Texas A&M AgriLife Bushland Corn Herbicide Trials
with
Corn Herbicides and Management for the Texas High Plains

Jourdan Bell, Assistant Professor and Agronomist
Carla Naylor, Research Associate
Preston Sirmon, Extension Assistant
Bronc Finch, Research Technician II
Texas A&M AgriLife Research and Extension Center
Amarillo, Texas

Table of Contents

Introduction

Weeds rob essential water and nutrients from the primary crop necessary to optimize yields. In the Texas High Plains, more than 50% of the yearly water requirement for corn is supplemented by irrigation from the declining Ogallala Aquifer. Consequently, competition from weeds must be limited to maintain efficient use of water by the crop. To maximize production and stabilize yields, irrigation is necessary; therefore, herbicides are recognized as a method to enhance crop water use by eliminating weeds and competition. Resistant and herbicide tolerant weed species including palmar amaranth (pigweed and common waterhemp) and kochia have become a problem in the Texas High Plains. Hard to control weeds require critical evaluation of herbicide programs that include preplant burndown and residual herbicides as well as in- season herbicide applications. Management decisions are magnified by the expense of herbicide applications. Consequently, trials to evaluate commercially available herbicides provide producers information about weed control under regional conditions. This publication includes herbicide tank-mixes evaluated in corn herbicide trials at the Texas A&M AgriLife James Bush Research Farm at Bushland, Texas, and corn herbicides marketed for Texas High Plains corn production. Herbicides listed are registered with the Environmental Protection Agency and approved for use on corn in Texas.

Section 1: Texas A&M AgriLife Bushland Corn Herbicide Trials

Corn Trials

Herbicide treatments evaluated in 2016 and 2017 Bushland corn herbicide trials were provided by industry partners (AmVac, Bayer, Corteva Agriscience (previously Dow and Dupont), FMC, and Syngenta. All treatments were replicated three-times using the same corn hybrid (DG55VP77) at the Texas A&M James Bush Research Farm, in Bushland, Texas to evaluate crop injury and weed control. Plots were fertilized for a predetermined yield goal based on a soil test performed prior to planting, and plots were irrigated at a deficit rate throughout the growing season. Plots were sprayed at a total spray volume of 15 gallon/acre with a Lee Agra Spider broadcast sprayer using flat-fan nozzles at 40 PSI.

Weed Species Targeted

Primary weeds targeted in the Bushland herbicide trials included redroot pigweed (Amaranthus retroflexus), Palmer Amaranth (Amaranthus palmeri), tumble pigweed (Amaranthus albus), kochia (Kochia scoparia), morning glory (Ipomoea sp.), Russian thistle (Salsola ibercia), barnyardgrass (Echinochloa crus-galli), and tumble windmill grass (Chloris verticillate).

Ratings

All treatments were evaluated against an untreated check to evaluate herbicide efficacy. Crop injury was evaluated as a percent average of all replicated plots. Reported weed control ratings are an average of the percent control of all the weeds targeted across all plot replications, shown at preemergence, at planting, or the days after application. Ratings were conducted to independently reflect pre-emergent and post emergent control. Broadleaf weed ratings are averages of ratings for all targeted broadleaf weeds. Although numerous broadleaf weeds were present and evaluated, the primary broadleaf weeds in all plots were redroot pigweed, Palmer Amaranth, tumble pigweed, and kochia. Weedy grass ratings are an average of the principle monocot species (barnyardgrass and tumble windmill grass).

Acknowledgements

We gratefully acknowledge the assistance of graduate student Miss Aislinn Walton with herbicide applications and plot maintenance.

Table 1. 2016 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
AmVac	Impact	0.75 oz/a	Post V2-V4	0 @ 7d	7 Days		34 Days	
	Sequence	2.5 pt/a	Post V2-V4		87	98.3	96	100
	Aatrex	1 qt/a	Post V2-V4					
	NIS	0.25 %v/v	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					
AmVac	Halex GT	3.6 pt/a	Post V2-V4	0 @ 7 Days	7 Days		34 Days	
	Aatrex	1 qt/a	Post V2-V4		70.7	99.3	94	100
	NIS	0.25 %v/v	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					
AmVac	Impact	0.75 oz/a	Post V2-V4	0 @ 7 Days	7 Days		34 Days	
	Roundup Powermax	22 oz/a	Post V2-V4		75	100	98	100
	Aatrex	1 qt/a	Post V2-V4					
	Zidua	2 oz/a	Post V2-V4					
	MSO	0.5 %v/v	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		100	95	100	100
	Roundup Powermax	1 qt/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		99	100	100	100
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx	8 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		94	99	100	100
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx	10 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		100	95	100	76
	Roundup Powermax	1 qt/a	Post V3-V6					
	Laudis	3 oz/a	Post V3-V6					
	Diflexx	8 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		99	100	100	89
	Roundup Powermax	1 qt/a	Post V3-V6					
	Laudis	3 oz/a	Post V3-V6					
	Clarity	8 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		100	97	100	95
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx Duo	32 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					

Table 1 continued. 2016 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		100	95	100	99
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx Duo	24 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Balance Flex	3 oz/a	Pre at planting	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Pre at planting		100	99	100	99
	Roundup Powermax	1 qt/a	Post V3-V6					
	Status	5 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	Interlock	0.5 % v/v	Post V3-V6					
Bayer	Capreno	3 oz/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		76	58	51	70
	Roundup Powermax	1 qt/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
Bayer	Capreno	3 oz/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		70	45	99	92
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx	8 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	MSO	0.5 % v/v	Post V3-V6					
Bayer	Laudis	3 oz/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		61	53	67	96
	Roundup Powermax	1 qt/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
Bayer	Laudis	3 oz/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		79	67	95	78
	Roundup Powermax	1 qt/a	Post V3-V6					
	Diflexx	8 oz/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	MSO	0.5 % v/v	Post V3-V6					
Bayer	Diflexx Duo	1 qt/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		61	55	83	99
	Roundup Powermax	1 qt/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	MSO	0.5 % v/v	Post V3-V6					
Bayer	Diflexx Duo	24 oz/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		68	33	86	71
	Roundup Powermax	1 qt/a	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					
	MSO	0.5 % v/v	Post V3-V6					
Bayer	Halex GT	3.6 pt/a	Post V3-V6	0 @ 22, 44 & 71 Days	44 Days		71 Days	
	Atrazine	1.5 pt/a	Post V3-V6		85	32	100	92
	NIS	0.25%v/v	Post V3-V6					
	AMS	17 lb/100gal	Post V3-V6					

Table 1 continued. 2016 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
Corteva Agricience	Sure Start II	2.25 pt/a	Pre at planting	0 @ 24 Days	7 Days		71 Days	
	Aatrex	1qt/a	Pre at planting		100	100	100	
	Durango DMA	1qt/a	Post Weeds 6-8"					
	AMS	2.5% v/v	Post Weeds 6-8"					
Corteva Agricience	Sure Start II	1.75 pt/a	Post V2-4 Weeds 2-4"	0 @ 24 Days	7 Days		71 Days	
	Aatrex	1qt/a	Post V2-4 Weeds 2-4"		100	100	99	
	Durango DMA	1qt/a	Post V2-4 Weeds 2-4"					
	AMS	2.5% v/v	Post V2-4 Weeds 2-4"					
Corteva Agricience	Resicore	2.75 qt/a	Pre at planting	0 @ 24 Days	7 Days		71 Days	
	Aatrex	1qt/a	Pre at planting		100	100	100	
	Durango	1qt/a	Post Weeds 6-8"					
	AMS	2.5% v/v	Post Weeds 6-8"					
Corteva Agricience	Resicore	1.25 qt/a	Pre at planting	0 @ 24 Days	7 Days		71 Days	
	Aatrex	1qt/a	Pre at planting		100	100	100	
	Resicore	1.25 qt/a	Post Weeds 6-8"					
	Aatrex	1qt/a	Post Weeds 6-8"					
	Durango	1qt/a	Post Weeds 6-8"					
	AMS	2.5% v/v	Post Weeds 6-8"					
Corteva Agricience	Resicore	1.25 qt/a	Pre at planting	0 @ 24 Days	7 Days		71 Days	
	Aatrex	1qt/a	Post Weeds 2-4"		100	100	100	
	Durango	1qt/a	Post Weeds 2-4"					
	AMS	2.5% v/v	Post Weeds 2-4"					
Corteva Agricience	Basis Blend	0.825 oz/a	30 Day pre-plant	0 @ 24 Days	33 Days		71 Days	
	Atrazine	0.75 lb ai/a	30 Day pre-plant		100	83	100	98
	Weedmaster	1pt/a	30 Day pre-plant					
	MSO	1% v/v	30 Day pre-plant					
	AMS	2lbs/a	30 Day pre-plant					
	Cinch ATZ	2 pt/a	Pre At planting					
	Balance Flexx	2 oz/a	Pre At planting					
	Realm Q	4 oz/ac	Post Weeds 2-4"					
	Dicamba	4 oz/a	Post Weeds 2-4"					
	Glyphosate	22 oz/a	Post Weeds 2-4"					
	NIS	0.5%v/v	Post Weeds 2-4"					
	AMS	2 lb/a	Post Weeds 2-4"					
Corteva Agricience	Afforia	2.5 oz/a	30 Day pre-plant	0 @ 24 Days	33 Days		71 Days	
	Atrazine	0.75 lb ai/a	30 Day pre-plant		100	95	100	98
	Weedmaster	1pt/a	30 Day pre-plant					
	MSO	1% v/v	30 Day pre-plant					
	AMS	2lbs/a	30 Day pre-plant					
	Cinch ATZ	2 pt/a	Pre At planting					
	Balance Flexx	2 oz/a	Pre At planting					
	Resolve	1.2 oz/a	Post Weeds 2-4"					
	Dicamba	4 oz/a	Post Weeds 2-4"					
	Glyphosate	22 oz/a	Post Weeds 2-4"					
	Atrazine	0.25 lb a.i./a	Post Weeds 2-4"					
	NIS	0.5%v/v	Post Weeds 2-4"					
	AMS	2 lb/a	Post Weeds 2-4"					
Corteva Agricience	Prequel	1.33 oz/a	30 Day pre-plant	0 @ 24 Days	33 Days		71 Days	
	Atrazine	0.75 lb ai/a	30 Day pre-plant		100	77	98	93
	Weedmaster	1pt/a	30 Day pre-plant					
	MSO	1% v/v	30 Day pre-plant					
	AMS	2lbs/a	30 Day pre-plant					
	Cinch ATZ Lite	2 pt/a	Pre At planting					
	Cinch	5 oz/a	Pre At planting					
	Resolve	0.92 oz/a	Post Weeds 2-4"					
	Realm Q	4 oz/a	Post Weeds 2-4"					
	Atrazine	0.25 lb/a	Post Weeds 2-4"					
	Dicamba	4 oz/a	Post Weeds 2-4"					
	Glyphosate	22 oz/a	Post Weeds 2-4"					
	AMS	2 lb/a	Post Weeds 2-4"					
	NIS	0.5%v/v	Post Weeds 2-4"					

Table 1 continued. 2016 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Solstice	3 oz /a	Post V2		100	100	100	99
	Atrazine	1 qt/a	Post V2					
	Roundup Powermax	1.5 pt/a	Post V2					
	COC	0.5 % v/v	Post V2					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Solstice	3 oz/a	Post 12" Corn		98	83	98	76
	Atrazine	1 qt/a	Post 12" Corn					
	Roundup Powermax	1.5 pt/a	Post 12" Corn					
	COC	0.5 % v/v	Post 12" Corn					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Solstice	3 oz/a	Post 12" Corn		100	93	98	100
	Roundup Powermax	1.5 pt/a	Post 12" Corn					
	COC	0.5 % v/v	Post 12" Corn					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Status	3 oz/a	Post 12" Corn		93	92	89	96
	Atrazine	1 qt/a	Post 12" Corn					
	COC	0.5 % v/v	Post 12" Corn					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Status	3 oz/a	Post 12" Corn		90	82	94	67
	Roundup Powermax	1.5 pt/a	Post 12" Corn					
	COC	0.5 % v/v	Post 12" Corn					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Atrazine	1 qt/a	Pre at planting		96	77	93	87
	Solstice	3oz /a	Post V8					
	Roundup Powermax	1.5 pt/a	Post V8					
	COC	0.5 % v/v	Post V8					
FMC	Anthem Max	3 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Atrazine	1 qt/a	Pre at planting		100	100	98	100
	Status	3 oz wt/a	Post V8					
	Roundup Powermax	1.5 pt/a	Post V8					
	COC	0.5 % v/v	Post V8					
FMC	Anthem Max	2 oz/a	Post 10 Day	0 @ 24 Days	33 Days		71 Days	
	Sosltice	3 oz/a	Post 10 Day		93	82	98	64
	Atrazine	1 qt/a	Post 10 Day					
	Roundup Powermax	1.5 pt/a	Post 10 Day					
FMC	Dual II Magnum	21 oz/a	Pre at planting	0 @ 24 Days	33 Days		71 Days	
	Atrazine	1 qt/a	Pre at planting		98	99	89	98
	Roundup Powermax	1.5 pt/a	Post V8					
Syngenta	Acuron	2.5 qt/a	Pre at planting	0 @ 22 Days	21 Days		41 Days	
					60	100	51	100
Syngenta	Acuron	1.25 qt/a	Pre at planting	0 @ 22 Days	21 Days		41 Days	
	Acuron	1.25 qt/a	Post V4-V6		100	100	100	100
	N-PAC AMS liq.	2.5%v/v	Post V4-V6					
	NIS	0.25%v/v	Post V4-V6					
Syngenta	Acuron	1.25 qt/a	Pre at planting	0 @ 22 Days	21 Days		41 Days	
	Halex GT	3.6 pt/a	Post V4-V6		100	100	100	100
	Aatrex	1pt/a	Post V4-V6					
	N-PAC AMS liq.	2.5%v/v	Post V4-V6					
	NIS	0.25%v/v	Post V4-V6					
Syngenta	Acuron	2 qt/a	Pre at planting	0 @ 22 Days	21 Days		41 Days	
	N-PAC AMS liq.	2.5%v/v	Post V4-V6		100	100	100	100
	NIS	0.25%v/v	Post V4-V6					
	Roundup Powermax	32 oz/a	Post V4-V6					

Table 2. 2017 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	92	98
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		99	100	92	97
	Roundup PowerMax	32 oz/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	92	99
	Liberty 280 SL	29 oz/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	93	100
	Sharpen	1 oz/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	93	100
	2.4-D Amine	1 pt/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	93	99
	Clarity	1 pt/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Roundup PowerMax	32 oz/a	14 Day Preplant		100	100	93	100
	Clarity	1 pt/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Dual II Magnum	1.25 pt/a	14 Day Preplant	0 @ 29 Days	29 Days		83 Days	
	Impact	0.75 oz/a	14 Day Preplant		100	100	94	98
	Gramoxone Inteon	2 pt/a	14 Day Preplant					
	Aatrex	2 pt/a	14 Day Preplant					
	MSO	0.5% v/v	14 Day Preplant					
	UAN 28% (Fertilizer)	2.5% v/v	14 Day Preplant					
AmVac	Harness Xtra 5.6	3.6 pt/a	Pre at planting	0 @ 24 Days; 0 @ 119 Days	24 Days		78 Days	
	Impact Z	8 oz/a	Post 2-4" Weeds		100	100	100	100
	MSO	1 % v/v	Post 2-4" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post 2-4" Weeds					
AmVac	Harness Xtra 5.6	3.6 pt/a	Pre at planting	0 @ 24 Days; 25 @ 119 Days	24 Days		78 Days	
	Impact Z	8 oz/a	Post 2-4" Weeds		100	100	100	100
	Roundup PowerMax	32 oz/a	Post 2-4" Weeds					
	MSO	1 % v/v	Post 2-4" Weeds					
	0.25%v/v	0.25%v/v	Post 2-4" Weeds					
AmVac	Harness Xtra 5.6	3.6 pt/a	Pre at planting	0 @ 24 Days; 75 @ 119 Days	24 Days		78 Days	
	Impact Z	8 oz/a	Post 2-4" Weeds		100	100	100	100
	Liberty 280 SL	29 oz/a	Post 2-4" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post 2-4" Weeds					
AmVac	Harness Xtra 5.6	3.6 pt/a	Pre at planting	0 @ 24 & 119 Days	24 Days		78 Days	
	Impact Z	8 oz/a	Post 2-4" Weeds		99	100	100	100
	Status	5 oz/a	Post 2-4" Weeds					
	MSO	1 % v/v	Post 2-4" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post 2-4" Weeds					

Table 2 continued. 2017 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
AmVac	Harness Xtra 5.6	1.75 pt/a	Post 2-4" Weeds	0 @ 24 & 119 Days	24 Days		78 Days	
	Impact Z	8 oz/a	Post 2-4" Weeds		99	100	99	100
	Roundup PowerMax	32 oz/a	Post 2-4" Weeds					
	NIS	0.25%v/v	Post 2-4" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post 2-4" Weeds					
AmVac	Armezon PRO	20 oz/a	Post <2" Weeds	0 @ 24 & 119 Days	24 Days		78 Days	
	Roundup PowerMax	32 oz/a	Post <2" Weeds		98	100	94	99
	Atrazine	0.5 pt/a	Post <2" Weeds					
	NIS	0.25%v/v	Post <2" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post <2" Weeds					
AmVac	Halex GT	3.6 pt/a	Post <2" Weeds	0 @ 24 & 119 Days	24 Days		78 Days	
	Atrazine	0.5 pt/a	Post <2" Weeds		98	100	90	100
	NIS	0.25%v/v	Post <2" Weeds					
	N-PAC AMS liq.	2.5%v/v	Post <2" Weeds					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		94	100	100	100
	Roundup PowerMax	32 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	100	100
	Roundup PowerMax	32 oz/a	Post V4-V6					
	Diflexx Duo	32 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	100	100
	Roundup PowerMax	32 oz/a	Post V4-V6					
	Laudis	3 oz/a	Post V4-V6					
	Diflexx Duo	8 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	97	100
	Liberty 280	22 oz/a	Post V4-V6					
	Laudis	3 oz/a	Post V4-V6					
	Diflexx Duo	8 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 8 @ 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	96	100
	Liberty 280	22 oz/a	Post V4-V6					
	Diflexx Duo	24 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	100	100
	Roundup PowerMax	32 oz/a	Post V4-V6					
	Diflexx Duo	24 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
Bayer	Balance Flexx	3 oz/a	Pre At planting	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Pre At planting		100	100	100	100
	Roundup PowerMax	32 oz/a	Post V4-V6					
	Status	3 oz/a	Post V4-V6					
	AMS	8.5 lb/100 gal	Post V4-V6					
	Interlock	0.5% v/v	Post V4-V6					
Bayer	Laudis	3 oz/a	Post V2-V4	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Post V2-V4		100	100	95	100
	Roundup PowerMax	32 oz/a	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					
Bayer	Laudis	3 oz/a	Post V2-V4	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 qt/a	Post V2-V4		100	100	96	100
	Roundup PowerMax	32 oz/a	Post V2-V4					
	Diflexx	8 oz/a	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					
	Agri-Dex	0.5% v/v	Post V2-V4					
Bayer	Halex GT	3.6 pt/a	Post V2-V4	0 @ 23 & 57 Days	23 Days		77 Days	
	Atrazine	1 pt/a	Post V2-V4		100	100	77	100
	NIS	0.25 %v/v	Post V2-V4					
	AMS	8.5 lb/100 gal	Post V2-V4					

Table 2 continued. 2017 Bushland Corn Herbicide Trials

Primary Company Protocol	Treatment	Rate	Application Timing	Crop Injury Days After First/Last Application	% Weed Control Days After First/Last Application		% Weed Control Days After First/Last Application	
					Broadleaf Weeds	Weedy Grasses	Broadleaf Weeds	Weedy Grasses
Corteva Agriscience	Resicore	2.75 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Durango DMA	1 qt/a	Post V2-4		100		99	
	AMS	2.5 % v/v	Post V2-4					
Corteva Agriscience	Resicore	1.5 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Durango DMA	1 qt/a	Post V4-V6		100	100	99	100
	AMS	2.5 % v/v	Post V4-V6					
Corteva Agriscience	Resicore	1.5 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Aatrex L	1 qt/a	Pre At planting		100	100	98	100
	Durango DMA	1 qt/a	Post V4-V6					
	AMS	2.5 % v/v	Post V4-V6					
Corteva Agriscience	Resicore	1.5 qt/a	Post 2-3 Leaves	0 @ 7 & 14 Days	14 Days		108 Days	
	Durango DMA	1 qt/a	Post V2-4		100	100	99	100
	AMS	2.5 % v/v	Post V2-4					
Corteva Agriscience	Resicore	1.5 qt/a	Post V2-4	0 @ 7 & 14 Days	14 Days		108 Days	
	Aatrex L	1 qt/a	Post V2-4		100	100	108	100
	Durango DMA	1 qt/a	Post V2-4					
	AMS	2.5 % v/v	Post V2-4					
Corteva Agriscience	Resicore	1.5 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Aatrex L	1 qt/a	Pre At planting		100	100	99	100
	Resicore	1 qt/a	Post V4-V6					
	Aatrex L	1 qt/a	Post V4-V6					
	Durango DMA	1 qt/a	Post V4-V6					
	AMS	2.5 % v/v	Post V4-V6					
Corteva Agriscience	Keystone NTX	1.7 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Durango DMA	1 qt/a	Post V4-V6		100	100	99	100
	AMS	2.5 % v/v	Post V4-V6					
Corteva Agriscience	Fultime NXT	2.9 qt/a	Pre At planting	0 @ 7 & 14 Days	14 Days		108 Days	
	Durango DMA	1 qt/a	Post V4-V6		100	100	99	100
	AMS	2.5 % v/v	Post V4-V6					

Table 3. Rotational Intervals of Herbicides Evaluated in the Bushland Herbicide Trials

Active Ingredient	Manufacturer	Corn	Cotton	Sorghum	Wheat
		months unless interval noted differently*			
2,4-D amine	Alligare	7 days	1	7days	7days
Aatrex	Syngenta	0	12	0	12
Acuron	Syngenta	0	10	10	4
Afforia	Corteva Agriscience	2wks-4mos.	1 to 2	1	1 to 2
Anthem Max	FMC	0	4	11 to 18	4 to 6
Armezon Pro	BASF	0	9	9	18
Atrazine	Syngenta	0	12	0	12
Authority MTZ	FMC	4 to 18	12 to 18	12 to 18	4
Balance Flexx	Bayer	0	10	6	4
Basis Blend	Corteva Agriscience	0	1	10	3
Bicep II Magnum	Syngenta	0	12	0	12
Callisto	Syngenta	0	10	0	4
Caprino	Bayer	0	10	10	4
Cinch	Corteva Agriscience	0	0	0	4
Cinch ATZ	Corteva Agriscience	0	12	0	4.5
Clarity	BASF	0 to 4	1 to 4	0.5 to 4	1
Diflexx Duo	Bayer	0	10	0	4
Dual II Magnum	Syngenta	0	0	0	4.5
Durango and Durango DMA	Corteva Agriscience	0	0	0	0
Facet L	BASF	10	10	0	0
Fulltime NXT	Corteva Agriscience	0	12	0	12
Gramoxine Inteon	Syngenta	0	0	0	0
Halex GT	Syngenta	0	10	0	4.5
Harness Xtra 5.6	Monsanto	0	12	12	4
Impact	AmVac	0	9	9	3
ImpactZ	AmVac	0	12	9	12
Laudis	Bayer	0	10	10	4
Liberty 280SL	Bayer	0	0	6	2
Lumax	Syngenta	0	18	0	4.5
Keystone NTX	Corteva Agriscience	0	12	0	4
Peak	Syngenta	1	10	0	0
Prequel	Corteva Agriscience	1 to 10	18	10	4
Prowl	BASF	0	12	12	4
Realm Q	Corteva Agriscience	0	10	10	4
Resicore	Corteva Agriscience	0	12	10.5	4
Resolve	Corteva Agriscience	0	1	10	4
Round-up Powermax	Monsanto	0	0	0	0
Sequence	Syngenta	0	0	0	4.5
Sharpen	BASF	0	1.5 to 9	0 to 1	0 to 3
Solstice	FMC	0	10	0	4
Status	FMC	7 days	1	1	1
Sure Start II	Corteva Agriscience	0	26	12	4
Verdict	BASF	0	1.5 to 12	0	4
Warrant	Monsanto	0	0	0	4
Weedmaster	BASF	6	6	6	15days
Zemax	Syngenta	0	12	0	4.5
Zidua	BASF	0	1 to 4	6 to 12	0 to 6

***For all herbicides, ranges will vary due to application rate, cummulative irrigation and/or precipitation, soil texture, and soil organic matter. Always check the label and follow label instructions. Brand names and companies are subject to change.**

Section 2: Corn Herbicides and Management for the Texas High Plains

Safety Precautions

Precautions must be taken to ensure safe handling of herbicides. Applications of all herbicides must follow federal and state pesticide laws. Always apply according to the current label and check regularly for any changes or updates with supplemental labels. Use approved personal protective equipment, clothing, and the appropriate respirator if required, during mixing and application. Mix herbicides away from water sources to prevent water contamination. If chemigation is used, ensure that irrigation systems have anti-backflow devices, especially if broadcasting through center pivot systems. Triple rinse all equipment in accordance with label instructions. Many herbicides require including bleach, ammonia, or tank neutralizers as a component of the second rinse. Store and dispose of herbicides in accordance with Environmental Protection Agency Requirements and follow all label guidelines for storage of herbicides.

Herbicide Activity

The **site of absorption** is the location where the plant takes up the herbicide. The plant absorbs the herbicide through the root, shoot, or leaves. Preplant and preemergent herbicides are soil applied herbicides, which prevent germination of seeds as the seed imbibes in addition to absorption of the herbicide via the root and shoots. Absorption through the leaves is the common site of most post emergence herbicides. Herbicides can have more than one site of absorption. Labels list the primary site of absorption first followed by subsequent sites of absorption. Some herbicides are used for both pre-and post-emergence and are classified as R/L (roots/leaves), but the primary site of absorption, and generally most effective for weed kill, is the roots.

The **mode of action** describes how herbicides affect plant development. Damage to the plant occurs by absorption through the tissues and translocation through the plant parts. Classification of modes of actions are numbered and correspond to the plant process affected.

Group 1 - Lipid Biosynthesis Inhibitors
Group 2 - Amino Acid Biosynthesis Inhibitors
Group 3 - Cell Division Inhibitors
Group 4 - Synthetic Auxins (Growth Regulators)
Groups 5, 6, 7 - Photosynthesis Inhibitors D1 Protein
Group 9 - EPSA Synthase Inhibitors
Group 13 – Pigment Inhibitor
Group 14 - Pigment Inhibitors
Group 22 - Cell Membrane Disruptors
Groups 16, 17, 26 - Unknown

The **site of action** is the targeted location where the herbicide works or the biochemical pathway within the plant where the herbicide acts. For example, Groups 5, 6, and 7 have the same mode of action and are all photosynthesis inhibitors, but they differ at the site where they bind with a different amino acid to disrupt the synthesis of the D1 protein. Herbicides work by binding to proteins at specific sites. There are thirty sites of action recognized by the WSSA and twenty-four letters denoting sites of action by the Herbicide Resistance Action Committee (HRAC). The HRAC established a group letter to classify herbicides by site of action, thereby using herbicides while minimizing weed resistance. If different herbicides share the same mode of action only one letter is used, and numbers are added as sub-scripts. The letters O, J, and Q are omitted to avoid confusion. The WSSA group number along with (HRAC) classification letter is usually found on the label or product information guide and should be consulted before applying any herbicide.

Managing Herbicides to Enhance Weed Control and Prevent Resistance

For proper weed management, several suggestions are listed below for long term sustainability of crops in well-managed fields.

1. Continually scout your fields and the fields around you. Misidentification of weed species can lead to improper treatments. Scout adjacent fields for weeds which may end up in your fields without proper care. Especially after cultivation or herbicide applications, scout fields for weed control. Control weeds on fallow ground, CRP grass pastures, and in bar ditches. By not achieving complete control of all weeds, resistance can develop. Control weeds you suspect of being resistant with an alternative herbicide before they go to seed.
2. Rotate crops and cropping systems.
3. Use cultural practices such as tillage, in conjunction with herbicide applications may be necessary to control resistant or herbicide tolerant weed species.
4. Burn down and control all weeds between rotations and at each application, thereby lowering the possibility for resistant weeds to populate.
5. Select and apply herbicides with different modes of actions. Applying the same herbicides repeatedly in the same year, or year after year applications of single mode of action herbicides, promotes resistance. Use tank mixes that are recommended on the label for control.
6. Always use the recommended labeled rate, spray volume, nozzle and pressure at the correct stage to ensure good spray coverage. Poor spray coverage and subsequent control leads to escapes and/or a partial “kill” that increases the risk of herbicide resistance.
7. Consult your local Extension Agent or Texas A&M AgriLife Research and Extension Center for advice if needed.

More information about controlling glyphosate resistant Pigweeds can be found at: http://publications.tamu.edu/WEEDS_HERBICIDES/4%20Step%20Program%20for%20Managing%20Glyphosate%20Final.pdf While this publication was developed for controlling pigweeds in cotton, many of the management principles apply to all crops.

Herbicide Application Calculations

Proper mixing is the most important step in herbicide applications and understanding how to calculate rates is critical. The 19th Edition of the Private Pesticide Applicator Training Manual and the Pesticide Environmental Stewardship recommendations for calculating herbicide mixes.

To calculate the herbicide application rate, express your rate question as a proportion. When using proportions to determine pesticide application rates, the units on the top and bottom of one ratio must match the units on top and bottom of the other ratio. The examples below will illustrate:

How much do you need to apply to an area that is f the label indicates that 3 lbs. o f granular herbicide are to be applied per 1

Set up the equation and cross multiply

$$\frac{3\ lbs}{1\ acre} = \frac{n}{270\ acres}$$

1 x *n* = 3 x 270

1 *n* = 810

$$n = \frac{810}{1}$$

n = 810 lbs/270 acres

Proportions can be used when converting between square feet and acres.

How much herbicide is needed to treat 3 acres if the label rate is 2 oz per 1,000 sq. ft.?

First convert area to square feet:

3 acres x $\frac{43{,}560\ sq.ft.}{acre}$ = 130,680 sq. ft.

Then cross multiply to find out how many ounces:

$$\frac{2\ oz}{1000 sqft} = \frac{n\ oz}{130{,}680\ sqft}$$

1,000 x *n* = 2 x 130,680 sq. ft.

1,000*n* = 261,360

$$n = \frac{261{,}360}{1000} = 261.4\ oz$$

Proportions can be used to convert from acres to square feet.

How much is needed to treat 4,000 sq. ft. if the label rate is 3 quarts herbicide per acre?

As a first step, convert the label rate to match the square feet units

$$\frac{3\ qts.}{43{,}560\ sq.ft.} = \frac{n\ qts.}{4000\ sq.ft.}$$

43,560 x *n* = 3 x 4,000

43,560*n* = 12,000

n = $\frac{12{,}000}{43{,}560}$ = 0.275 qt.

Then convert quarts to ounces:

0.28 qt. x $\frac{32\ oz.}{qt.}$ = 9.28 oz.

Multiplying Fractions: Calculations involving conversions from one unit of measure to another, can be done by multiplying fractions or setting up ratios. To solve, you need to target the units of measure desired in your answer, then use ratios to cancel out the units that are the same on top and bottom.

What is the flow rate in gallons per minute if 52 ounces of water were collected from a nozzle in one minute? (The units of measurement in your answer are gallons/minute.)

$\frac{52\ oz.}{min}$ *x* $\frac{1\ gal}{128\ oz.}$

Ounces cancel:

$\frac{52}{128}$

resulting in gallons per minute in the final answer:

$\frac{0.41\ gal}{min}$

How many acres can be treated from a spray tank with a capacity of 300 gallons for an application rate of 25 gallons per acre?

The target units of measure in the answer are acres/tank

$\frac{300\ gal.}{tank}$ x $\frac{1\ acre}{25\ gal.}$

Gallons are cancelled, and the answer is in acres per tank:

$\frac{300}{25}$ = 12 acres/tank

How many gallons per acre (GPA) are needed to apply 5 pints per acre in a spray volume of 20 gallons per acre if the nozzle output is 55 OPM (ounces/min)? The sprayer speed is 4 MPH (miles/hour), and the nozzle spacing on the boom is 20 inches (W). How much herbicide will be needed for 50 acres?

Use the formulas:

GPA = $\frac{GPM\ x\ 5{,}940}{MPH\ x\ W}$ other helpful formulas: W= $\frac{Bad\ Width\ (in)}{\#\ Nozzles\ per\ Band}$ GPM = $\frac{GPA\ x\ MPH\ x\ W}{5940}$

GPM = Gallons per Minute Output per Nozzle
MPH = Miles per Hour Travel Speed
W = Spray Width Between Nozzles

First convert 55 OPM to GPM:

GPM = $\frac{55}{128\ oz/gal}$ = 0.43

GPA = $\frac{0.43\ x\ 5{,}940}{4\ x\ 20}$

GPA = 31.93

Multiply the GPA by the number of acres that will be sprayed to find total spray solution.

31.93 x 50 acres = 1596 gallons of spray solution are needed

At 5 pints per acre multiply 5 x 50 acres = 250 pints or 31.25 gallons of herbicide is needed

For percentages: To create a solution that is mixed with water at a specific percent solution, convert the percentage of concentrate in the final solution to a decimal before calculating the amount of concentrate to mix with water.

How to mix 5 gallons of a 3% pesticide solution in water?

1. Convert 3% to its decimal equivalent:
   $\frac{3}{100}$ = 0.03

2. To determine the number of ounces of herbicide needed per gallon:
   Multiply the rate per gallon (0.03) by 128 (ounces in 1 gallon):

   0.03 × 128 = 3.84 oz.

3. To determine the amount of herbicide needed: Multiply the amount of herbicide per gallon by the total spray mix:

$\frac{3.84oz.}{gal.}$ x 5 gal. = 19.2 oz.

Adjuvants are typically added to herbicide mixtures based on a percentage of the final solution.

How much adjuvant should be added to 500 gallons of the herbicide mixture if the adjuvant is used at 0.5 percent concentration by volume?

Convert to decimal: 0.5% = 0.005

500 gal. × 0.005 = 2.5 gal. adjuvant

* Herbicides and other liquid ingredients should be considered a part of the total solution. For example, if you want to make 100 gallons of a 10% solution of herbicide solution in water, you would add 10 gallons of herbicide concentrate to 90 gallons of water (10% of 100=10).

Calculating Commercial Products
Many recommendations state the application rate in amount of active ingredient (a.i.) per acre or 1,000 sq. ft. The active ingredient must then be converted to the actual product.

For dry formulations (wettable powders, granules and dusts) the amount of a.i. is expressed as a percentage of the weight.

$\frac{Amount\ a.i.}{\%a.i.(decimal)} =$ amount product

How many lbs. of a.i. are in a 50-lb. bag of herbicide with the label stating 23WP where 23% is a.i.?

50 x 0.23 = 11.5 lbs.

A 50-pound bag of will have 11.5 pounds of active ingredient.

How much product is needed per acre for an herbicide that is 75WP applied at a rate of 2 lbs. a.i./acre?

$\frac{2lbs.a.i./acre}{0.75}$ = 2.66 lbs. of the 75 WP/acre

How much is needed to treat 15 acres?

$\frac{2.66\ lbs.of\ 75WP}{acre}$ x 15 acres = 39.9 lbs.

For liquid formulations (emulsifiable concentrates and flowables are liquids where the amount of active ingredient is expressed as the weight in pounds a.i. per gallon of product.) This information is provided as part of the label.

$$\frac{lbs.\ a.i.}{lbs.\ a.i./gal} = \text{gal. product}$$

How many lbs. of a.i. in a 3-gallon jug of herbicides with 4 pounds a.i. in each gallon?

3 gal. × 4 lbs. a.i./gallon = 12 lbs.).

A 3 gal. jug of 4EC has 12 lbs. a.i.

How much product is needed per acre for a 4EC herbicide applied at a rate of 2 lb a.i./acre.

$$\frac{2\ lbs.a.i./acre}{4\ lbs.a.i/gal} = 0.5 \text{ gal./acre}$$

How much is needed to treat 15 acres?

$$\frac{0.5\ gal.}{acre} \text{ x 15 acres} = 7.5 \text{ gal.}$$

Examples modified from Pesticide Environmental Stewardship training materials: https://pesticidestewardship.org/calibration/calibration-introduction/

The correct formula needs to be used to calculate the amount of product needed to treat an area at the rate specified on the label. Keep in mind that the package information on dry formulations and liquid formulations means different things, and that the formula you will use to figure the amount of product will be different. For further information on calibrations contact the pesticide Environmental Stewardship website at: **https://pesticidestewardship.org/**

Commonly Used Conversions

1 gallon = 128 ounces

1gallon = 4 quarts = 8 pints = 16 cups

1 quart = 32 ounces

1 quart = 2 pints = 4 cups

1 pint = 16 ounces

1 pint = 2 cups

1 cup = 8 ounces

Herbicide Mixing

Herbicides are usually sold as mixtures or formulations of one or more herbicides with various additives. Additives increase the effectiveness of herbicides. On certain labels, they are referred to as adjuvants, surfactants, emulsifiers, or wetting agents. The type of formulation determines the toxicity to plants, uniformity of plant coverage, and stability in storage. Herbicides are formulated to permit uniform and easy application is liquid sprays or dry granules if mixed with dry fertilizers.

When mixing herbicides, one-third to one-half of the water needed for the mix should be added first along with any fertilizer, followed by the amount of herbicide denoted on the label, then add the remaining amount of water needed to reach the desired mix amount. Read the label for information on necessity and rates for additives, such as surfactants. When creating tank mixes, herbicides should be added following the order following the WALES acronym order:

- One-third to one-half of the water needed for the mix.
- Add compatibility agents, ammonium sulfate, buffering agents, or other mixing adjuvants. For maximum benefit, they must be in the solution before herbicides are added.
- **W**ettable powders and **w**ater dispensable granules.
- **A**gitate
- **L**iquid flowables and suspensions
- **E**mulsifiable concentrates formulations
- **S**urfactants

*A compatibility test should be performed by mixing herbicides in a jar before tank mixing occurs if any questions arise about the compatibility of combining herbicides, or herbicides and fertilizers.

Herbicide Types

Emulsifiable concentrates (EC or E) are liquid formulations with an active ingredient that is dissolved in one or more petroleum-based solvents. An emulsifier is added to cause oil to form tiny globules that disperse in water. The formulation will then mix readily with water for proper application.

Emulsifiable gels (EG or GL) are herbicides that traditionally are emulsifiable liquids formulated as gels. The gels typically are packaged in water-soluble bags (WSB) and are stable at temperatures ranging from –20 to 500°C.

Wettable powders (WP or W) are finely ground, dry particles that may be dispersed and suspended in water. They contain from 25 to 80 percent active ingredient. Suspensions of wettable powders appear cloudy and are nearly insoluble requiring agitation to remain in suspension.

Soluble liquid (S) and soluble powders (SP) dissolve in water to form a true solution. Once the soluble liquid or powder is dissolved, the spray mixture requires no additional mixing or agitation.

Dry flowables (DF), Water-dispersible granules (WDG or WG) or Dispersible Granules (DG) are wettable powders formed into balls so they pour easily into the sprayer tank without clumping or producing a cloud of dust. Nearly insoluble, they require agitation to remain in suspension.

Flowables (F or FL), Suspension Concentrates (SC), and aqueous suspension (AS) are finely ground, wettable powders or solids already suspended in a liquid so they can be poured or pumped from one tank to another. They usually contain at least 4 pounds of active ingredient per gallon of formulation. Flowables are nearly insoluble in water and require agitation to remain in suspension.

Suspoemulsion (SE) is a combination formulation of an SC and an oil-based emulsion (E).

Microencapsulated (ME or MT) and capsule suspension (CS) are encased in extremely small capsules that can be suspended in a liquid carrier and pumped and applied with normal equipment. Microencapsulated formulations are nearly insoluble in water and require agitation to remain in suspension.

Granules (G) are formulated with a premixed carrier that contains a low percentage of active ingredient. The carrier may be fertilizer, clay, lime, vermiculite, or ground corn cobs. These herbicides are applied directly (dry) to the soil without further dilution. Granular forms generally require rainfall for activation.

Pellets (P) are like granules but are compressed into larger cylinders about ¼ inch long. Herbicides formulated as pellets usually contain from 5 to 20 percent active material and are hand-applied to control clumps of brush. They also may be applied with cyclone-type spinner spreaders mounted on helicopters or aircraft to control brush in forests or permanent pastures. Pellets gradually break down from rainfall and leach into the soil for root uptake.

Premixes are two or more herbicide active ingredients mixed into one product by the manufacturer. The actual formulation can be any of those discussed above and commonly combines two or more herbicides that are already used together. The primary reason for using premixes is convenience.

Adjuvants

An adjuvant is a substance added to an herbicide tank mix that will modify or enhance the properties of the mixture and increase the effectiveness of the active ingredients in the herbicide. An adjuvant active ingredient is not the same as an herbicide active ingredient. There are two basic types of adjuvants; utility adjuvants and activators.

Utility adjuvants modify the physical characteristics of the tank mix commonly referred to as utility adjuvants. These adjuvants have specific uses in tank mixes such as pH adjustment or buffering, compatibility agents with fertilizers or other pesticides, spray drift reduction, deposition aids for drift control, and defoaming agents.

Activator adjuvants enhance the efficacy of the chemical in the tank mix. The activator(s) changes the chemistry of the herbicide by acting as a modifier (changes the herbicide properties by a physiological

mechanism, extender (extends the life of the herbicide in the soil), safener (reduces the herbicides toxicity to a plant), synergist (increases the toxicity of an herbicide), or surfactant (improves the properties of an herbicide by modifying its surface characteristics). Common activator adjuvants are surfactants, crop oil concentrates, methylated seed oil, and nitrogen fertilizer. They can also be referred to as wetting agents, spreading agents, sticking agents, humectants, and penetration agents.

Surfactants are binding agents that act on the surface and are divided into categories depending on their ability to form ions in aqueous solutions:

nonionic - a binding agent made up of water and lipid segments, with no ions formed in water (NIS).
anionic - a binding agent that forms a negative ion (anion) when placed in water.
cationic - a binding agent that forms a positive (cation) when placed in water.
Amphoteric - a binding agent that can form either a surface-acting anion or cation depending on the pH of the solution. (rarely effective in tank mixes)

A complete listing of 779 adjuvants from 38 companies is available in the 13th Edition of the Compendium of Herbicide Adjuvants and can be down-loaded from:
https://ppp.purdue.edu/wp-content/uploads/2016/11/PPP-115.pdf

The booklet organizes adjuvants by type provided by the manufacturer. Most herbicide labels will also recommend which adjuvants to use and the mixing order. Many adjuvants contain a combination of products to enhance the effectiveness of the tank mix.

Label Instructions

The label is the law. Consult the label for all product information regarding:

- Mixing rate
- Maximum application rate for single spraying application
- Total application rate for yearly applications
- Soil texture information regarding rates (finer-textured soils or soils with high organic matter usually require higher application rates)
- Weeds controlled, and weeds partially controlled
- Rotational crops and re-plant intervals
- Nozzeling including type and orientation
- Types of applications permitted (some herbicides are not approved for aerial application)
- Droplet size, volume and pressure
- Boom width and application height
- Wind drift considerations
- Temperature and humidity recommendations
- Temperature inversions
- Sensitive areas
- Cleaning and rinsing instructions- some herbicides require rinses with bleach and some require rinses with ammonia, bleach, or tank neutralizers
- Storage instructions

Table 4. Single Mode of Action Herbicides Commonly Used in Texas on Corn and/or Evaluated in the Bushland Corn Herbicide Trials.

Trade Name	Active Ingredient	Chemical Family	Mode of Action*	WSSA Site of Action Group #	Manufacturer	Application Timing
2,4-D amine or ester	2,4-D	Synthetic Auxin	Growth Regulator/Auxin	4	various	Burndown
Aatrex	atrazine	Triazine	Photosynthesis Inhibitor	5	Syngenta	Pre/Post
Abundit	glyphosate	Glycine	EPSP Synthase	9	Corteva Agriscience	Post
Accent Q	nicosulfuron	Sulfonylurea	ALS	2	Corteva Agriscience	Post
Aim	carfentrazone	Triazolinone	PPO	14	FMC	Post
Armezon	topramezone	Triketone	HPPD	27	BASF	Post
Balance Flex	isoxaflutole	Pyrazole	HPPD	27	Bayer	Pre/Post
Banvel	dicamba	Benzoic Acid	Growth Regulator/Auxin	4	Arysta	Pre/Post
Banvel II	dicamba	Benzoic Acid	Growth Regulator/Auxin	4	BASF	Pre/Post
Barrage HF	2.4-D ester	Phenoxy-carboxylic-acid	Growth Regulator/Auxin	4	Helena	Pre/Post
Basagran	bentazon	Benzothiadiazinone	Photosynthesis Inhibitor	6	Arysta	Post
Basis	rimsulfuron + thifensulfuron	Sulfonylurea	ALS	2+2	Corteva Agriscience	Pre/Post
Beacon	primisulfuron	Sulfonylurea	ALS	2	Syngenta	Post
Buctril	bromoxynil	Nitrile	Photosynthesis Inhibitor	6	BASF	Pre/Post
Cadet	fluthiacet methyl	Thiadiazole	PPO	14	FMC	Pre/Post
Callisto	mesotrione	Triketone	HPPD	27	Syngenta	Pre/Post
Cinch	S-metolachlor	Chloroacetamide	Mitosis Inhibitor	15	Corteva Agriscience	Pre/Post
Clarity	dicamba	Benzoic Acid	Growth Regulator/Auxin	4	BASF	Pre/Post
Crusher	rimsulfuron + thifensulfuron	Sulfonylurea	ALS	2	Cheminova	Post/Burndown
DiFlexx	dicamba	Benzoic Acid	Growth Regulator/Auxin	4	Bayer	Pre/Post
Direx	diuron	Urea	Photosynthesis Inhibitor	7	Adama	Pre/Post
Dual II Magnum	S-metolachlor	Chloroacetamide	Mitosis Inhibitor	15	Syngenta	Pre/Post
Dual Magnum	S-metolachlor	Chloroacetamide	Mitosis Inhibitor	15	Syngenta	Pre/Post
Durango DMA	glyphosate	Glycine	EPSP Synthase	9	Corteva	Pre/Post
Exceed	primisulfuron + prosulfuron	Sulfonylurea	ALS	2 + 2	Syngenta	Post
FirstShot SG	thifensulfuron + tribenuron	Sulfonylurea	ALS	2 + 2	Corteva Agriscience	Burndown
Gramoxone	paraquat	Bipyridylium	Cell Membrane Disrupter	22	Syngenta	Pre/Post
Halo Max 75	halosulfuron	Sulfonylurea	ALS	2	Aceto	Pre/Post
Harmony Extra SG	thifensulfuron + tribenuron	Sulfonylurea	ALS	2 + 2	Corteva Agriscience	Burndown
Harmony GT	thifensulfuron	Sulfonylurea	ALS	2	Corteva Agriscience	Post/Burndown
Harness	acetochlor	Chloroacetamide	Mitosis Inhibitor	15	Monsanto	Pre/Post
Impact	topramezone	Triketone	HPPD	27	Amvac	Post
Incinerate	mesotrione	Triketone	HPPD	27	Winfield	Pre/Post
Karmex	diuron	Urea	Photosynthesis Inhibitor	7	Adama	Post
Laudis	tembotrione	Triketone	HPPD	27	Bayer	Post
LeadOff	rimsulfuron + thifensulfuron	Sulfonylurea	ALS	2 + 2	Corteva Agriscience	Pre
Liberty, Interline	glufosinate	Phosphinic acid	Nitrogen Metabolism	10	Bayer, UPI	Pre/Post
Outlaw	2,4-D + dicamba	Phenoxy-carboxylic-acid + Benzoic Acid	Growth Regulator/Auxin	4 + 4	Helena	Burndown
Outlook	dimethenamid	Chloroacetamide	Mitosis Inhibitor	15	BASF	Pre/Post
Parazone	paraquat	Bipyridylium	Cell Membrane Disrupter	22	ADAMA	Pre/Post
Peak	prosulfuron	Sulfonylurea	ALS	2	Syngenta	Post
Pendimax	pendimethalin	Dinitroaniline	Seedling Root Growth Inhib.	3	Corteva	Pre/Post
Permit	halosulfuron	Sulfonylurea	ALS	2	Gowan	Post
Princep	simazine	Triazine	Photosynthesis Inhibitor	5	Syngenta	Pre
Profine	halosulfuron	Sulfonylurea	ALS	2	Aceto	Pre/Post
Prowl	pendimethalin	Dinitroaniline	Seedling Root Growth Inhib.	3	BASF	Pre/Post
Prowl H2O	pendimethalin	Dinitroaniline	Seedling Root Growth Inhib.	3	BASF	Pre/Post
Python	flumetsulam	Triazolopyrimidine	ALS	2	Corteva	Post
Quik-Quat	paraquat	Bipyridylium	Cell Membrane Disrupter	22	Drexel	Pre/Post
Rely	glufosinate	Phosphinic acid	Nitrogen Metabolism	10	Bayer	Pre/Post
Resolve DF	rimsulfuron	Sulfonylurea	ALS	2	Corteva Agriscience	Pre/Post
Resolve Q	rimsulfuron + thifensulfuron-methyl	Sulfonylurea	ALS	2 + 2	Corteva Agriscience	Pre/Post
Resource	flumiclorac	N-phenylphthalimide	PPO	14	Valent	Pre/Post
Round-up	glyphosate	Glycine (isopropylamine)	EPSP Synthase	9	Monsanto	Pre/Post
Sandea	halosulfuron	Sulfonylurea	ALS	2	Gowan	Post
Sharpen	saflufenacil	Pyrimidindione	PPO	14	BASF	Pre
Status	dicamba	Benzoic Acid	Growth Regulator/Auxin	4	BASF	Post
Status	dicamba + diflufenzopyr	Benzoic Acid + semicarbazone	Growth Regulator/Auxin	4 + 4	BASF	Post
Steadfast Q	nicosulfuron + rimsulfuron	Sulfonylurea	ALS	2 + 2	Corteva Agriscience	Pre/Post
Touchdown, HiTech, Total	glyphosate	Glycine (diammonium)	EPSP Synthase	9	Syngenta	Pre/Post
Treflan HFP	trifluralin	Dinitroaniline	Seedling Root Growth Inhib.	3	Dow	Post
Valor SX	flumioxazin	N-phenylphthalimide	PPO	14	Valent	Pre
Warrant	acetochlor	Chloroacetamide	Mitosis Inhibitor	15	Monsanto	Pre
Zidua	pyroxasulfone	Isoxazoline	Mitosis Inhibitor	15	BASF	Pre/Post

*Mode of Action	Site of Action
ALS	Acetolactate Synthase Inhibitor
AHAS	Acetohydroxy Acid Synthase Inhibitor
EPSP Synthase	Amino Acid Synthesis Inhibitor: Inhibitor of 5-enolypyruvyl-shikimate-3-phosphate synthase
Cell Membrane Disrupter	PPO, Inhibitor of protoporphyrinogen oxidase (Protox)
Cell Membrane Disrupter	Photosystem I electron diverter
HPPD	Inhibitor of 4-hydroxyhenyl-pyruvatedioxygenase
Nitrogen Metabolism	Inhibitor of glutamine synthetase
Seedling Root Growth Inhibitor	Inhibitor of microtubule assembly
Growth Regulator	Phenoxy-carboxylic-acid
Photosynthesis Inhibitor	Photosystem II Inhibitor

Herbicide group number according to primary site of action by Weed Science Society of America (WSSA) number designation.

Table 5. Multiple Mode of Action Herbicides Commonly Used in Texas on Corn and/or Evaluated in the Bushland Corn Herbicide Trials.

Trade Name	Active Ingredient	Chemical Families	Modes of Action*	WSSA Site of Action Group #s	Manufacturer	Application Timing
Acuron	S-metolachlor + bicyclopyrone + mesotrione + atrazine	Chloroacetamide + Triketone + Triazine	HPPD + Photosynthesis Inhibitor + Photosynthesis Inhibitor	15 + 27 + 27 +5	Syngenta	Pre/Post
Acuron Flexi	bicyclopyrone + mesotrione + S-metolachlor +	Benzoylbicyclooctanedione + Triketone + Chloroacetamide	HPPD + HPPD + Photosynthesis Inhibitor	27 + 27 + 15	Syngenta	Pre/Post
Afforia	flumioxazin + thifensulfuron + tribenuron	N-Phenylphthalimide + Sulfonyurea	PPO + ALS	14 + 2	Corteva	Pre
Anthem Maxx	pyroxasulfone + fluthiacet-methyl	isoxazoline + Thiadiazole	Mitosis Inhibitor + PPO	15 + 14	FMC	Pre/Post
Armezon PRO	isoxoflutole + thiencarbazone-methyl	Isoxazole + Sulfonly-amino-carbonyl-triazolinones (SACT)	HPPD + ALS	27 + 2	Bayer	Pre/Post
Authority MTZ	metribuzin + sulfentrazone	Triazolinone + Triazinone	PPO + Photosthesis Inhibitor	14 + 5	FMC	Pre
Axiom DF	flufenacet + metribuzin	Oxyacetamide + Triazolinone	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Bayer	Pre
Bicep II Magnum	S-metolachlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Syngenta	Pre/Post
Bicep Lite II Magnum	S-metolachlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Syngenta	Pre/Post
Capreno	tembotrione + thiencarbazone-methyl	Triketone + Sulfonly-amino-carbonyl-triazolinones (SACT)	HPPD + ALS	27 + 2	Bayer	Pre/Post
Cinch ATZ	S-metolachlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Corteva	Pre/Post
Corvus	isoxoflutole + thiencarbazone-methyl	Pyrazole + Sulfonly-amino-carbonyl-triazolinones (SACT)	HPPD + ALS	27 + 2	Bayer	Pre/Early Post
Costarr	glyphosate + dicamba	Glycine + Benzoic Acid	EPSP Synthase + Growth Regulator/Auxin	9 + 4	Albaugh	Pre/Post
Degree Xtra	acetochlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Monsanto	Pre/Post
DiFlexx DUO	tembotrine + dicamba	Triketone + Benzoic Acid	HPPD + Growth Regulator/Auxin	27 + 4	Bayer	Pre/Post
Enlist Duo	glyphosate + 2,4-D	Glycine + Phenoxy-carboxylic-acid	EPSP Synthase + Growth Regulator/Auxin	9 + 4	Dow	Pre/Post
Fierce	pyroxasulfone + flumioxazin	Pyrazole + N-Phenylphthalimide	Mitosis Inhibitor + PPO	15 + 14	FMC	Pre/ Burndown
Guardsman Max	dimethenamid + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	BASF	Pre/Post
Halex GT	mesotrione + S-metolachlor + glyphosate	Triketone + Chloroacetamide + Glycine	HPPD + Photosynthesis Inhibitor + EPSP Synthase	27 + 15 + 9	Syngenta	Post
Harness Max	mesotrione + acetochlor	Triketone + Chloroacetamide	HPPD + Photosynthesis Inhibitor	27 + 15	Monsanto	Pre/Post
Harness Xtra	acetochlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Monsanto	Pre
Impact Z	topramezone + atrazine	Triketone + Triazine	HPPD + Photosynthesis Inhibitor	27 + 5	AmVac	Post
Integrity	dimethenamid + saflufenacil	Chloroacetamide + Other	Mitosis Inhibitor + PPO	15 + 14	BASF	Pre
Keystone/ FulTime NXT	acetochlor + atrazine	Chloroacetamide + Triazine	Mitosis Inhibitor + Photosynthesis Inhibitor	15 + 5	Corteva	Pre/Post
Landmaster	glyphosate + 2,4-D	Glycine + Phenoxy-carboxylic-acid	EPSP Synthase + Growth Regulator/Auxin	9 + 4	Albaugh	Pre
Lariat	alachlor + atrazine	Chloroacetanilide + Triazine	Pigment Inhibitor + Photosynthesis Inhibitor	13 + 5	Monsanto	Pre
Lexar EZ	mesotrione + S metolachlor + atrazine	Triketone + Chloroacetamide + Triazine	HPPD + Photosynthesis Inhibitor + Photosynthesis Inhibitor	27 + 15 + 5	Syngenta	Pre
Lumax	mesotrione + S-metolachlor + atrazine	Triketone + Chloroacetamide + Triazine	HPPD + Photosynthesis Inhibitor + Photosynthesis Inhibitor	27 + 15 + 5	Syngenta	Pre
Prequel	isoxaflutole + rimsulfuron	Pyrazole + sulfonylurea	HPPD + ALS	27 + 2	Corteva	Pre
Realm Q	mesotrione + rimsulfuron	Triketone + sulfonylurea	HPPD + ALS	27 +2	Corteva	Burndown/ Post
Resicore	mesotrione + acetochlor + clopyralid +	Triketone + Chloroacetamide + Pyridine carboxylic acid	HPPD + Photosynthesis Inhibitor + Growth Regulator/Auxin	27 + 15 + 4	Corteva	Pre/Post
Revulin Q	mesotrione + nicosulfuron	Triketone + sulfonylurea	HPPD + ALS	27 +2	Corteva	Post
Sequence	glyphosate + S-metolachlor	Chloroacetamide + Glycine	Mitosis Inhibitor + EPSP Synthase	15 +9	Syngenta	Pre/Post
Solstice	mesotrione + fluthiacet methyl	Triketone + Thiadiazole	HPPD + PPO	27 + 14	FMC	Post
Starane NXT	bromoxynil + fluroxypyr	Nitrile + Synthetic Auxin	Photosynthesis Inhibitor + Growth Regulator/Auxin	6 + 4	Corteva	Post
SureStart	acetochlor + clopyralid + flumetsulam	Chloroacetamide + Pyridine carboxylic acid + Triazolopyrimidine	Mitosis Inhibitor + Growth Regulator/Auxin + ALS	15 + 4 + 2	Corteva	Pre/Post
SureStart II	acetochlor + clopyralid + flumetsulam	Chloroacetamide + Pyridine carboxylic acid + Triazolopyrimidine	Mitosis Inhibitor + Growth Regulator/Auxin + ALS	15 + 4 + 2	Dow	Pre/Post
TripleFLEX	acetochlor + clopyralid + flumetsulam	Chloroacetamide + Pyridine carboxylic acid + Triazolopyrimidine	Mitosis Inhibitor + Growth Regulator/Auxin + ALS	15 + 4 + 2	Monsanto	Pre/Post
Verdict	dimethenamid + saflufenacil	Chloroacetamide + Other	Mitosis Inhibitor + PPO	15 + 14	BASF	Pre/ Burndown
Yukon	halosulfuron + dicamba	Sulfonylurea + Benzoic Acid	ALS + Growth Regulator/Auxin	2 + 4	Gowan	Pre/Post
Zemax	mesotrione + S-metolachlor	Triketone + Chloroacetamide	HPPD + Photosynthesis Inhibitor	27 + 15	Syngenta	Pre/Post

*Mode of Action	Site of Action
ALS	Acetolactate Synthase Inhibitor
AHAS	Acetohydroxy Acid Synthase Inhibitor
EPSP Synthase	Amino Acid Synthesis Inhibitor: Inhibitor of 5-enolypyruvyl-shikimate-3-phosphate synthase
Cell Membrane Disrupter	PPO, Inhibitor of protoporphyrinogen oxidase (Protox)
Cell Membrane Disrupter	Photosystem I electron diverter
HPPD	Inhibitor of 4-hydroxyhenyl-pyruvatedioxygenase
Nitrogen Metabolism	Inhibitor of glutamine synthetase
Seedling Root Growth Inhibitor	Inhibitor of microtubule assembly
Growth Regulator	Phenoxy-carboxylic-acid
Photosynthesis Inhibitor	Photosystem II Inhibitor
Pigment Inhibitor	deoDOxy-D-xyulose 5-phosphate sunthatase Inhibitor

Herbicide group number according to primary site of action by Weed Science Society of America (WSSA) number designation