota Cooperative Extension Service
SDSU.

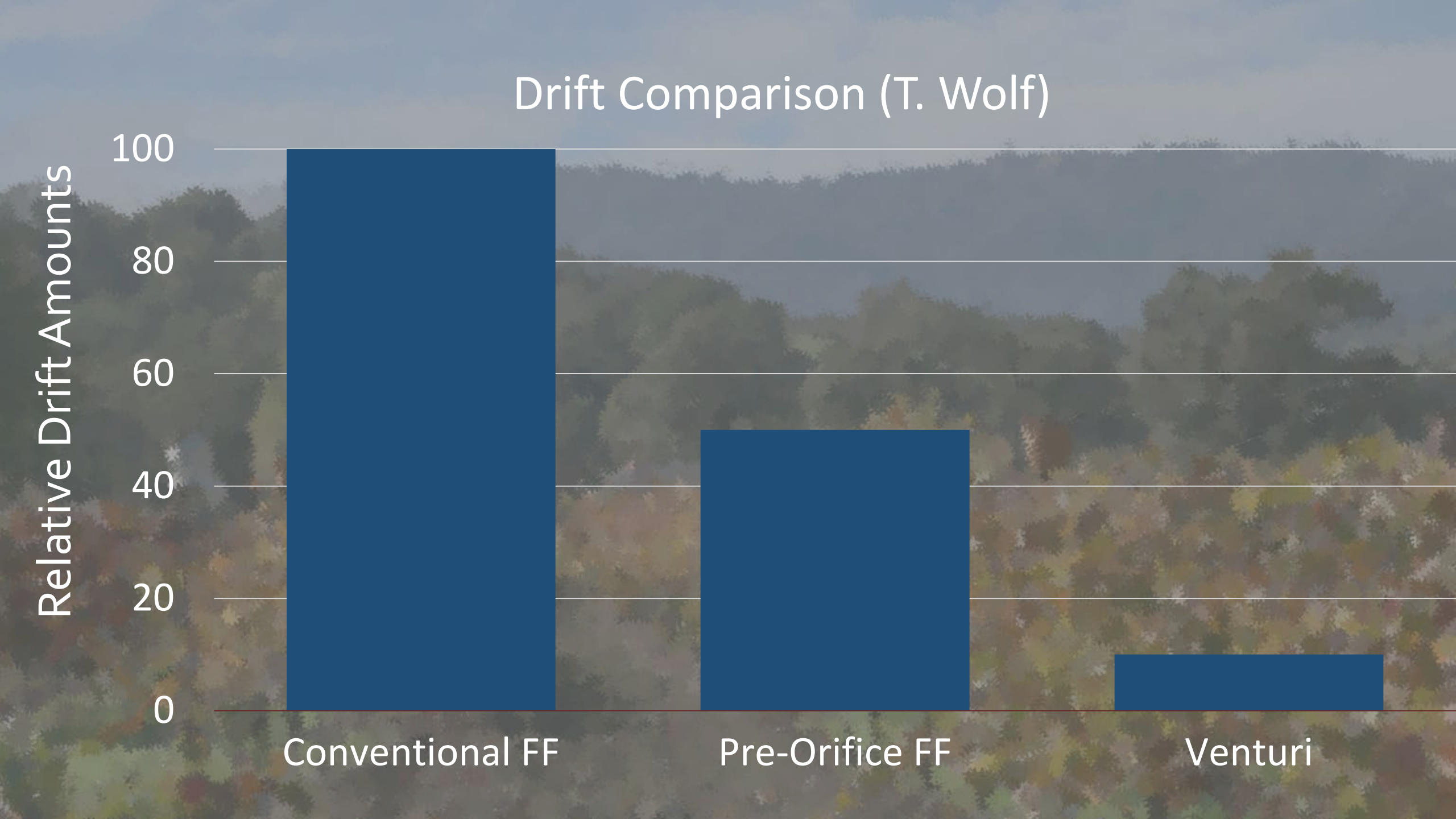
NDSU Extension Service
North Dakota State University

USDA

- Further acknowledge:
  - Kurt Hembree, UCCE Fresno
  - Kassim al Khatib, UC Davis
  - Ken Giles, UC Davis (Emeritus)
  - Bob Wolf, Wolf Consulting and Research, LLC, Mahomet, IL (Retired)
  - Tom Wolf of Agri-metrix Research and Training, Saskatoon.

Nozzle choice

- Directly affects:
  - spray droplet size
  - spray drift potential
  - uniformity and coverage
- Which impacts:
  - weed control
  - economics
  - environmental quality

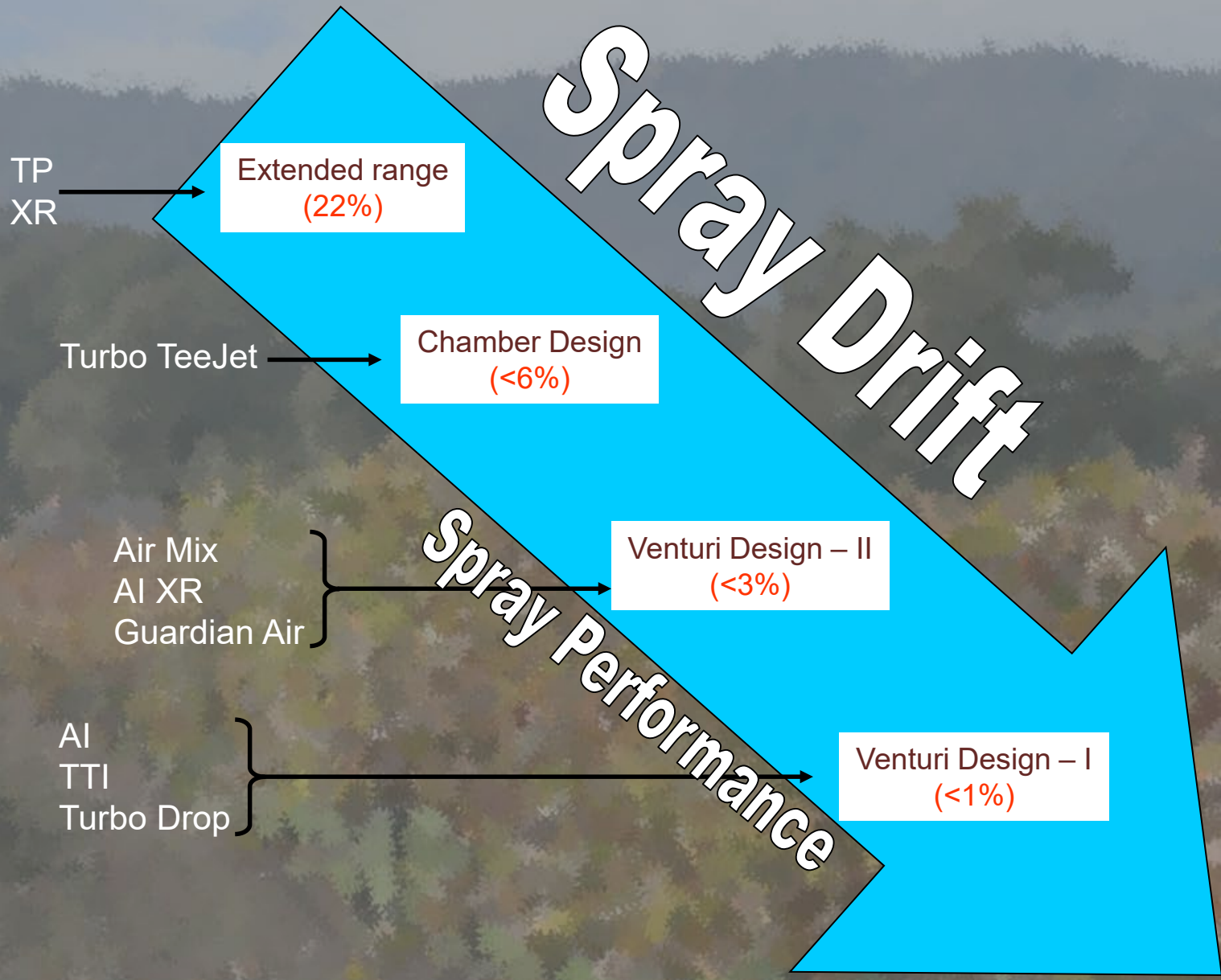

Drift Comparison (T. Wolf)
Relative Drift Amounts
100
80
60
40
20
0
Conventional FF
Pre-Orifice FF
Venturi

Spray nozzles, drift, and performance

Dr. Kassim Al-Khatib, UCIPM Program

TeeJet® Broadcast Nozzle Selection Guide

	Herbicides		
	Soil Applied	Post-Emergence	
		Contact	Systemic
Turbo TeeJet®		Very Good	Very Good
Turbo TeeJet® at pressures below 30PSI	Good	Good	Excellent
Turbo TwinJet®	Good	Excellent	Excellent
Turbo TwinJet® at pressures below 30PSI	Very Good	Very Good	Excellent
XR, XRC TeeJet®		Excellent	Good
XR, XRC TeeJet® at pressures below 30PSI	Good	Good	Very Good
AIXR TeeJet®	Very Good	Good	Excellent
AI, AIC TeeJet®	Very Good	Good	Excellent
Air Induction Turbo TwinJet®	Very Good	Good	Excellent



NOZZLE TYPE (0.5 GPM FLOW) 110 angle nozzle	Approx. Percent of Spray Volume less than 150 Microns	
	15 psi	40 psi
XR-Extended Range TeeJet	19%	30%
TT-Turbo TeeJet	4%	13%
TT360 Turbo TwinJet	3%	10%
AIXR-Air Induction XR	2%	7%
AI-Air Induction TeeJet	N/A	5%

Extended Range Flat Fan

Dv0.1 =171 Dv0.5 =365 Dv0.9 =532 40 psi 8 gpa

Turbo TeeJet

Dv0.1 =153 Dv0.5 =307 Dv0.9 =475 40 psi 8 gpa

* Note: Spot cards have been enlarged to show differences in drop sizes.

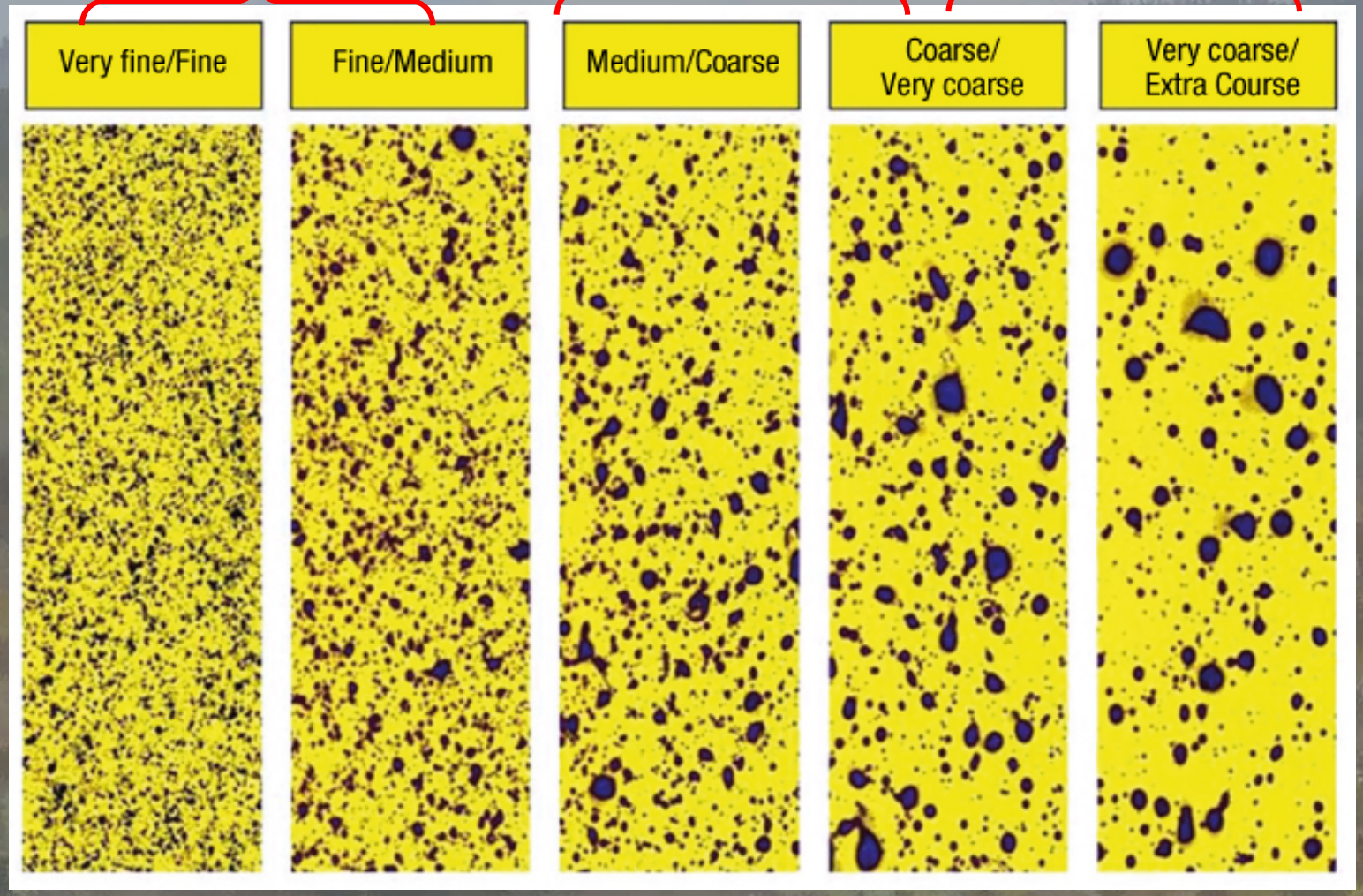
Greenleaf TurboDrop XL

Dv0.1=160 Dv0.5=323 Dv0.9=474 70 psi 8 gpa

TeeJet Air Induction (AI)

Dv 0.1=210 Dv0.5=394 Dv0.9=563 70 psi 8 gpa

Coverage Requirements



Off-Center, OC nozzle

Postemergence Herbicides Registered for Use on Bearing Grapes

Systemic Herbicides

Broadleaves

- 2,4-D

Grasses

- Fusilade
- Poast

Contact Herbicides

- Rely
- Goal
- Shark
- Gramoxone
- Venue
- Organic Herbicides

Spray nozzle choices for herbicide application, drift management, and herbicide performance.

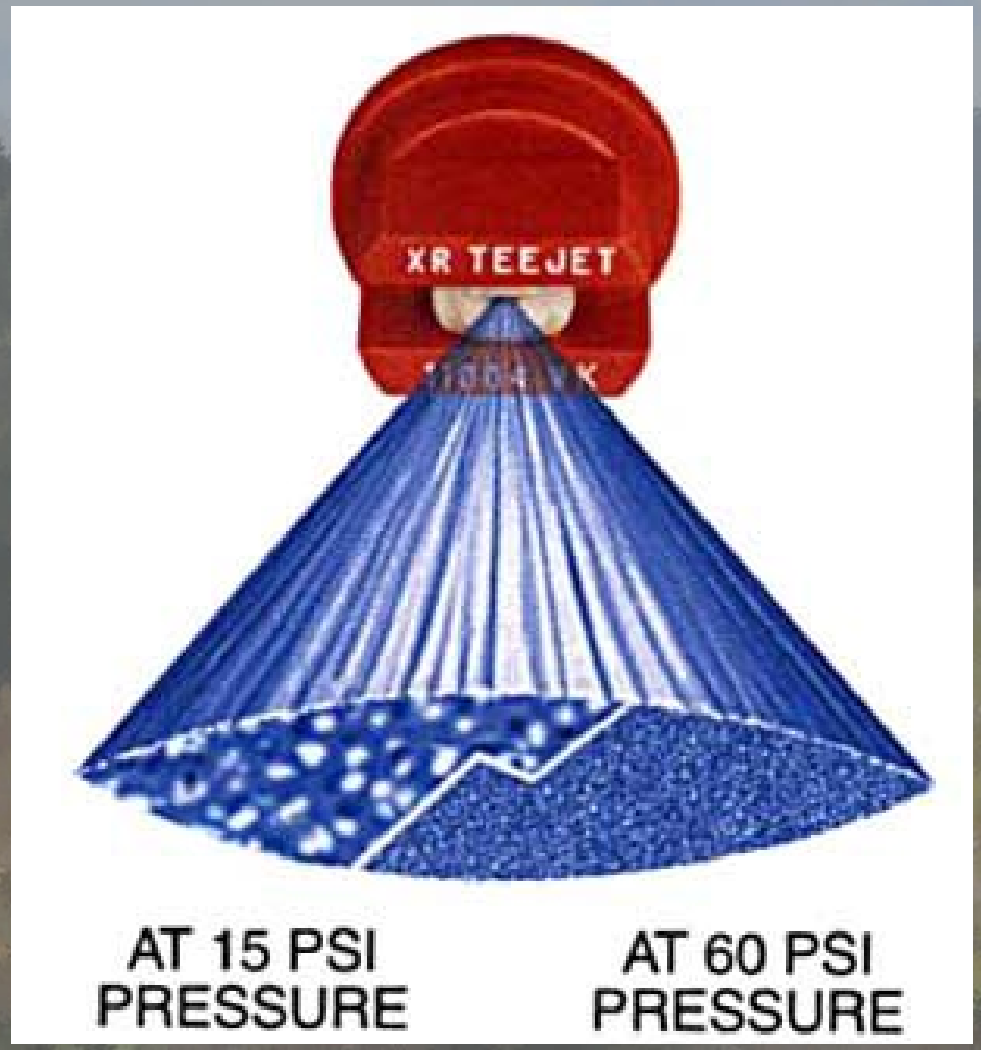
Table 1. Spray nozzle description, operating pressure, droplet size, drift, and general herbicide use patterns

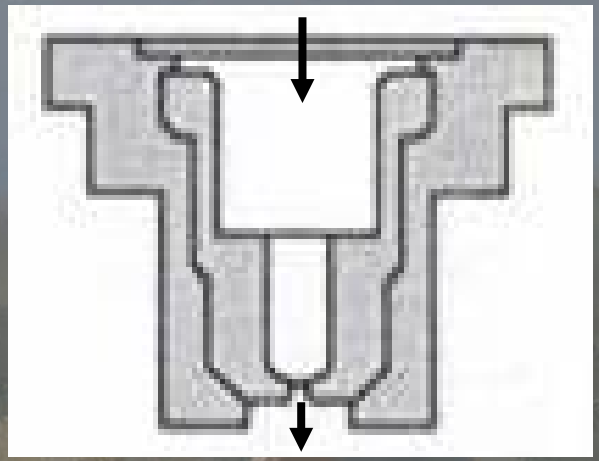
Spray Nozzle Description	PSI range	Droplet size	Drift management	Preemergents	Systemics	Contacts
Extended Range (XR) flat fan	15 – 60	F-C (15 psi) VF-M (50 psi)	Good (15-20 psi)	Good	Very Good (15-30 psi)	Good (>40 psi)
Off-Center	30 – 60	M-VC	Good (>size 06)	Very good**	Good**	Poor
Turbo TeeJet	15 – 90	M-XC	Very good (<30 psi)	Good	Excellent (<30 psi)	Good
Drift Guard TeeJet	30 – 60	F-C	Good	Good	Good	Poor
Air Induction	30 – 100	C-XC	Excellent	Very good	Excellent	Good
Air Induction XR	15 – 90	M-XC	Excellent	Very good	Excellent	Good
Turbo TeeJet Induction	15 – 100	XC	Excellent	Excellent	Excellent	Poor
TwinJet	30 – 60	F-M	Poor	Poor	Good	Excellent
Drift Guard TwinJet	30 – 60	F-C	Very good	Very good	Excellent	Very good
Turbo TwinJet	20 - 90	M-XC	Excellent (20 psi)	Very good (<30 psi)	Excellent (<30 psi)	Very good (>30 psi)

VF (very fine), F (fine), M (medium), C (coarse), XC (extra coarse)

Nozzle tip wear: nozzle tip wear depends primarily on tip material:
(wears quickly) brass > polyacetyl > stainless > ceramic > carbide (little to no wear).

Extended Range (XR) Flat Fan

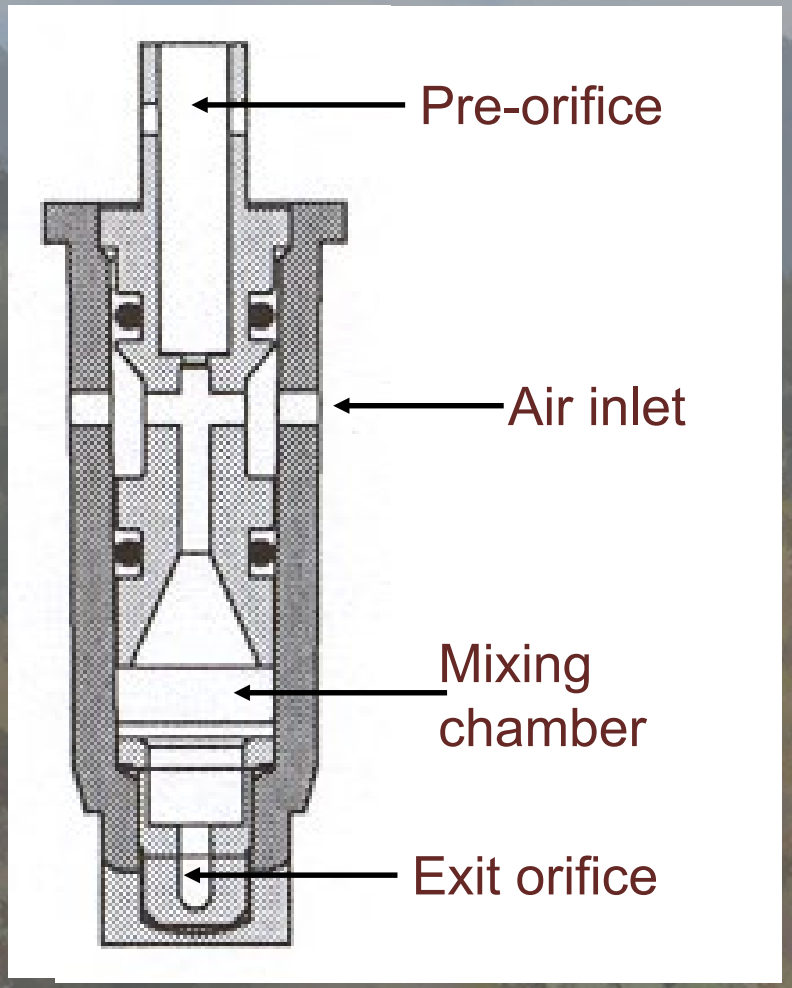




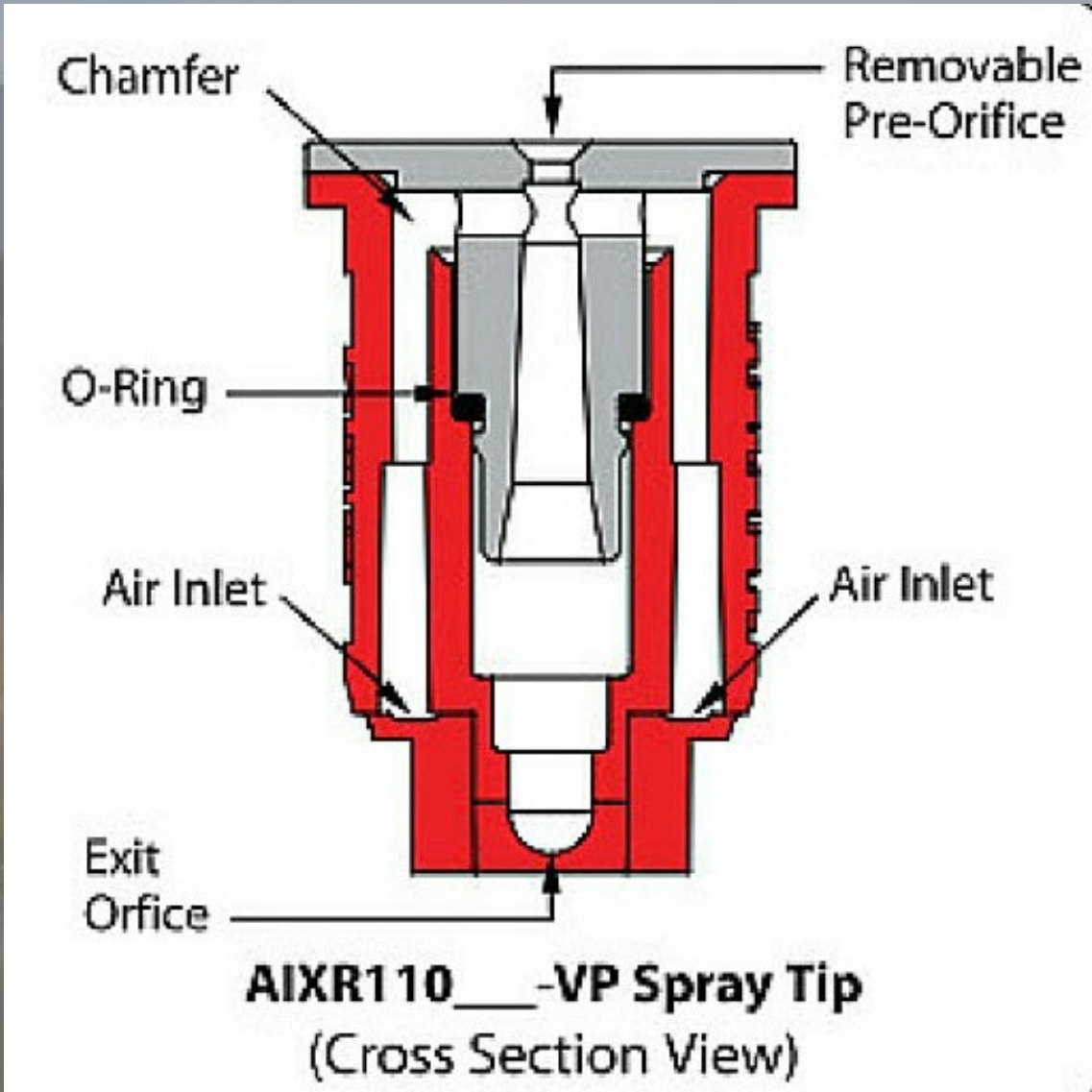
PSI: 15 - 60
C – F (400-145)

Drift rating:
Good (15 - 20 psi)

Air Induction (AI) Flat Fan



Air Induction-Extended Range (AIXR) Flat Fan



AIXR110___-VP Spray Tip

(Cross Section View)

Figure 2. Conventional flat fan spray tips at 40 psi. (Wolf)

Figure 3. Air induction nozzles at 70 psi. (Wolf)

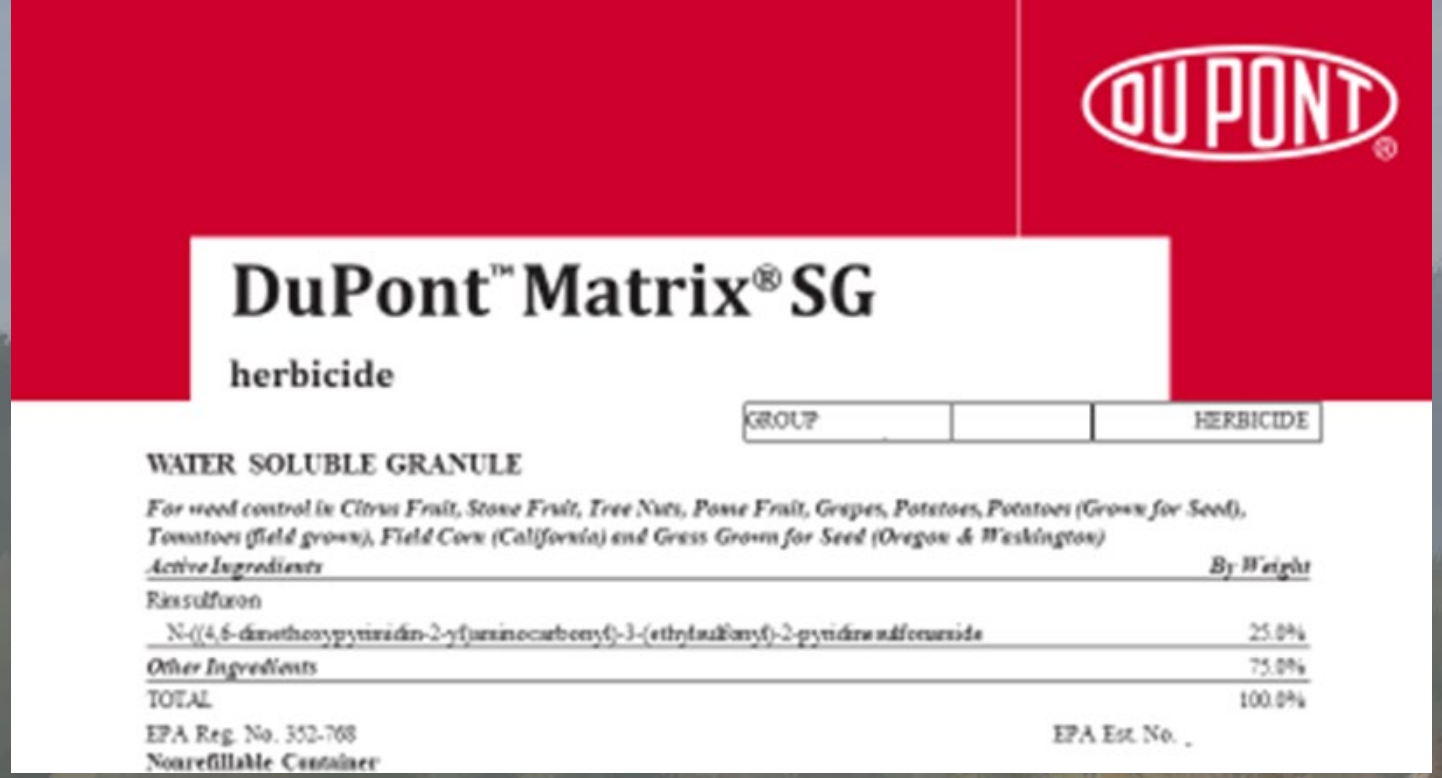

Example

Table 6. Droplet size-classification for nozzle size and pressure (example from Spraying Systems Co.).

	PSI						
	15	20	25	30	40	50	60
XR8001	M	F	F	F	F	F	F
XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

Controlling Spray Droplet Size

Volume Median Diameter (VMD)- VMD is the expression of the droplet size of the spray cloud. The VMD value means that 50% of the droplets are larger than the expressed value and 50% of the droplets are smaller than the expressed value. Optimum SHARK EW Herbicide spray clouds should be 450 microns with fewer than 10% of the droplets being 200 microns or less.



DuPont™ Matrix® SG

herbicide

GROUP		HERBICIDE

WATER SOLUBLE GRANULE

For weed control in Citrus Fruit, Stone Fruit, Tree Nuts, Pome Fruit, Grapes, Potatoes, Potatoes (Grown for Seed), Tomatoes (field grown), Field Corn (California) and Grass Grown for Seed (Oregon & Washington)

Active Ingredients	*By Weight*
Rimsulfuron	
N-((4,6-dimethoxypyrimidin-2-yl)aminocarbonyl)-3-(ethylsulfonyl)-2-pyridinesulfonamide	25.0%
Other Ingredients	75.0%
TOTAL	100.0%

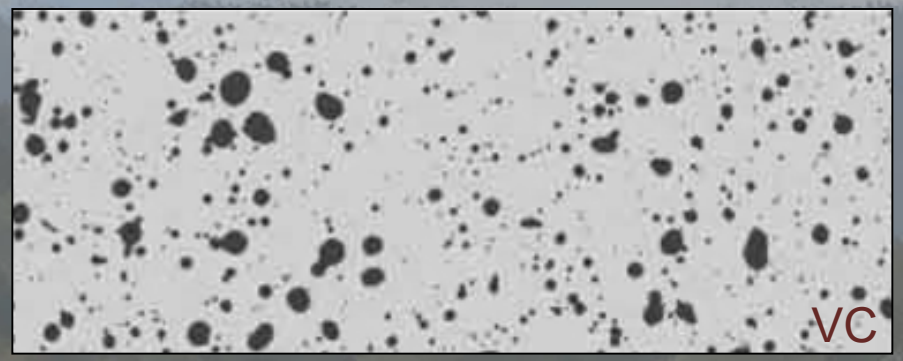
EPA Reg. No. 352-768 EPA Est. No.

Nonrefillable Container

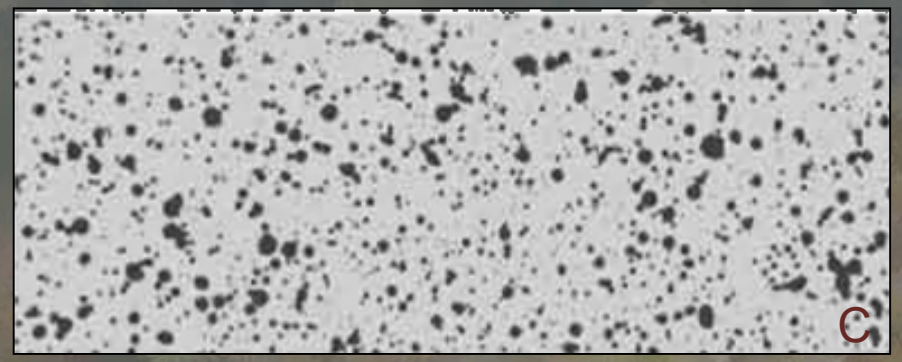
For applications prior to the emergence of crops and target weeds, applicators are required to use a Coarse or coarser droplet size (ASABES572.1). • For all other applications, applicators are required to use a Medium or coarser dropletsize (ASABE S572.1)

Droplets <~200 µm drift more

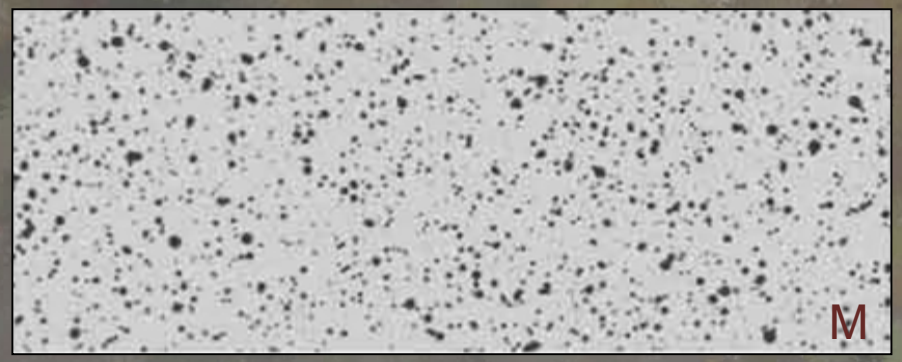
410 microns



340 microns



235 microns



Less Drift

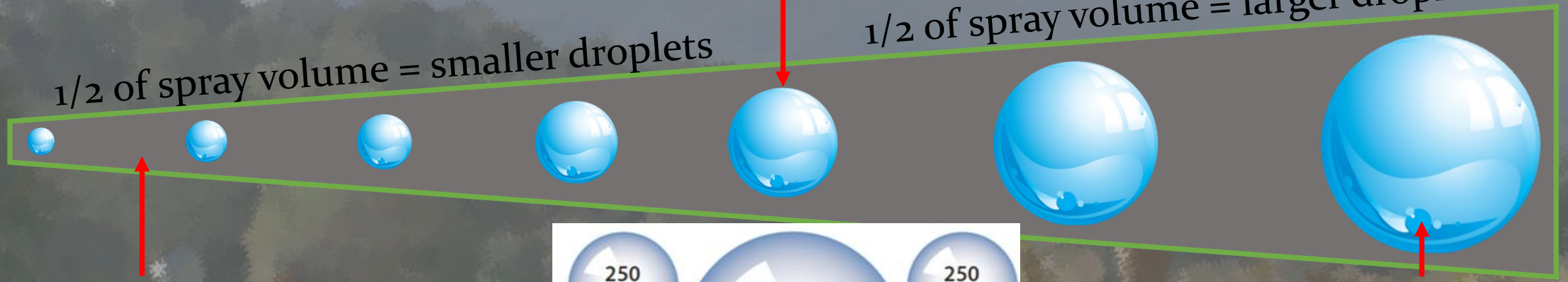
Better coverage, but more drift

Significance of Droplet Design

Volume Mean Diameter
"VMD" or "DV0.5"

1/2 of spray volume = smaller droplets

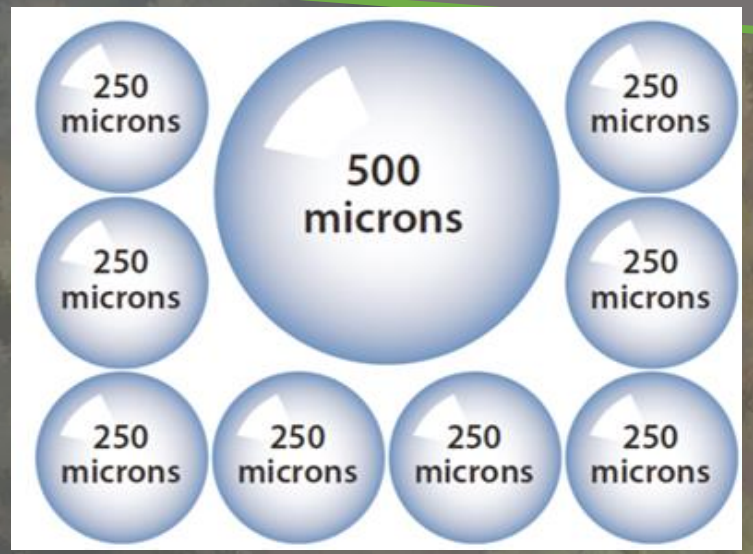
1/2 of spray volume = larger droplets



"DV0.1"

"DV0.9"

10% of volume contains droplets smaller than *this* micron size.



90% of volume contains droplets larger than *this* micron size.

- You have XR 8004 vs nozzles delivering 0.4 gallons of spray solution per minute at 40 psi. An XR 8004 nozzle at 40 psi corresponds to an ‘M’ for medium droplet size or a VMD range of 226-325 microns.

- You want to apply SHARK herbicide. It requires a VMD of at least 450- What do you do?

Droplet size classification
(droplets <~200 microns drift more)

Spray droplet diameter (µm)	Spray droplet category	Example
10	---	Dry fog
<145	Very fine	Wet fog
145-225	Fine	Fine mist/drizzle
226-325	Medium	Very fine rain
326-400	Coarse	Fine rain
401-500	Very coarse	Light rain
>500	Extremely coarse	Medium rain
1000	---	Heavy rain

Table 6. Droplet size-classification for nozzle size and pressure (example from Spraying Systems Co.).

	PSI						
	15	20	25	30	40	50	60
XR8001	M	F	F	F	F	F	F
XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

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XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
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XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

AIXR TeeJet® (AIXR)

	PSI										
	15	20	25	30	35	40	50	60	70	75	90
AIXR110015	XC	XC	VC	C	C	C	C	M	M	M	M
AIXR11002	XC	XC	XC	VC	VC	C	C	C	C	M	M
AIXR110025	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11003	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11004	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11005	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11006	UC	XC	XC	XC	XC	XC	VC	VC	VC	C	C

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XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

AIXR TeeJet® (AIXR)

	PSI										
	15	20	25	30	35	40	50	60	70	75	90
AIXR110015	XC	XC	VC	C	C	C	C	M	M	M	M
AIXR11002	XC	XC	XC	VC	VC	C	C	C	C	M	M
AIXR110025	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11003	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11004	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11005	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11006	UC	XC	XC	XC	XC	XC	VC	VC	VC	C	C

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XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

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	PSI										
	15	20	25	30	35	40	50	60	70	75	90
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AIXR110025	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11003	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11004	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11005	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11006	UC	XC	XC	XC	XC	XC	VC	VC	VC	C	C

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XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C

AIXR TeeJet® (AIXR)

	PSI										
	15	20	25	30	35	40	50	60	70	75	90
AIXR110015	XC	XC	VC	C	C	C	C	M	M	M	M
AIXR11002	XC	XC	XC	VC	VC	C	C	C	C	M	M
AIXR110025	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11003	XC	XC	XC	XC	VC	VC	C	C	C	C	C
AIXR11004	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11005	UC	XC	XC	XC	XC	XC	VC	VC	C	C	C
AIXR11006	UC	XC	XC	XC	XC	XC	VC	VC	VC	C	C

- **At 40 psi the AIXR11003 will produce a droplet size ‘VC’ or Very coarse with a VMD range of 401-500 microns that almost is twice the diameter or eight times the volume of the XR8004.**

Field Bindweed

- *Convulvulus arvensis (Convolvulaceae)*
- Perennial with vinelike stem
- Spreads by seed, rhizome and creeping roots.
- Roots can penetrate soil to 10 feet or more.
- Seeds can remain dormant for 15-20 years- or more
- Maximum translocation of carbohydrates from shoots to roots occurs from the bud to full flower stage

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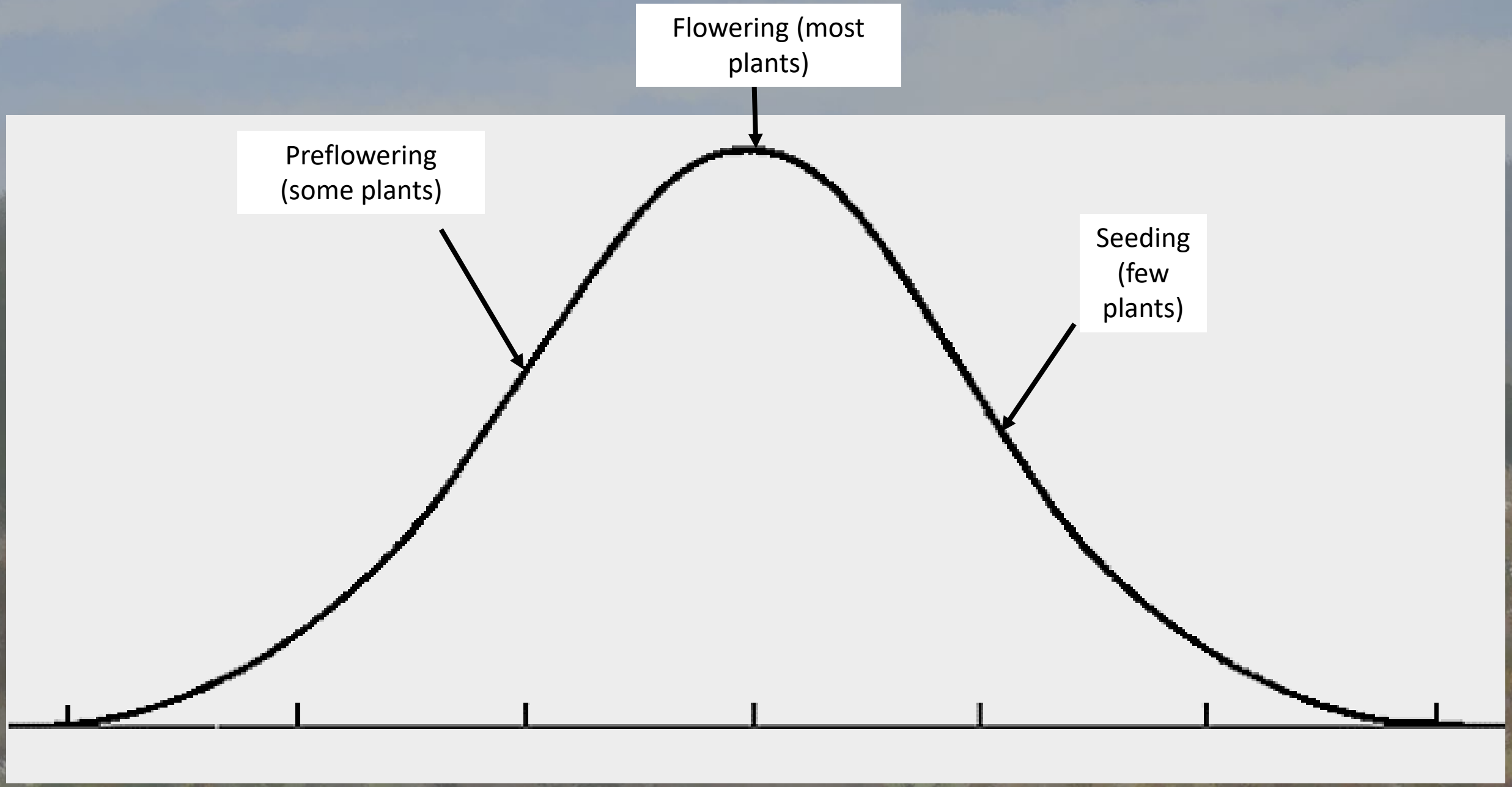
“The Tip of the Iceberg”

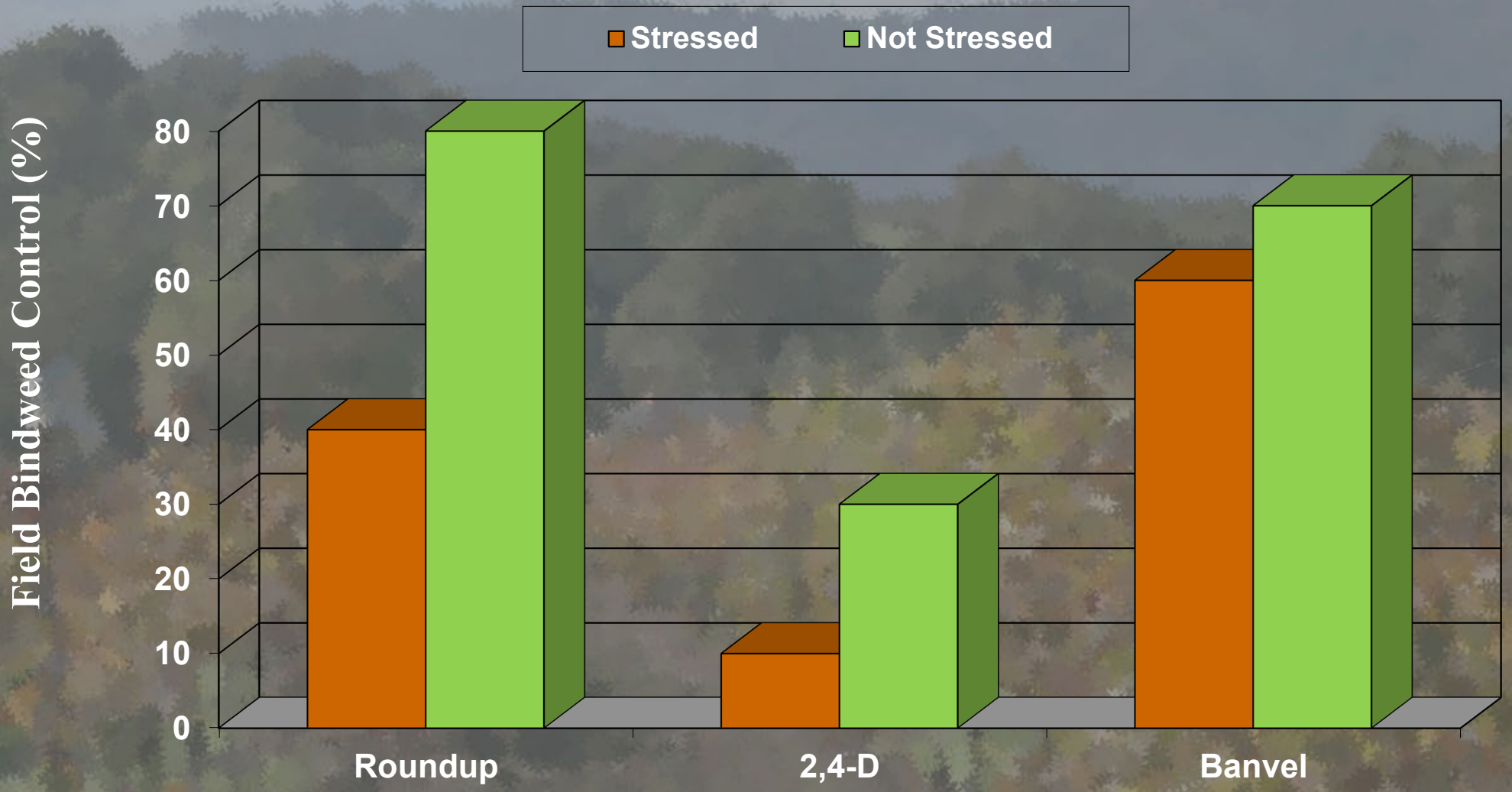
Timing


Flowering (most plants)
Preflowering (some plants)
Seeding (few plants)

Glyphosate Translocation

Photosynthates
(sugars)

Field Bindweed Control Relative to Plant Stress

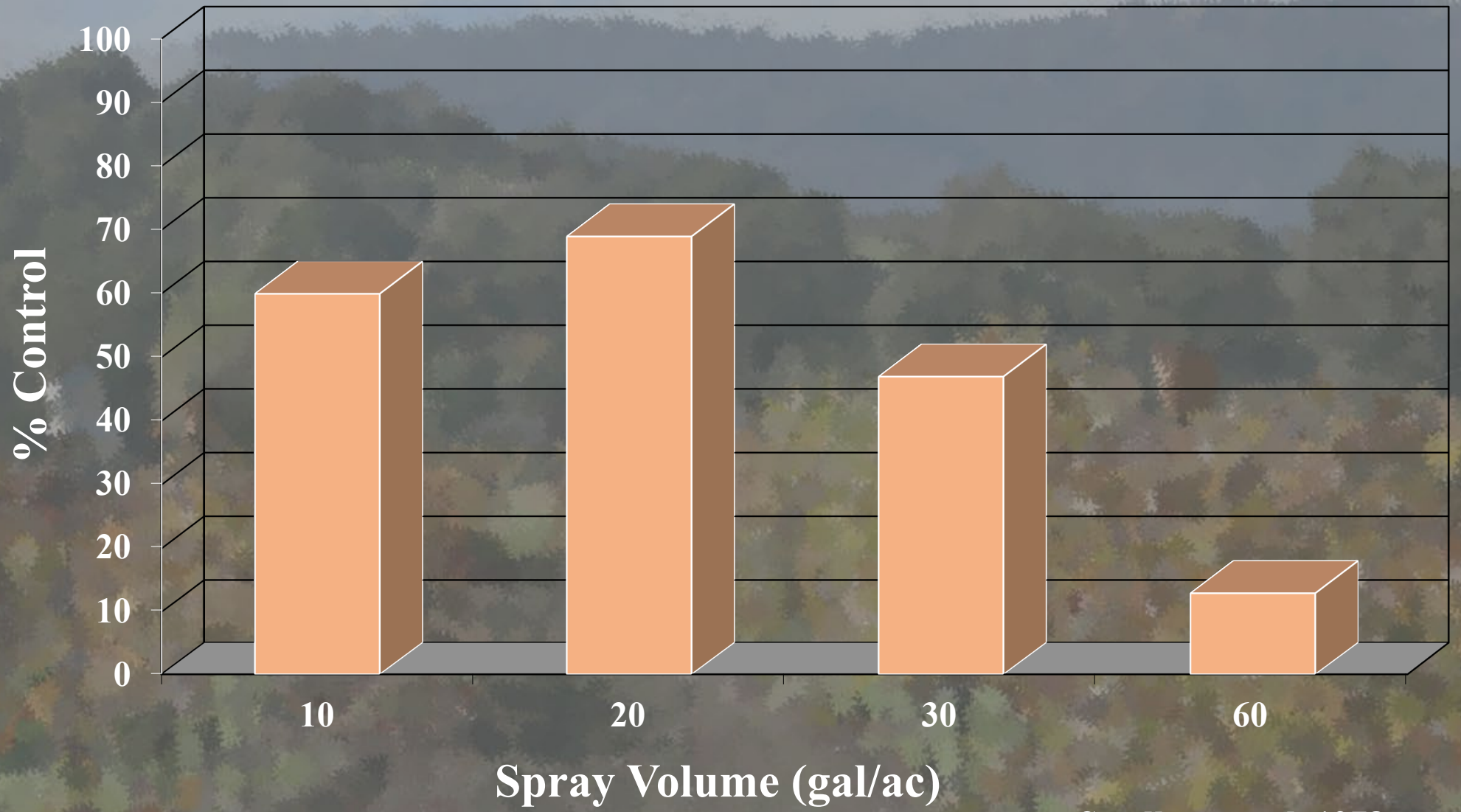


Control 1yr after application

Bayer 1987

Field Bindweed control relative to spray volume

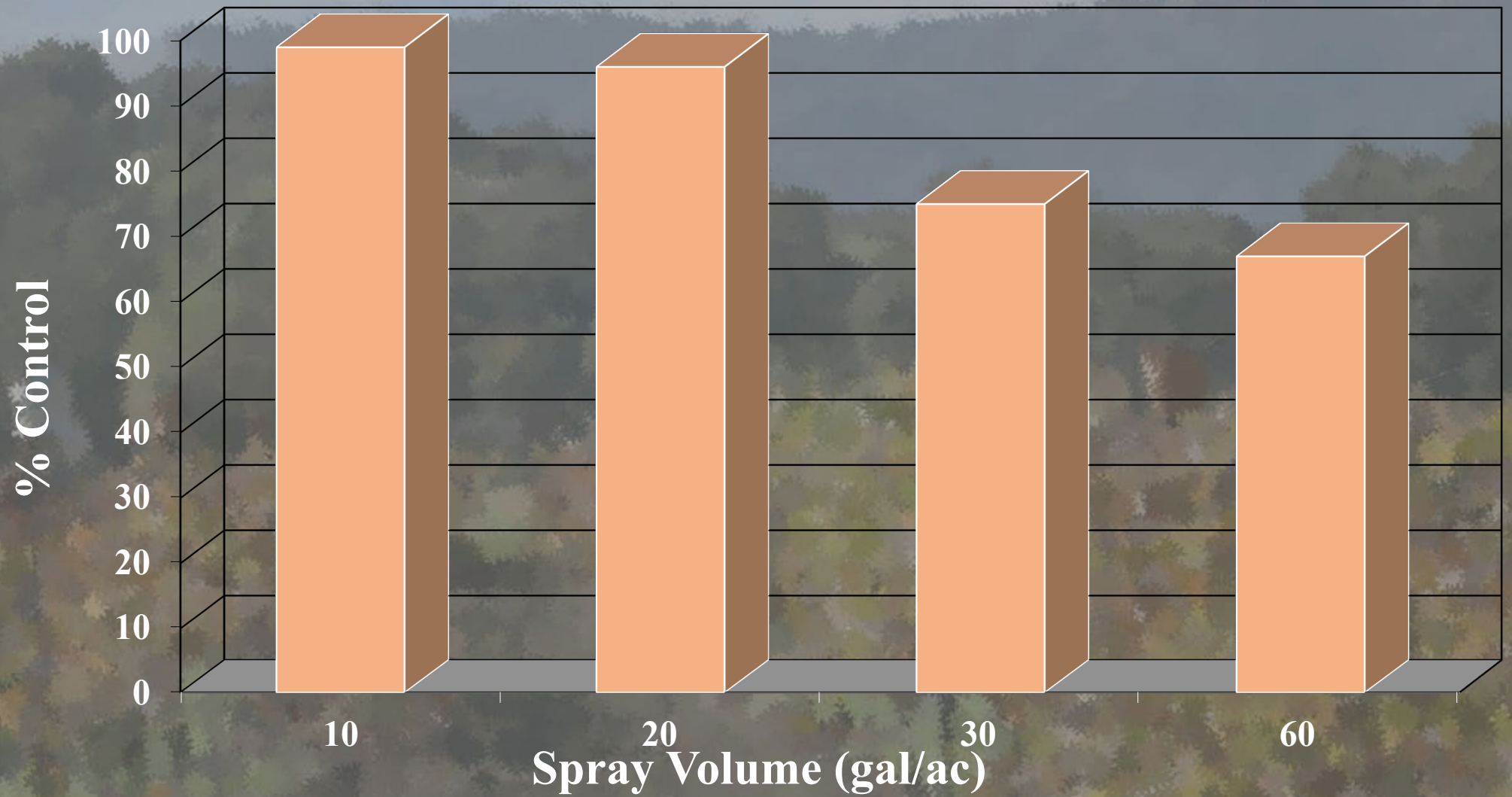
Roundup applied @ **1.50 lbs/ac**



Sandberg et al. 1978

Field Bindweed control relative to spray volume

Roundup applied @ **3.00 lbs/ac**



Sandberg et al. 1978

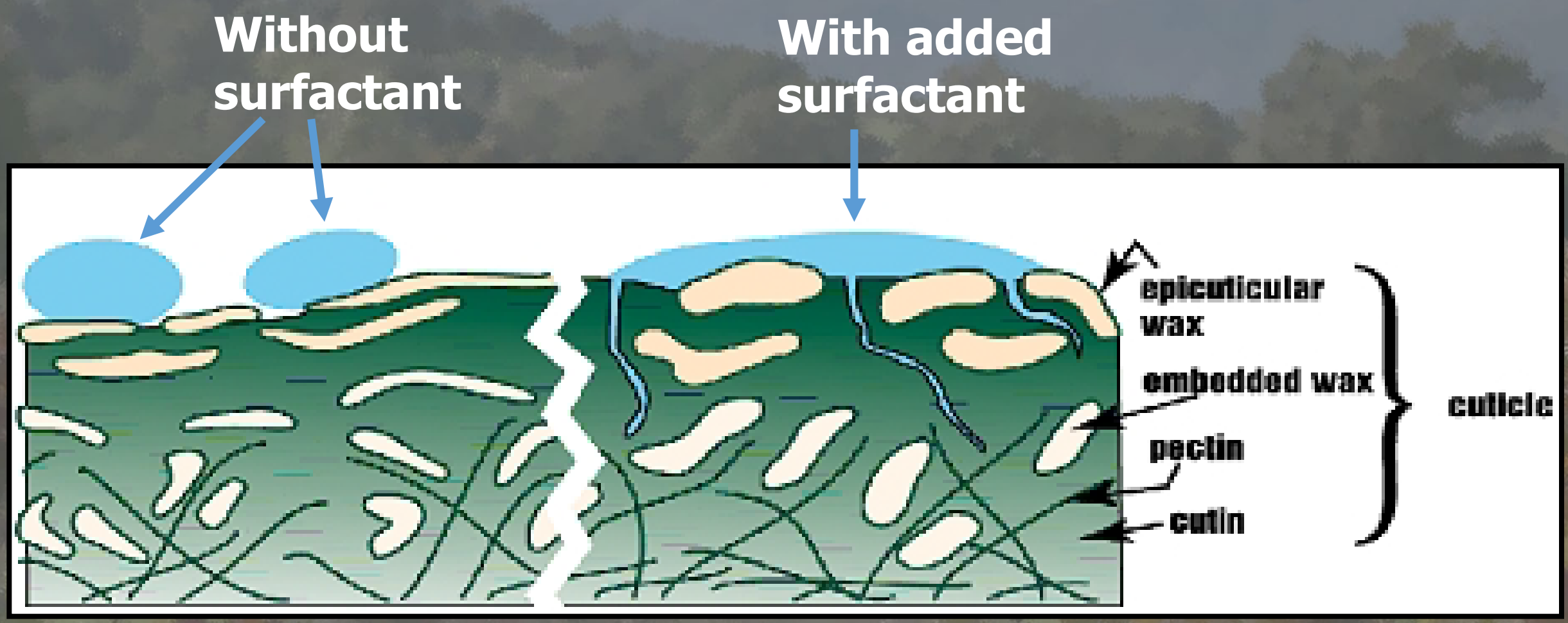
Surfactants

- Surfactants are products that enhance the ability of a herbicide to enter into a leaf or to stay in an aqueous solution
  - Surface Active Agents
- Normally used at 0.25 to 1%, v/v (2 to 8 pt/100 gal)
- Most are nonionic surfactants, although silicon surfactants are also available
- All act on the surface tension of water

Surface Tension of Water

Caused by hydrogen bonding between water molecules

Adding surfactant to the mix can increase herbicide droplet contact with foliage



Fertilizers and Water Conditioners

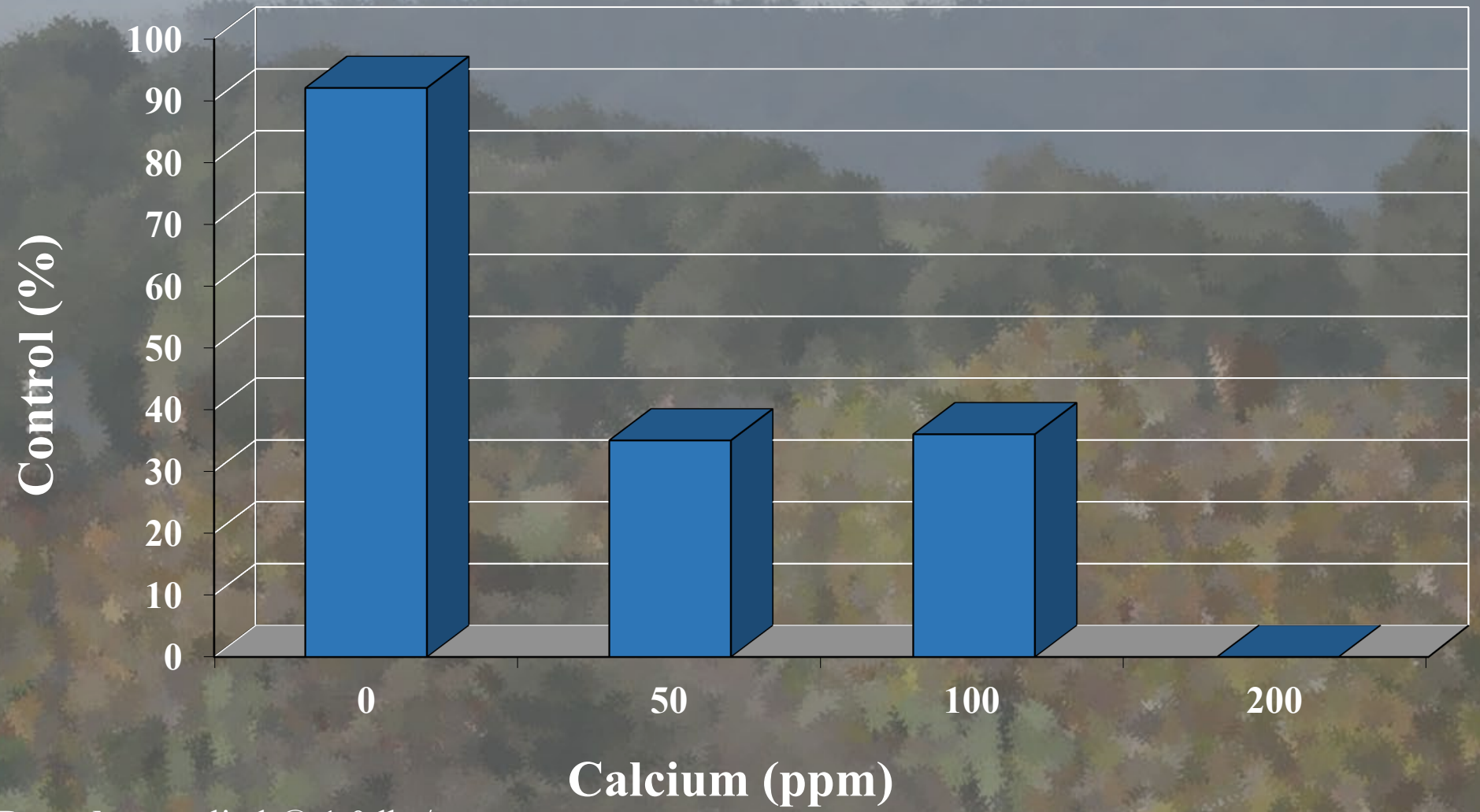
- Fertilizers and water conditioners can decrease antagonism of herbicides in hard water and enhance the ability of a herbicide to be translocated within a plant
- Ammonium Sulfate (AMS) or Ammonium Nitrate (AN)
  - Normally used at 2%, wt/v (17 lbs/100 gals)
- Urea + Ammonium Nitrate (URAN)
  - Liquid formulations containing 28 or 32% N
  - Used at up to 4% v/v (4 gal/100 gal)

Things To Watch Out For

- The threshold level for “hard” water antagonism ranges from 150 ppm for calcium to 300 ppm for sodium
- Compatibility problems from addition of liquid fertilizers
- If dry AMS is used, be sure to filter out non-soluble materials to prevent clogging of nozzles

http://www.culligansw.com

Torpedograss Control relative to Calcium conc.



Roundup applied @ 1.0 lbs/ac

Shilling and Haller 1985

Glyphosate and Hard Water

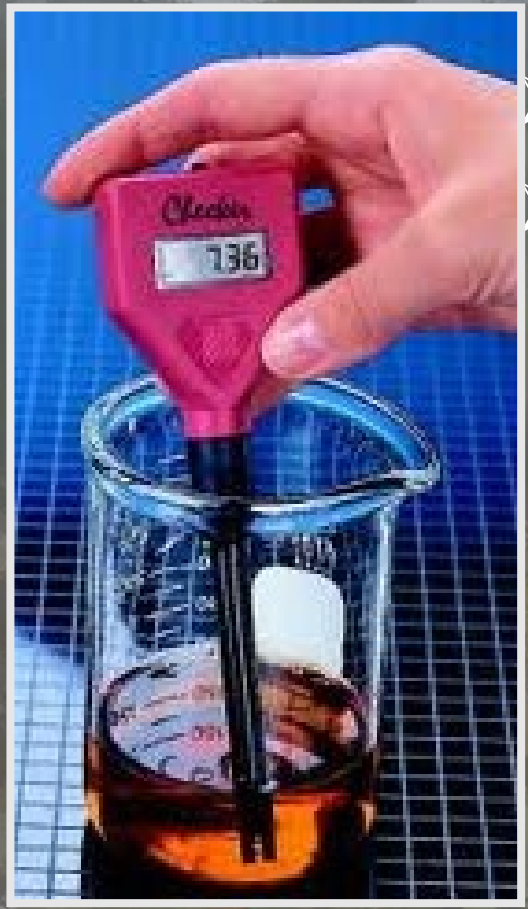
- Glyphosate salts are antagonized by other salts in hard water such as calcium, sodium, magnesium, and iron
  - These elements form cations (positively charged ions) that react with negatively charged glyphosate salts
- Both ammonium (NH_3^{1+}) and sulfate (SO_4^{2-}) active
  - Glyphosate is more readily absorbed into foliage when combined with ammonium than when combined with Ca^{2+}, Na^{1+}, Mg^{2+}, or Fe^{2+} ions
  - Free sulfate binds with Ca^{2+}, Na^{1+}, Mg^{2+}, or Fe^{2+} ions

Wheat fresh weight *% reduction* from Roundup (0.2 lbs/a) at 14 DAT

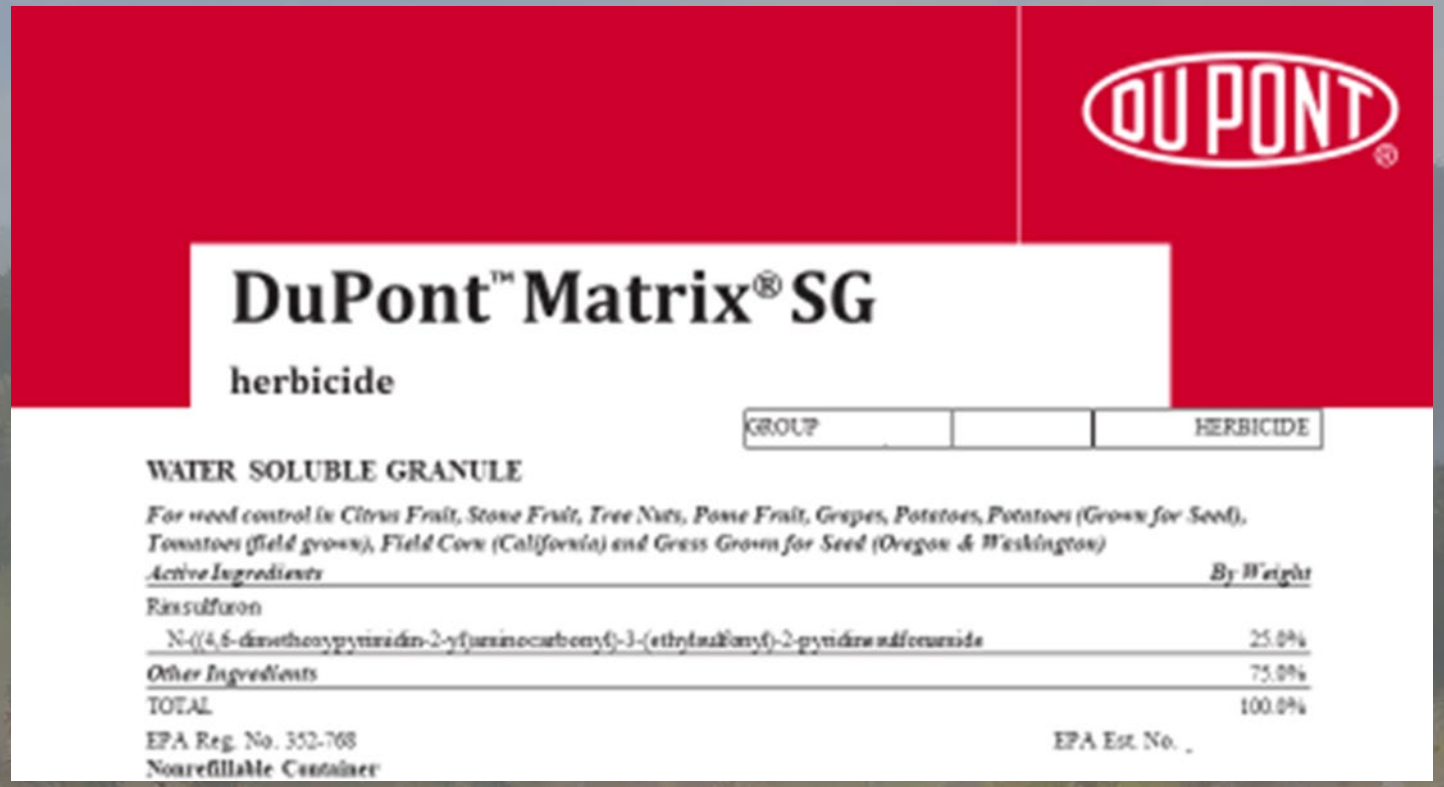
Ammonium Sulfate added	Distilled water	Well water #1	Well water #2
None	79	0	0
2%	84	85	83

Nalewaja and Matysiak 1993

Buffering Agents and Glyphosate



- Buffers modify the pH of a solution
- At low pH, more glyphosate exists as a salt than as the free acid
  - Slightly acidic spray solution applied to leaves results in better glyphosate uptake
  - So when spraying glyphosate, its best to use water with a pH from 4 to 6
  - If water exceeds pH 7, consider using a buffer



DuPont™ Matrix® SG

herbicide

GROUP		HERBICIDE

WATER SOLUBLE GRANULE

For weed control in Citrus Fruit, Stone Fruit, Tree Nuts, Pome Fruit, Grapes, Potatoes, Potatoes (Grown for Seed), Tomatoes (field grown), Field Corn (California) and Grass Grown for Seed (Oregon & Washington)

Active Ingredients	*By Weight*
Rimsulfuron	
N-((4,6-dimethoxypyrimidin-2-yl)aminocarbonyl)-3-(ethylsulfonyl)-2-pyridinesulfonamide	25.0%
Other Ingredients	75.0%
TOTAL	100.0%

EPA Reg. No. 352-768 EPA Est. No. _

Nonrefillable Container

- For best results, maintain spray tank solution at pH 5 to 7.

weed slayer®

controls grass and weeds...sustainably

NON-SELECTIVE HERBICIDE

ACTIVE INGREDIENTS:	
Eugenol:	6.0%
INERT INGREDIENTS:	
Water and Molasses:	94.0%
Total:	**100.0%**

PRODUCT INFORMATION:

WEED SLAYER is a unique broad spectrum natural herbicide made from a Eugenol an essential oil of clove and molasses. It can be applied to control grass and weeds. Results are normally seen in less than a week but can take up to 10 to 14 days.

DIRECTIONS FOR USE:

Apply 1 to 3 quart into 20 and up to 25 gallons of water total (1% to 3% dilution rate). It is recommended to bring the water pH below 4 prior to adding **WEED SLAYER.** When applying, make sure to protect all desirable crop or plants from overspray as **WEED SLAYER** will affect them. Do not apply to young trees or shrubs with green bark. For best results apply with an approved biological amendment. **SHAKE WELL BEFORE USE. KEEP PRODUCT AGITATED IN THE TANK.**

WEED SLAYER is exempted from EPA registration under FIFRA 25 (b).

CAUTION: KEEP OUT OF REACH OF CHILDREN

PRECAUTIONS:

Avoid getting in eyes or on skin or clothing. The use of side-shield safety glasses and gloves is recommended. Harmful if swallowed. If skin contact occurs, remove contaminated clothing and wash with large amounts of soap and water. If in eyes, rinse repeatedly with clean water for 15 minutes. Obtain medical attention for any persistent irritation.

CONTAINER DISPOSAL:

Dispose of waste material in accordance with federal, state and local environmental laws and regulations.

STORAGE:

Keep container sealed tightly when not in use. Keep product in a cool location away from direct sunlight. Store in temperatures below 90° F (32° C).

CONDITIONS OF SALE:

Seller warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on the label when used in accordance with directions under normal use and conditions. Crop injury, inefficacy, or other unintended consequences may result from factors, such as weather conditions, presence of other materials, or the manner of use or application, which are beyond the control of seller. In no case shall seller or its affiliates be liable for consequential, special or indirect damages resulting from the use, handling, or shipping of this product. No warranty is expressed or implied, including warranty of merchantability or fitness for a particular purpose.

NET VOLUME:
2.5 US gal / 9.5 L
NET WEIGHT:
10.61 kg / 23.4 lb.

LOT: MMDDYYXX-# **EXP:** MM YY

REGISTERED MATERIAL For Use In Organic Agriculture Washington State Dept. of Agriculture

ÖKO-GARANTIE BCS AGRINPUT

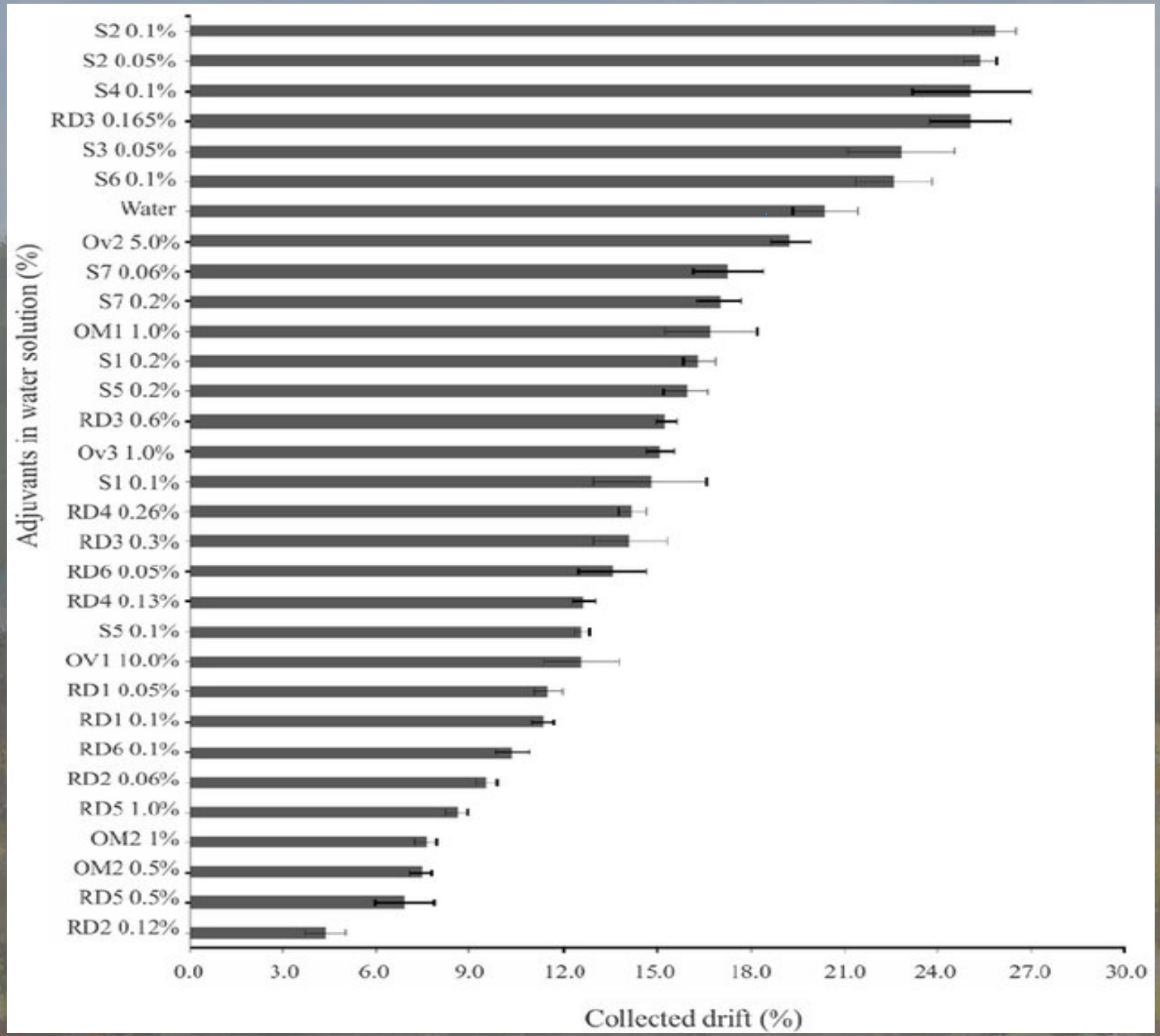
FOR COMMERCIAL USE ONLY
Manufactured in the USA

From the farm to the table...sustainably

MANUFACTURED BY:
Agro Research International LLC
29203 State Road 46
Sorrento, FL 32776
(407) 302 6116
www.agroresearchinternational.com

Use spray additives within label guidelines to reduce production of small spray droplets

But which one, and how much will it help?


S2 0.1%
S2 0.05%
S4 0.1%
RD3 0.165%
S3 0.05%
S6 0.1%
Water
Ov2 5.0%
S7 0.06%
S7 0.2%
OM1 1.0%
S1 0.2%
S5 0.2%
RD3 0.6%
Ov3 1.0%
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RD6 0.1%
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RD5 1.0%
OM2 1%
OM2 0.5%
RD5 0.5%
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Adjuvants in water solution (%)
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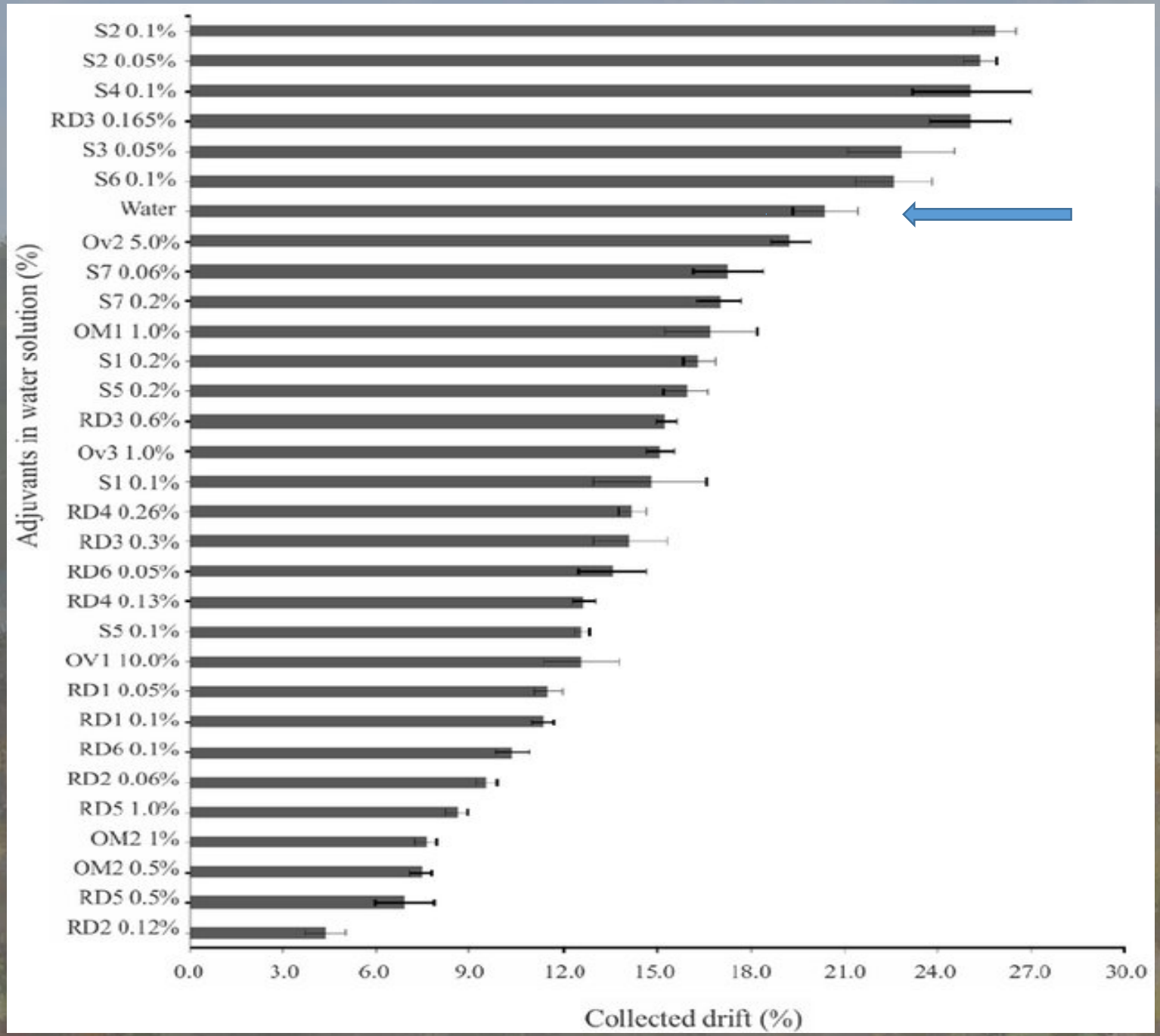
Collected drift (%)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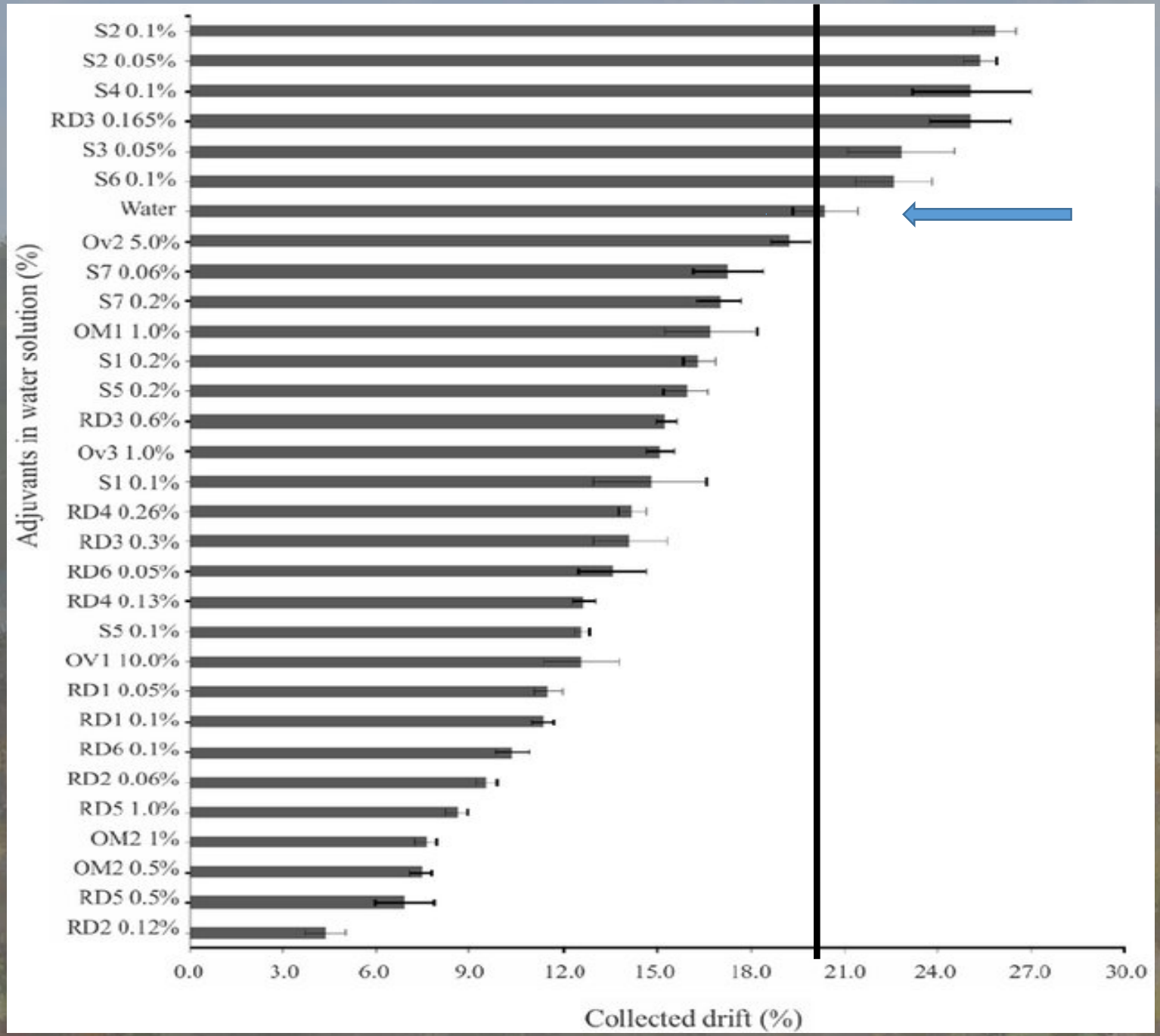
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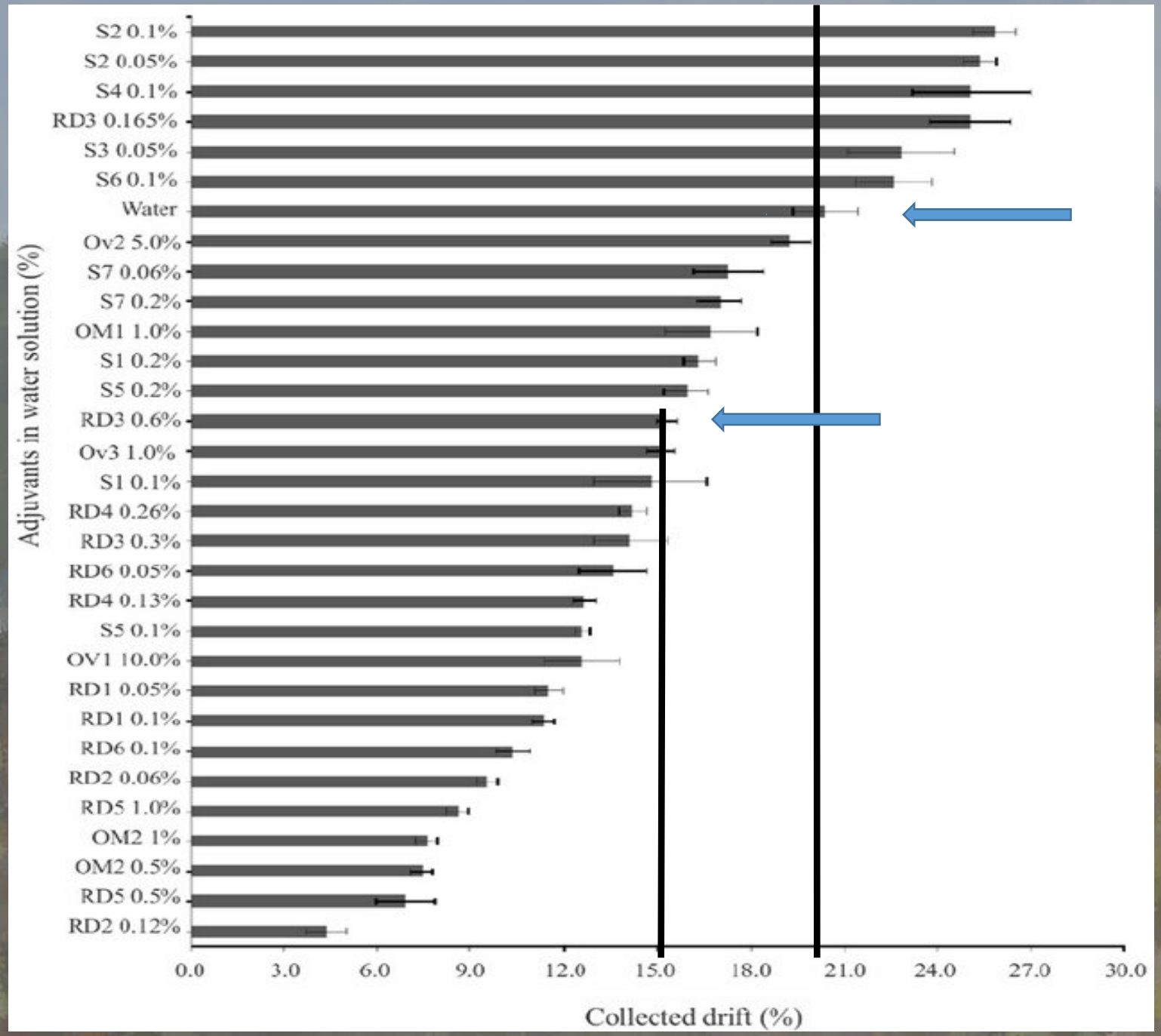
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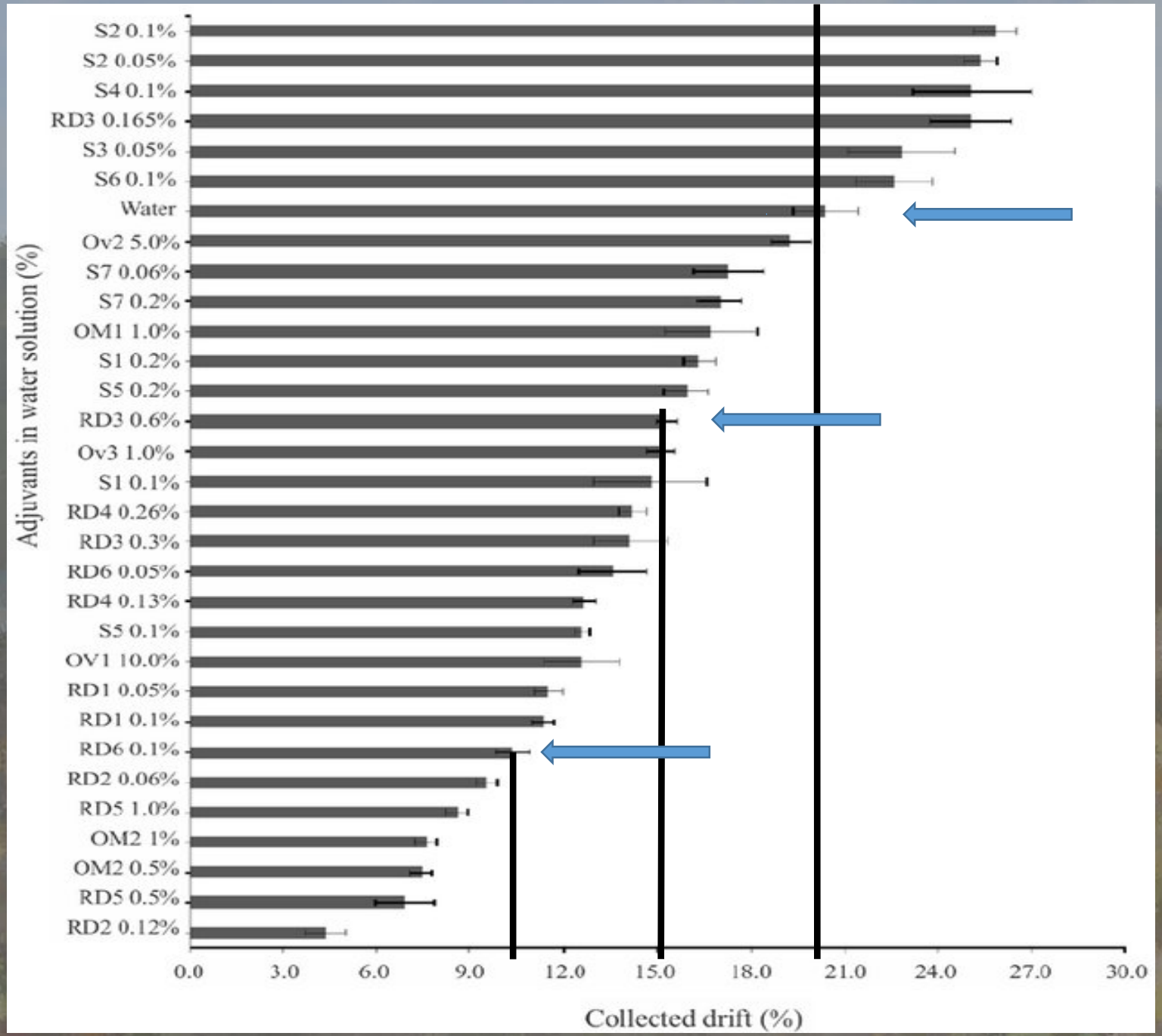
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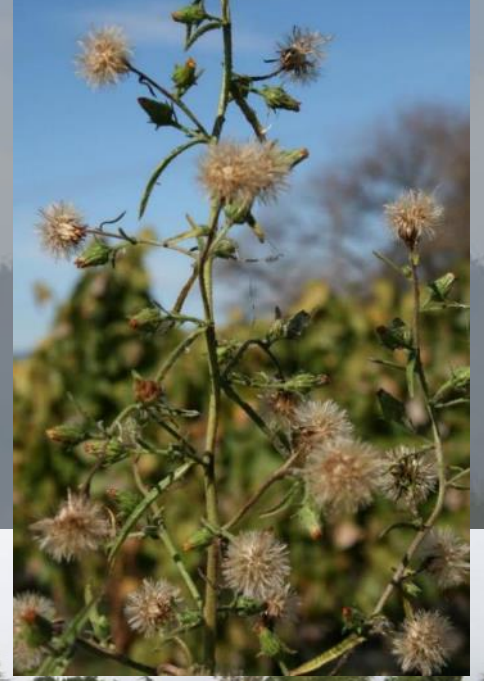
27.0
30.0
Collected drift (%)

Problem Weeds

Stinkwort (Dittrichia graveolens)

- Flowers from September-December
- Germinates in winter but remain small until spring-maybe
- Resembles Russian thistle, but is more similar to tarweeds (Asteraceae)
- Erect, fall flowering, aromatic annual 3 feet tall.



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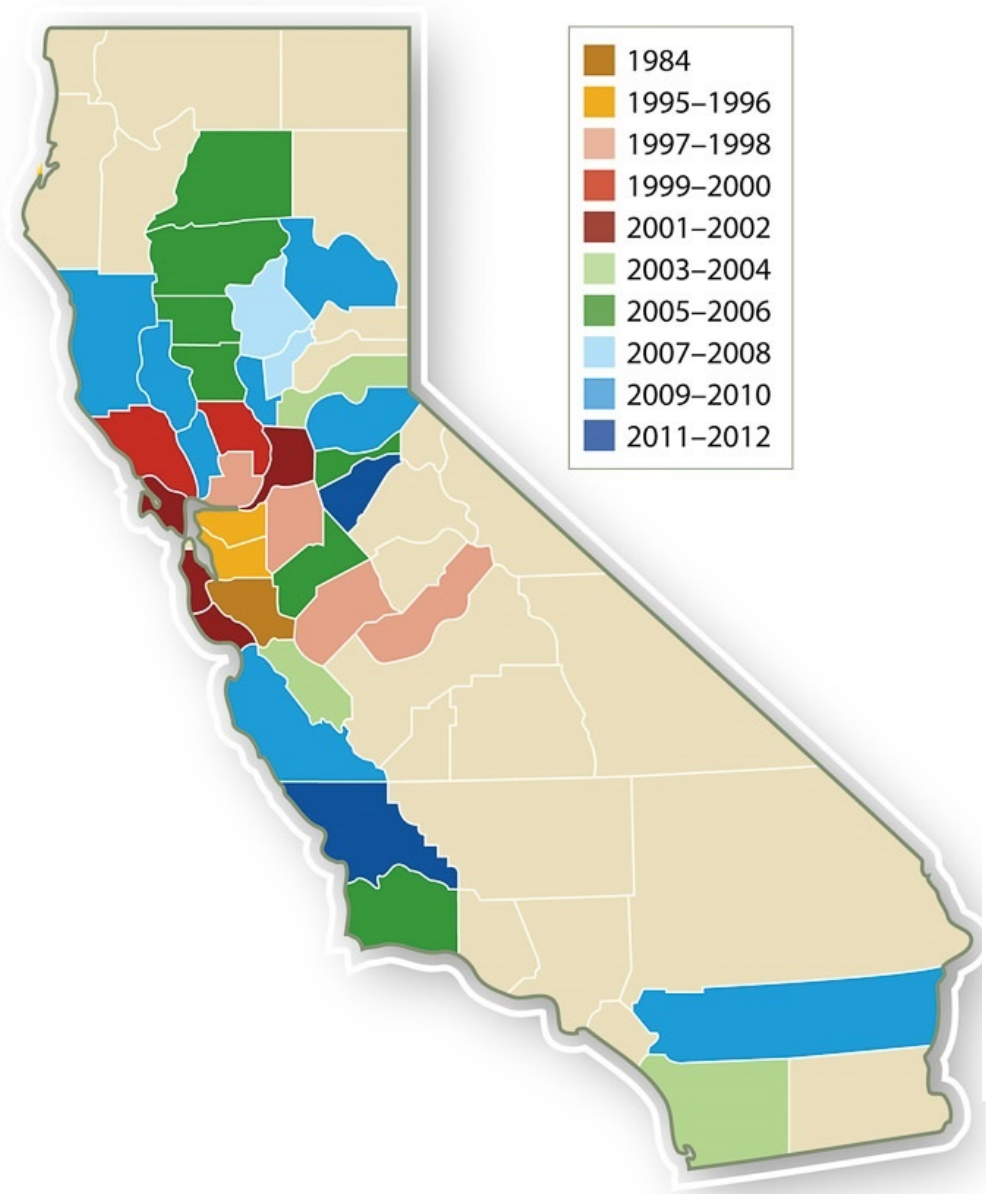
Stinkwort is rapidly expanding its range in California

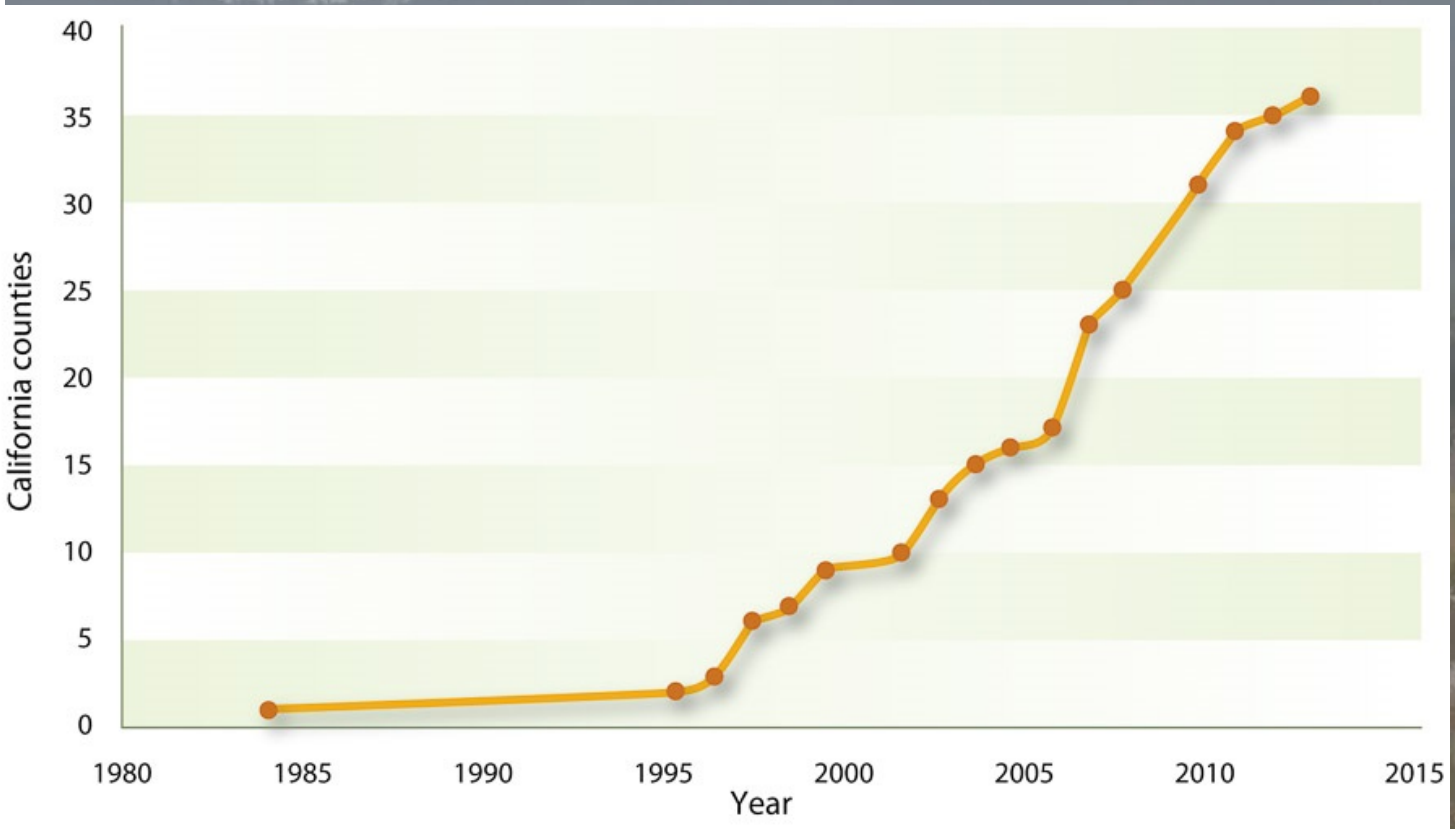
by Rachel Brownsey, Guy B. Kyser *and* Joseph M. DiTomaso

Stinkwort (Dittrichia graveolens) is a Mediterranean native that has become a weed in areas of Europe as well as in Australia. This strongly aromatic weed was first reported in California in 1984 in Santa Clara County, and it had spread to 36 of the 58 California counties by 2012. Stinkwort is not palatable to animals, and can be poisonous to livestock and cause contact allergic dermatitis in humans. In California, this weed is found primarily along roadsides. However, the biology of this annual plant suggests that it could also invade open riparian areas and overgrazed rangelands. Stinkwort has an unusual life cycle among annual plants: Unlike most summer or late-season winter annuals, stinkwort flowers and produces seeds from September to December. Such basic biological information is critical to developing

Joseph DiTomaso

Stinkwort is related to fleabanes and goldenasters and grows to about 2.5 feet tall. In California, this rapidly invading weed most often occurs in disturbed and wasteland sites.





Brownsey R, Kyser G, DiTomaso J. 2013. . Calif Agr 67(2):110-115.

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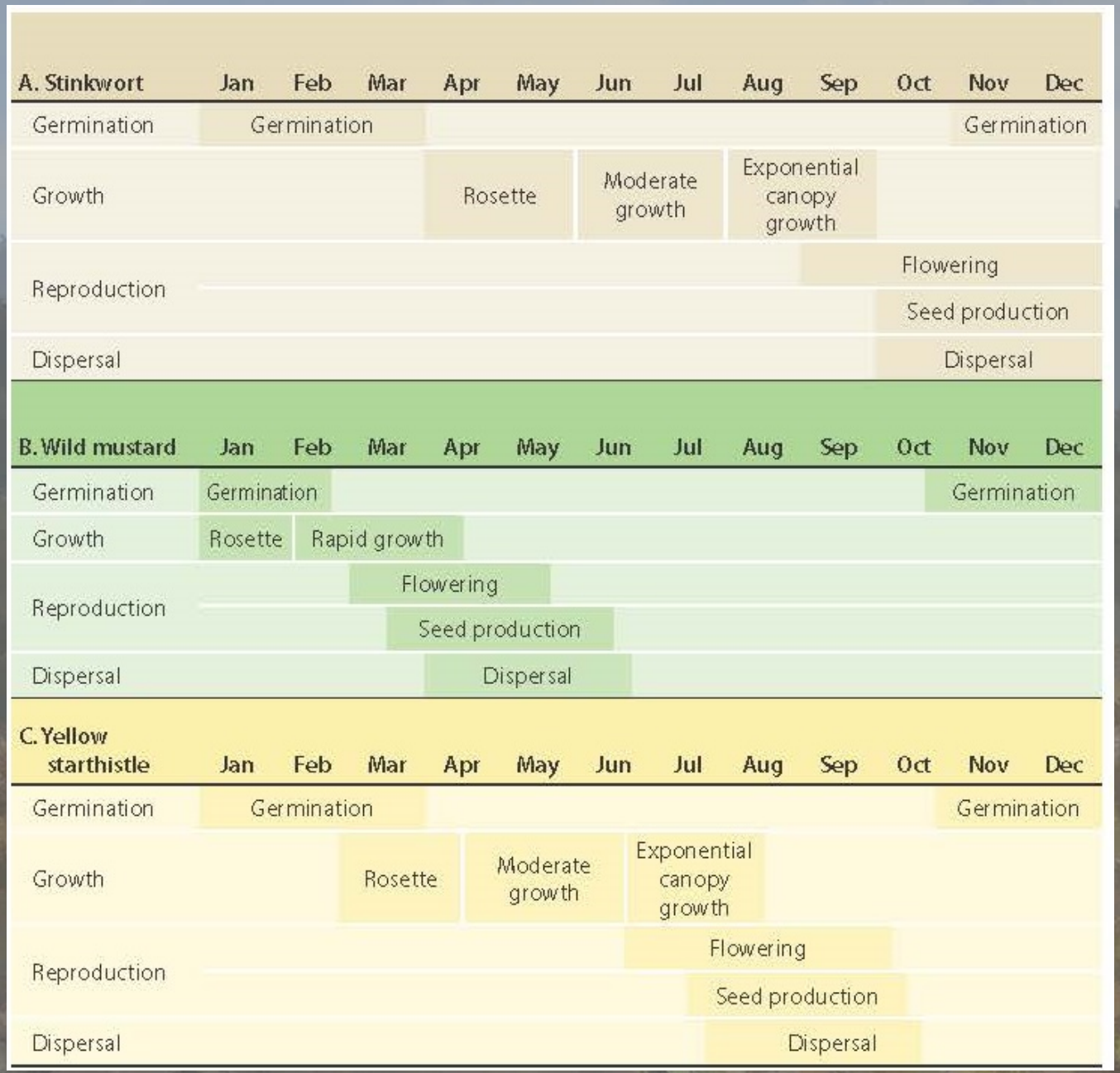
Invasive Plant Science and Management 6(3):371-380. 2013

Seed and Germination Biology of Dittrichia graveolens (Stinkwort)

Rachel N. Brownsey, Guy B. Kyser, and Joseph M. DiTomaso

Weed Science Society of America

Understanding seed characteristics and seedling establishment patterns is essential for the development of effective management strategies for invasive annual species. Dittrichia graveolens (stinkwort) has increased its range rapidly within California since 1995, yet its biology is not well understood, which has led to poorly timed management. In this study, seed viability, germination, longevity, and dormancy, as well as seedling emergence characteristics of D. graveolens were evaluated in field, greenhouse, and laboratory experiments in Davis, CA, over a 2-yr period (fall 2010 to summer 2012). In the laboratory, seed germination of D. graveolens occurred at a wide range of constant temperatures (12 to 34 C). Cumulative germination was comparable to total seed viability (80 to 95%) at optimal germination temperatures, indicating that primary (innate) dormancy is likely absent. The base temperature for germination was identified using a thermal time model: 6.5 C and 4 C for 2010 and 2011 seed populations, respectively. In the field, seedlings emerged from fall through spring following precipitation events. A very low percentage of seedlings (2.5%) emerged in the second year after planting. Equivalent seedling emergence was observed over a wide range of light conditions (100, 50, 27, and 9% of available sunlight) in a greenhouse experiment, indicating that seed germination is not limited by high or low light. Results from these seed experiments improve our understanding of the reproductive biology of this rapidly expanding exotic annual and provide valuable information for developing effective timing and longevity of management programs.



Stinkwort skeleton

March 6

Rachel Brownsey

Stinkwort can grow roots as deep as those of yellow starthistle, though it generally roots more shallowly and grow more slowly.

Stinkwort

Russian Thistle

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TABLE 1. Effect of postemergence herbicides and mowing on the control of *Dittrichia graveolens*

Treatment	Product trade name	Ounce product/acre	Ounce acid equivalent (a.e.)/acre	Late postemergence treatment* June 24, 2009	
				% cover	Vigor†
Glyphosate	Roundup Pro	16	6	7.3abcd‡	6.8cd
Glyphosate	Roundup Pro	32	12	5.0ab	4.5b
Aminopyralid	Milestone	3.5	0.875	16.3de	9.8d
Aminopyralid	Milestone	7	1.75	15.0cde	9.0d
Aminocyclopyrachlor	—	4	2	10.0bcd	6.5bc
Aminocyclopyrachlor	—	8	4	7.3abcd	6.5bc
Triclopyr amine	Garlon 3A	32	12	3.0ab	8.5cd
Triclopyr amine	Garlon 3A	64	24	0a	0a
Mowing	—	—	—	5.3abc	10.0d
Untreated	—	—	—	23.8e	10.0d

* All late postemergence treatments were made prior to flowering.

† Vigor ratings based on a 0 to 10 scale with 0 = dead plants and 10 = healthy plants.

‡ Numbers in the same column with different letters are significantly different at 5% confidence level.


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Glyphosate Translocation

Photosynthates
(sugars)

‘Grass’ HerbicideTranslocation

Photosynthates
(sugars) & water

Yellow Starthistle

Northern California Weed Control Calendar

- September
- October
- November
- December
- January
- February
- March
- April
- May
- June
- July
- August

Harvest

Frost-leaf drop

Bud Break

Verasion

Dependable (?) Precipitation for incorporation

Drip irrigation

Preemergence Herbicides

glyphosate

glyphosate

Horseweed
Ryegrass
Filaree
Malva
Fluvellin

“Summer” annuals

Horseweed
Summer grasses*
Fluvellin

Northern California Weed Control Calendar

- September
- October
- November
- December
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- March
- April
- May
- June
- July
- August

Harvest

Frost-leaf drop

Bud Break

Verasion

Rush skeletonweed is a deep-rooted forb in the sunflower family, growing 1 to 4 feet in height. Sharply-lobed leaves, similar to those of dandelion, form a rosette that withers as the flower stem develops. Other leaves up the stem are inconspicuous, narrow, and entire. Each rosette produces 1 flowering stem, with multiple spreading or ascending branches. A distinguishing characteristic of rush skeletonweed is the presence of coarse, downward pointing brown hairs near the base of the stem. Flower heads are produced near the ends of stems, either individually or in groups of 2 to 5, each with 9 to 12 flowers. Seeds are about 0.1 inch long, with a slender beak at the top, bearing a copious pappus of numerous capillary bristles. The leaf, stem, and roots exude milky latex when cut or broken.

It has a slender, simple taproot that can reach over 6.5 feet deep and branch at depth into C-horizon soil and fissures in bedrock.

WEED RESISTANCE MANAGEMENT MATRIX®SG, which contains the active ingredient rimsulfuron, is a Group 2 herbicide based on the mode of action classification system of the Weed Science Society of America.

Proactively implementing diversified weed control strategies to minimize selection for weed populations resistant to one or more herbicides is a best practice. A diversified weed management program may include the use of multiple herbicides with different sites of action and overlapping weed spectrum with or without tillage operations and/or other cultural practices. Research has demonstrated that using the labeled rate and directions for use is important to delay the selection for resistance. The continued effectiveness of this product depends on the successful implementation of a weed resistance management program. To aid in the prevention of developing weeds resistant to this product, users should:

Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.

- **Start with a clean field, using either a burndown herbicide application or tillage**
- **Control weeds early when they are relatively small(less than 4 inches).**
- **Apply full rates of MATRIX®SG for the most difficult to control weed in the field at the specified time (correct weed size)to minimize weed escapes.**
- **Scout fields after application to detect weed escapes or shifts in control of weed species.**
- **Control weed escapes before they reproduce by seed or proliferate vegetatively.**
- **Report any incidence of non-performance of this product against a particular weed to your DuPont representative, local retailer, or county extension agent.**
- **Contact your DuPont representative, crop advisor, or extension agent to find out if suspected resistant weeds to this MOA have been found in your region.**

If resistant biotypes of target weeds have been reported, use the application rates of this product specified for your local conditions. Tankmix products so that there are multiple effective sites of actions for each target weed.

- **If resistance is suspected, treat weed escapes with an herbicide having a site of action other than Group 2 and/or use nonchemical methods to remove escapes, as practical, with the goal of preventing further seed production.**
- **Suspected herbicide-resistant weeds may be identified by these indicators:**
- **Failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds;**
- **A spreading patch of non-controlled plants of a particular weed species; and**
- **Surviving plants mixed with controlled individuals of the same species. Additionally, users should follow as many of the following herbicide resistance management practices as is practical:**
- **Use a broad spectrum soil-applied herbicide with other sites of action as a foundation in a weed control program.**
- **Utilize sequential applications of herbicides with alternative sites of action.**
- **Rotate the use of this product with non-Group 2 herbicides.**
- **Avoid making more than two applications of MATRIX®SG and any other Group 2 herbicides within a single growing season unless mixed with an herbicide with a different site of action with an overlapping spectrum for the difficult-to-control weeds.**
- **Incorporate non-chemical weed control practices, including mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.**
- **Use good agronomic principles that enhance crop development and crop competitiveness**
- **Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.**
- **Manage weeds in and around fields, during and after harvest to reduce weed seed production.**

Questions?