



## Arizona Cotton Herbicides-2009 Update

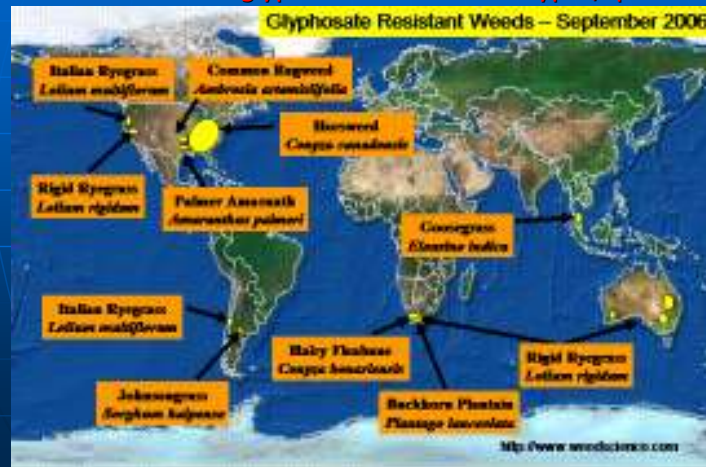
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Cooperative Extension  
University of Arizona, Tucson, Az

### Introduction

- In western irrigated agriculture, tillage is often necessary and is still conducted despite rising costs (capital, fuel, and labor).
- HR-cotton and topical applications of glyphosate, pyriithiobac sodium and glufosinate are common.
- Some growers have eliminated the use of preemergence herbicides to reduce costs and trips across fields.
- Objective – evaluate methods for applying preemergence herbicides.



Roundup or other glyphosate herbicides are the most commonly used postemergence herbicides in tree crops and cotton and are now popular in many other RR crops. There are now 15 glyphosate resistant biotypes/species.



Horseweed or marestalk (*Conyza canadensis*)



## Glyphosate Tolerant/Resistant Horseweed



Repeated low rate applications remove susceptible individuals leaving more resistant individuals to breed the next generation



**WeatherMax 22 oz, 2 d after application to 16 inch Palmer**

WMax 88 oz EPOST, 0.5"

WMax 88 oz MPOST, 3"

WMax 88 oz LPD, 10"



### **Managing Herbicide Resistant Weeds - *Use management strategies that avoid total reliance on a single herbicide***

- IWM (integrated weed management) – use non-chemical control measures in addition to herbicides (e.g., cultivation).
- Use herbicide mixtures (use different mechanisms of action) or combinations of herbicides annually.
- Alternate or rotate herbicides with different target site from year to year or application to application.
- Herbicide rate – most important for herbicide resistance due to metabolism (as opposed to a resistant enzyme).
- Limit seed dispersal – containment and eradication of small resistant populations

## Cotton Weed Control Operations

Preplant	Early POST topical or PD	Mid POST Post-direct	Layby PD broadcast
Tillage			
Pendimethalin, Prowl, Acumen			
Trifluralin, Treflan, Triap			
Prometryn, Caparol, Cotton Pro			
Diuron, Karmex			

## Secondary Tillage Implements

### Broadcast Field Cultivator



Prowl H<sub>2</sub>O (0.95 lb/A) applied PPI  
(field cultivator, listed, mulched, bed-shaped)



NO Prowl H<sub>2</sub>O



## Application Methods for Soil Residual Herbicides



## Experimental Procedures – Maricopa and Safford

- Conventional tillage, pre- and post-season, and 2 or 3 in-season cultivations
- Standard small plot research: 4 row by various lengths, randomized complete block design, 4 to 6 replications, plots sprayed with tractor mounted sprayers
- Experiments were planted in April:
  - Dry planted at MAC
  - Wet planted at SAC
  - Herbicide treatments:
    - glyphosate (w/AMS) applied topically, post-directed
    - Chateau (flumioxazin) and Layby Pro at layby

Ivyleaf Morningglory Canopy Infestation Maricopa



Palmer Amaranth Infestation at Maricopa

RR Flex+WeatherMAX





### Application Methods For Soil Residual Herbicides

- Preplant-incorporated, spray herbicide broadcast on level ground and incorporate prior to bed formation.
- Preplant-incorporated, spray herbicide band on listed beds before mulching (1 pass spray & mulch) and prior to bed shaping and planting.



### Application Methods For Soil Residual Herbicides



### 2008 Safford Experiments

- Trifluralin, pendimethalin or no preemergence herbicide
- PPI flat (incorporated)
  - Trif. 1.13 pt/A
  - Acumen 1.5 pt/A
- PPI Mulcher
  - Trif 2.25 pt/A
  - Acumen 3 pt/A
  - 50% band – effective broadcast rates similar to above



### Application Methods For Soil Residual Herbicides

- Preplant-incorporated, spray herbicide band on listed beds before mulching (1 pass spray & mulch) and prior to bed shaping and planting.
- 8001 or 80015 nozzles
- Higher pressure to avoid nozzle plugging.
- 1/2 to 2/3 band at broadcast rate



Pendimethalin PPI-flat, PPI-mulcher & Preemergence



Evaluated percent morningglory control – 7/14/8



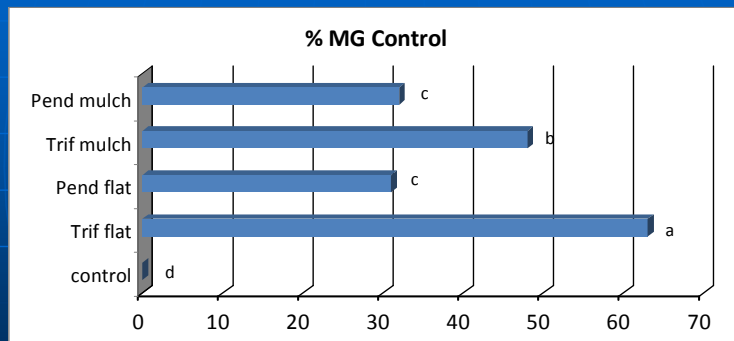
Trifluralin PPI-Mulcher



Untreated control



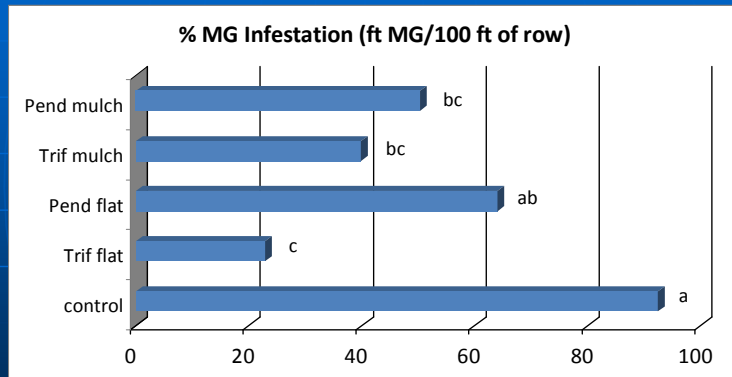
Trifluralin 0.56 lb ai/A  
Pendimethalin 0.62 lb ai/A



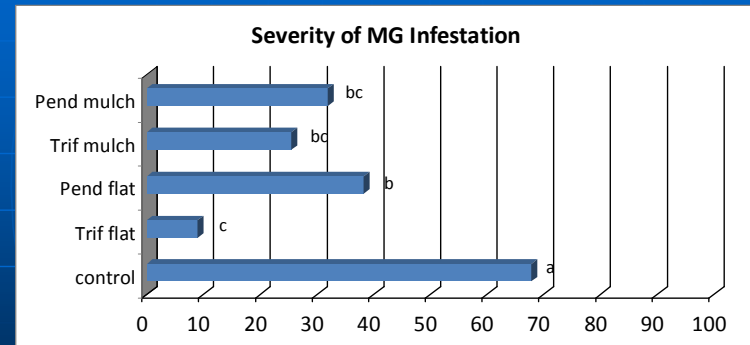
Good Palmer Amaranth Control,  
Poor Late Season Morningglory Control



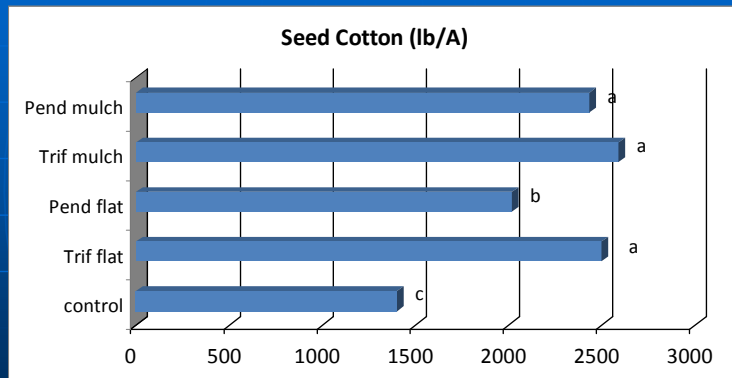
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Pendimethalin 0.62 lb ai/A



May 25, 2005 – Safford Ag. Center

NO Prowl H <sub>2</sub> O	Prowl H <sub>2</sub> O @ 0.95 lb/A
3.63 plants m <sup>-2</sup>	01.42 plants m <sup>-2</sup>



June 23, 2005 – A month after spraying topical herbicides, cultivating and irrigating, much more ivyleaf morningglory was emerging.

### Safford Ag. Center – 2005

Date	Prowl H <sub>2</sub> O (lb/A)	Application method	IPOHE density (plants/m <sup>2</sup> )
May 25	0	--	3.6
	0.95 (35 DAT)	PPI-mulched	1.4
July 13	0	--	48
	0.95 (47 DAT)	Topical spray	34
	0.95 (84 DAT)	PPI-mulched	5

### Safford Ag. Center – 2005 & 2007

Date	Prowl H <sub>2</sub> O (lb/A)	Application method	IPOHE density (plants/m <sup>2</sup> )
May 25 2005	0	--	3.6
	0.95 (35 DAT)	PPI-mulched	1.4
May 29 2007	0	--	2.2
Wet plant	0.95 (34 DAT)	PPI-mulched	0.8



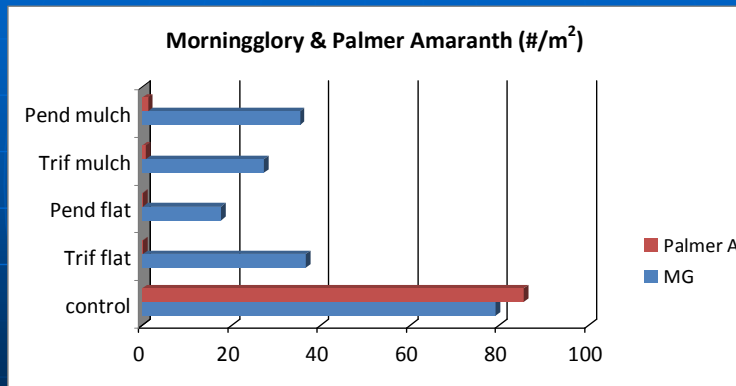
Maricopa Ag Center – 5/6/08



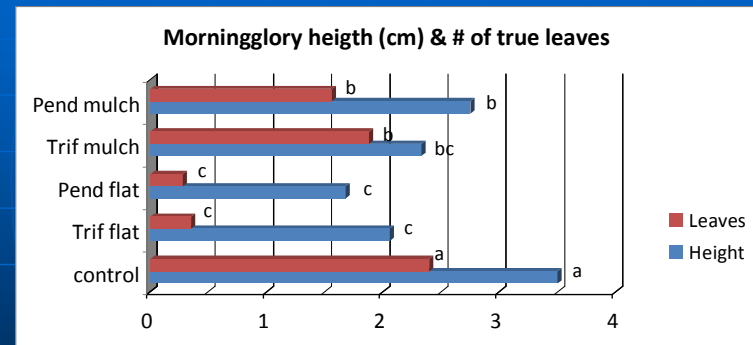
Maricopa Ag Center – 5/6/08



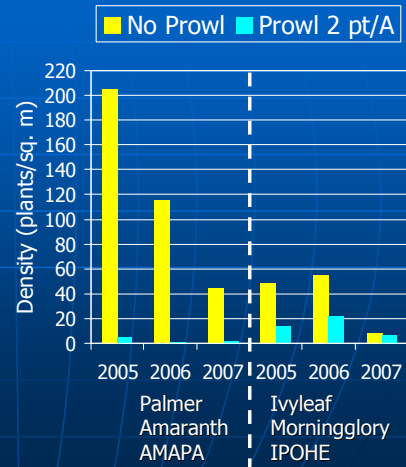
Maricopa Ag Center – 5/6/08



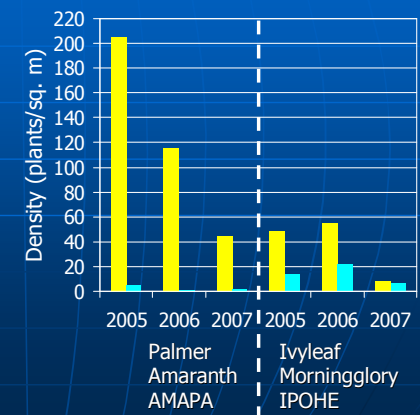
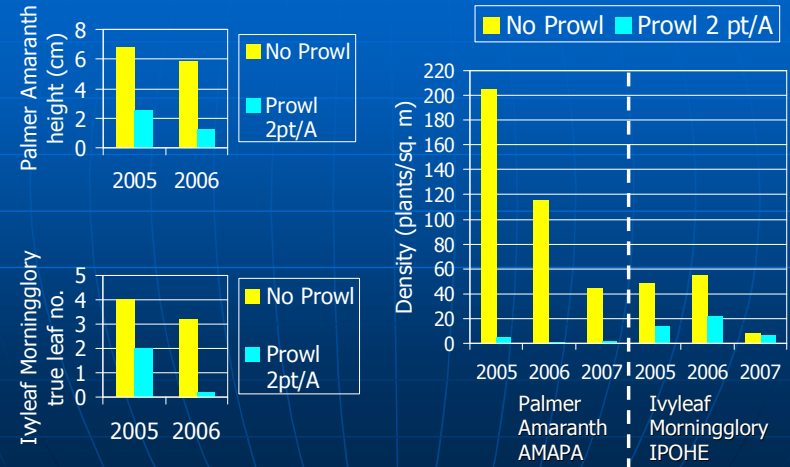
Maricopa Ag Center – 5/6/08



### Effect of Pendimethalin (0.95 lb/A) 1 Month After Planting at the Maricopa Agricultural Center



### Effect of Pendimethalin (0.95 lb/A) 1 Month After Planting at the Maricopa Agricultural Center



## Conclusions

- Applying dinitroaniline herbicides with a rotomulcher during bed formation
  - Greatly reduced Palmer amaranth emergence.
  - Reduced ivyleaf morningglory emergence and reduced the number of leaves and size.
  - Not quite as effective as applying dinitroaniline on the flat prior to bed formation but good enough to protect yield when combined with postemergence herbicides.
  - Reduce the number of weeds emerging after each irrigation.

## Cotton Weed Control Operations

Preplant	Early POST topical	Mid POST Post-direct	Layby PD broadcast
Tillage	Dual Magnum		
Pendimethalin, Prowl, Acumen	Prowl H <sub>2</sub> O		
Trifluralin, Treflan, Triap	Roundup, Touchdown, glyphosate		
Prometryn, Caparol, Cotton Pro	Staple LX		
Diuron, Karmex	Ignite 280		
	Post-Direct - MSMA		

### Postemergence: Cotton Up To 6 Inches Tall

- **Roundup Ready Flex cotton varieties**
  - Glyphosate @ 0.75 to 1.5 lb ae/A + AMS
    - Topical & post-direct (drop-tubes versus hoods)
- **All cotton varieties (0 to 6")**
  - Topical: Staple LX @ 2.5 to 3.8 oz/A (1.2 to 1.5 oz ai/A) + NIS (Season limit of 5.1 oz/A)
  - Topical: can use Dual Magnum (1.33 pt/A) for PREE control
  - Post-direct: MSMA @ 2.7 pt/A (2 lb ai/A) + NIS
- **Liberty Link Cotton – Fibermax cotton varieties**
  - Topical and post-direct (drop-tubes versus hoods)
    - Ignite 280 @ 29 to 43 oz/A (0.52 to 0.79 lb ai/A)
    - Topical 43 oz/A *fb* post-direct 29 oz/A +Staple or MSMA

### Cotton Weed Control Operations

Preplant	Early POST topical	Mid POST Post-direct	Layby PD broadcast
Tillage	Dual Magnum	Glyphosate	
Pendimethalin	Prowl H <sub>2</sub> O	Staple LX	
Trifluralin	Glyphosate	Ignite 280	
Prometryn	Staple LX	Sandea	
Diuron	Ignite 280	Prometryn*	
		Diuron*	
		Layby Pro*	
		Goal, Spike, Layby*	
		Aim	
*Soil activity		Chateau*	
		ET	

### Mid-Season Post-Directed Herbicide Options: Cotton 6 To 12 Inches Tall

- All cotton varieties (6" to 12")
    - Diuron\* 0.8 pt/A (0.4 lb ai/A) + NIS
    - Goal\* 1-2 pt/A (0.25 to 0.5 lb ai/A) + NIS [GoalTender]
      - (Aim, Chateau, ET - more restrictive labels, hoods)
    - Layby Pro\* 1.0-1.5 pt/A +NIS (cotton 8" tall)
    - Sandea @ 0.67-1.33 oz/A (0.5-1 oz ai/A)+NIS (do not exceed 1.33 oz/A per yer/season)
    - Prometryn\* 1 pt/A (0.5 lb ai/A) + NIS
    - Staple LX @ 2.5-3.8 oz/A (1.2 to 1.5 oz ai/A) + NIS
  - Tank Mixes
    - Glyphosate 0.75 lb ae/A (RR), Ignite 29 to 43 oz/A (Liberty Cotton), can also use Dual Magnum PD for PREE control
- \*Non-selective "Chemical Hoe" herbicides – Hoods, shields or accurate post-directed spray is necessary to avoid cotton injury.

### Cotton Weed Control Operations

Preplant	Early POST topical	Mid POST Post-direct	Layby PD broadcast
Tillage	Dual Magnum	Glyphosate	Glyphosate
Pendimethalin	Prowl H <sub>2</sub> O	Staple LX	Staple LX
Trifluralin	Glyphosate	Ignite 280	Ignite 280
Prometryn	Staple LX	Sandea	Prowl H <sub>2</sub> O*
Diruon	Ignite 280	Prometryn*	Prometryn*
		Diuron*	Diuron*
		Layby Pro*	Layby Pro*
		Goal,	Goal,
		Aim	Aim
*Preemergence soil activity		Chateau*	Chateau*
		ET	ET

## Application Methods & Nozzles for Layby Herbicides



### Turbo FloodJet Nozzles

- Wide angle flat spray tip
- Large spray droplets
- Excellent for preemergence herbicides with soil activity
- Good for systemic herbicides
- Not recommended for contact herbicides



## Cotton Layby Herbicides

Layby PD broadcast	Preemergence soil activity	Foliar Herbicide type/activity	
Glyphosate	NO	Systemic	
Staple LX	NO	Systemic	
Ignite 280	NO	Contact	
Prowl H <sub>2</sub> O	Yes	No POST activity	
Prometryn	Yes	Contact	
Diuron	Yes	Contact	
Layby Pro	Yes	Contact	
Goal, GoalTender	Yes	Contact	
Aim	NO	Contact	
Chateau	YES	Contact	
ET	NO	Contact	

## Spray Droplet Management!

- Need knowledge of the product being used.
- Herbicide, Fungicide, Insecticide
  - Systemic
  - Contact
- What is the target?
  - Soil
  - Grass
  - Broadleaf (smooth, hairy, waxy)
  - Leaf orientation – time of day
  - Penetration into canopy →

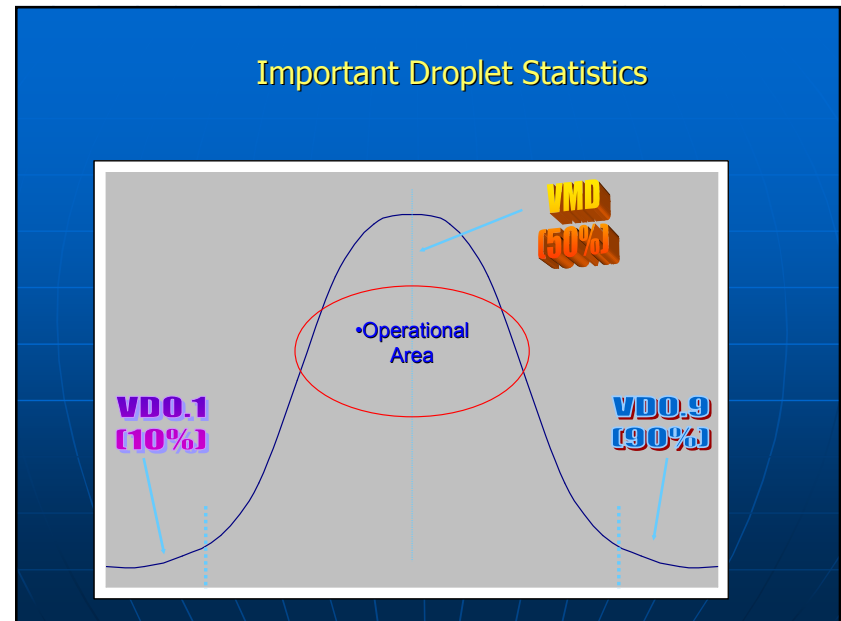
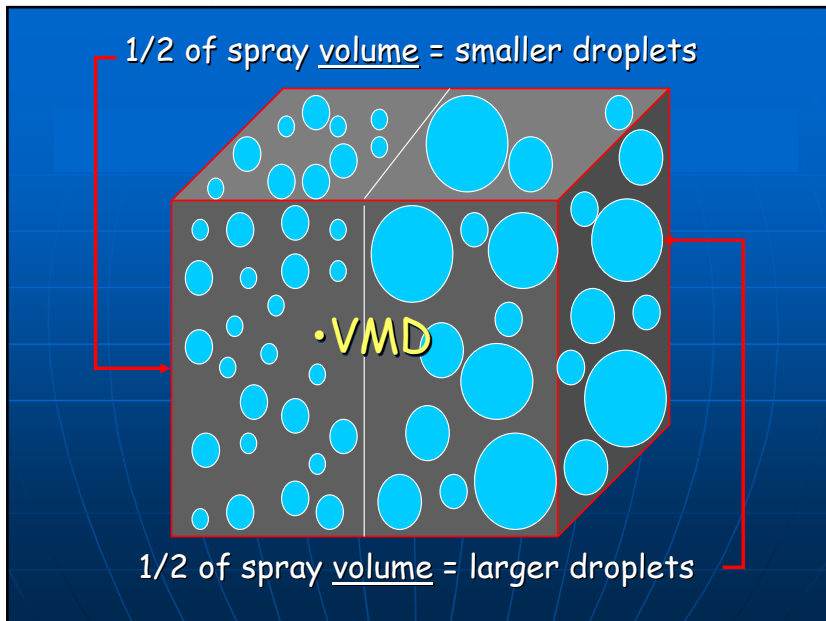


## Comparison of Micron Sizes for Various Items: (approximate values)

- pencil lead 2000 ( $\mu\text{m}$ )
- paper clip 850 ( $\mu\text{m}$ )
- staple 420 ( $\mu\text{m}$ )
- toothbrush bristle 300 ( $\mu\text{m}$ )
- sewing thread 150 ( $\mu\text{m}$ )
- human hair 100 ( $\mu\text{m}$ )







## Droplet Size Categories ASABE Standard S572\*

Category	Symbol	Color Code	D <sub>v0.1</sub> (in microns)	D <sub>v0.5</sub> (VMD) (in microns)	D <sub>v0.9</sub> (in microns)
Very Fine	VF	Red	< 57	< 144	< 274
Fine	F	Orange	57 - 111	144 - 235	274 - 415
Medium	M	Yellow	112 - 149	236 - 340	416 - 579
Coarse	C	Blue	150 - 170	341 - 403	580 - 732
Very Coarse	VC	Green	171 - 215	404 - 502	733 - 790
Extremely Coarse	XC	White	> 215	> 502	> 790

- \* Example data extracted from American Society of Agricultural Engineers (ASABE) Standard S572. Data is an average of three laser measuring instruments (Malvern, PMS, and PDPA) and is based on the following droplet size studies:
- 1) Womac, A.R., R.A. Maynard, I.W.Kirk.1999. Measurement variations in reference sprays for nozzle classification. *Transactions of the ASAE* 42(3):609-616
- 2) Womac, A.R., 2000. Quality control of standardized reference spray nozzles. *Transactions of the ASAE* 43(1):47-56.

**TeeJet Standard (TTE)**

Model	15	20	25	30	35	40	45	50	55	60	65	70	75	80
TTE1000	C	M	M	M	M	M	M	M	M	M	M	M	M	M
TTE1100	C	F	M	M	M	M	M	M	M	M	M	M	M	M
TTE1200	C	F	C	M	M	M	M	M	M	M	M	M	M	M
TTE1300	VF	VF	C	M	M	M	M	M	M	M	M	M	M	M
TTE1400	XO	VF	M	M	M	M	M	M	M	M	M	M	M	M
TTE1500	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
TTE1600	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
TTE1700	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
TTE1800	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M

**XR TeeJet® OSS and XC TeeJet® OSS**

Model	15	20	25	30	35	40	45	50	55	60	65	70	75	80
XR1000	C	M	M	M	M	M	M	M	M	M	M	M	M	M
XR1100	C	F	M	M	M	M	M	M	M	M	M	M	M	M
XR1200	C	F	C	M	M	M	M	M	M	M	M	M	M	M
XR1300	VF	VF	C	M	M	M	M	M	M	M	M	M	M	M
XR1400	XO	VF	M	M	M	M	M	M	M	M	M	M	M	M
XR1500	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
XR1600	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
XR1700	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
XR1800	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M

**D TeeJet®**

Model	15	20	25	30	35	40	45	50	55	60	65	70	75	80
D1000	C	M	M	M	M	M	M	M	M	M	M	M	M	M
D1100	C	F	M	M	M	M	M	M	M	M	M	M	M	M
D1200	C	F	C	M	M	M	M	M	M	M	M	M	M	M
D1300	VF	VF	C	M	M	M	M	M	M	M	M	M	M	M
D1400	XO	VF	M	M	M	M	M	M	M	M	M	M	M	M
D1500	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
D1600	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
D1700	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M
D1800	XO	VC	M	M	M	M	M	M	M	M	M	M	M	M

Droplet size classifications are based on ISO specifications and in accordance with ASAE Standard S572 for the sake of clarity. Classifications are subject to change.

**Legend:** VF (Red), F (Orange), M (Yellow), C (Blue), VC (Green), XC (White)

**Note:** Very Fine, Fine, Medium, and Coarse droplets are best suited for applying fungicides to control root rot. Make sure the capacity and pressure used fall within the correct droplet size range.

**TeeJet Spray Products**



## Cotton Layby Herbicides

Layby PD broadcast	Preemergence soil activity	Foliar Herbicide type/activity	
Glyphosate	NO	Systemic	
Staple LX	NO	Systemic	
Ignite 280	NO	Contact	
Prowl H <sub>2</sub> O	Yes	No POST activity	
Prometryn	Yes	Contact	
Diuron	Yes	Contact	
Layby Pro	Yes	Contact	
Goal, GoalTender	Yes	Contact	
Aim	NO	Contact	
Chateau	YES	Contact	
ET	NO	Contact	

## Hooded Sprayers – Redball 420 Layby Hooded Sprayer



Streamlined design of the Spray-Hoods allow them to glide gently between crop rows. This limits contact with crop and provides for faster travel speeds.

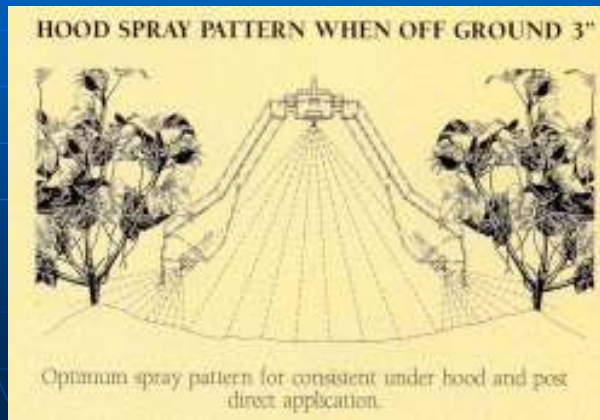


Center wheel is adjustable to set hood height which allows the hood to follow ground contours.

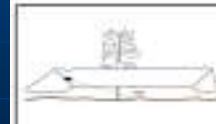
## Hooded Sprayers

- We can achieve selectivity by partially or totally physically blocking postemergence herbicides from contacting crop foliage.

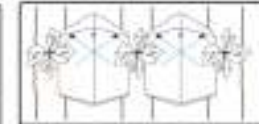
- Example of post-directed herbicide applications in an annual row crop using a Redball 420 hood.



## Wylie Spray Shield Directed Sprayer



Front View - Sprays is directed across the canopy while the hood protects the crop foliage. No need to worry about crop damage with the low quality aluminum shield, some Quincy blocks and 100 micron application.



### Post-directed and Layby Herbicide Options: Cotton 15 to 24 Inches Tall or Greater

- Herbicide (add adjuvants) Soil Texture
- Aim – 1 to 1.6 oz/A                      no soil activity
- Chateau – 2 oz/A                            all, soil activity
- Diuron – 0.8 to 1.6 qt/A                  coarse and medium
- ET – 0.5 to 1 oz/A                          no soil activity
- Prometryn - 0.8 to 1.6 qt/A              coarse and medium
- Goal – 0.5 lb ai/A                            all soil types
- Layby Pro (linuron, diuron)    1.6-2-2.4 pt/A (coarse, medium, fine)
- Prowl H<sub>2</sub>O                                    1.5-2-3 pt/A (coarse, medium, fine)  
if not applied preplant
- Tank mixes
  - PPO inhibitors (Aim, ET) + either prometryn or diuron
  - RR/glyphosate (e.g. grasses, nutsedges or large weeds) or Liberty Link Cotton/Ignite 280

### Cotton Layby Herbicides

Layby PD broadcast	Preemergence soil activity	Foliar Herbicide type/activity	General Crop Rotation intervals
Glyphosate	NO	Systemic	None
Staple LX	NO	Systemic	Medium-Long
Ignite 280	NO	Contact	Short
Prowl H <sub>2</sub> O	Yes	No POST activity	Medium-Long
Prometryn*	Yes	Contact	Short
Diuron*	Yes	Contact	Long
Layby Pro*	Yes	Contact	Short
Goal, GoalTender*	Yes	Contact	Long-small grains, Short labeled crops
Aim	NO	Contact	None-registered crops
Chateau*	YES	Contact	Short with tillage
ET	NO	Contact	Short (30 days)

### The best weed control programs include:

- Preplant incorporated dinitroaniline herbicide (Prowl or trifluralin) either before (disking) or after listing (mulcher).
- Early topical post-emergence herbicide application; use maximum rates.
- 2<sup>nd</sup> herbicide application after first post-planting irrigation
- Layby herbicide application that includes a residual herbicide