Diclosulam for Weed Control in Texas Peanut[1]

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ABSTRACT

Field experiments were conducted in 1995 through 1997 in south and west Texas to evaluate diclosulam [N-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro(1,2,4)-triazolo(1,5c)-pyrimidine-2-sulfonamide] for weed control in peanut. Diclosulam applied preplant incorporated at 0.01 kg ai/ha in combination with ethalfluralin at 0.84 kg ai/ha controlled Texas panicum, Palmer amaranth, morningglory species, and golden crownbeard at least 95% and devil's-claw 91%. When diclosulam rates were increased to 0.02 kg/ha, yellow and purple nutsedge were controlled at least 89 and 72%, respectively. Diclosulam applied postemergence (POST) provided erratic yellow nutsedge control.

Key Words: *Arachis hypogaea* L., groundnut, postemergence, preplant incorporated.

Palmer amaranth (*Amaranthus palmeri* S. Wats.), Texas panicum (*Panicum texanum* Buckl.), golden crownbeard [*Verbesina enceliodes* (Cav.) Benth. & Hook. f. ex. A. Gray], yellow nutsedge (*Cyperus esculentus* L.), and purple nutsedge (*C. rotundus* L.) are problem weeds in Texas peanut (Dowler, 1997). With increasing peanut acreage in west Texas, weeds such as devil's-claw [*Proboscidea louisianica* (Mill.) Thellung], lanceleaf sage (*Salvia reflexa* Hornem.), prairie sunflower (*Helianthus petiolaris* Nutt.), woollyleaf bursage [*Ambrosia grayi* (A.Nels.) Shinners], Texas blueweed (*Helianthus ciliaris* DC.), and silverleaf nightshade (*Solanum elaeagnifolium* Cav.) may soon become problematic weeds in peanut. The imidazolinone herbicides, imazethapyr {2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid} and imazapic {(±)-2[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid} partially control many of these weeds (Wilcut *et al.*, 1991b, 1994b; Grichar *et al.*, 1992; Webster *et al.*, 1997). However, imazethapyr does not consistently control yellow nutsedge (Wilcut *et al.*, 1991a; Grichar *et al.*, 1992). Imazapic controlled purple and yellow nutsedge as well as or better than imazethapyr at all application timings (Dotray and Keeling, 1997; Grichar and Nester, 1997) and provided better control of purple and yellow nutsedge in field experiments than other currently registered herbicides in peanut (Gooden and Wixson, 1992; Colvin and Brecke, 1993; Grichar and Nester, 1993; Wilcut *et al.*, 1994a). Imazapic also has a longer period of residual weed control when applied postemergence

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(POST) than imazethapyr. The 18-mo crop rotation restriction following imidazolinone herbicide use on peanut with cotton planting (*Gossypium hirsutum* L.) limits the use of the imidazoline herbicides, especially in west Texas (Wilcut *et al.*, 1993; Richburg *et. al.*, 1994).

Common crop rotation with peanut in west Texas is cotton-peanut-cotton. In south and central Texas, the common rotation is usually corn (*Zea mays* L.) or grain sorghum [*Sorghum bicolor* (L.) Moench] followed by peanut. The third year may be a grain crop or another year of peanut before the rotation back to a grain crop. In some areas of south and central Texas, watermelon (*Citrullus lanatus* L.) or other vegetable crops may be included in a rotation with peanut.

Imazapic and imazethapyr crop rotation restrictions after applying either in peanut include 9 mo for corn, 18 mo for cotton and grain sorghum, and 26 mo for most other crops including potatoes (*Solanum tuberosum* L.) which has a 40-mo rotation restriction (Anonymous, 1999). Proposed rotation restrictions following diclosulam use in peanut include 18 mo for corn and grain sorghum and 30 mo for all other crops (R. Lassiter, pers. commun.).

Diclosulam [N-(2,6-dichlorophenyl)-5-ethoxy-7-fluoro(1,2,4)-triazole(1,5c)-pyrimidine-2-sulfonamide] is a new triazolopyrimidine sulfonanilide herbicide being developed for use in soybean [*Glycine max* (L.) Merr.] and peanut (Gander *et al.*, 1997; Sheppard *et al.*, 1997; Stafford *et al.*, 1997). As a preplant incorporated (PPI) or preemergence (PRE) treatment, diclosulam controlled many weeds found in soybean and peanut, including common cocklebur (*Xanthium strumarium* L.), morningglory species (*Ipomoea* spp.), common ragweed (*Ambrosia artemisiifolia* L.), pigweed species (*Amaranthus* spp.), common lambsquarters (*Chenopodim album* L.), prickly sida (*Sida spinosa* L.), Florida beggarweed [*Desmodium tortuosum* (Sw.) DC.], bristly starbur (*Acanthospermum hispidum* DC.), and yellow nutsedge (Braxton *et al.*, 1997; Langston *et al.*, 1997; Richburg *et al.*, 1997; Sheppard *et al.*, 1997).

However, several studies have reported that diclosulam applied PPI or PRE did not control sicklepod [*Senna obtusifolia* (L.) Irwin Barneby] (Braxton *et al.*, 1997; Wilcut *et al.*, 1997). Diclosulam applied POST also did not control prickly sida or common lambsquarters (Wilcut *et al.*, 1997).

Field experiments were conducted in theTexas peanut-growing regions with the following objectives: (a) to evaluate diclosulam applied PPI or POST for weed control in peanut, (b) to determine peanut tolerance to diclosulam, and (c) to compare weed control and peanut yield with diclosulam to a commercial standard herbicide system.

Materials and Methods

Field studies were conducted at 12 south and west Texas locations during the 1995 through 1997 growing seasons. In south Texas, studies were conducted at the following locations: Texas Agric. Exp. Stn. near Yoakum in 1995 and 1996; James Mann Farm near Pearsall in 1996 and 1997; Church of Latter Day Saints (CLDS) Farm near Pearsall in 1995, 1996, and 1997; and the Joe Wier Farm near Charlotte in 1995. Soil type at the Yoakum location was a Tremona loamy fine sand (thermic Aquic Arenic Palenstalf) with less than 1% organic matter and pH of 6.8 to 7.2. At the James Mann Farm, the soil type was a Duval loamy fine sand (fine-loamy, mixed, hyperthermic Aridic Haplustalfs) with less than 1% organic matter and a pH of 7.0 to 7.2. Soil type at the CLDS Farm was a Duval fine sandy loam (fine loamy, mixed, hyperthermic Aridic Haplustalfs) with less than 1% organic matter and pH 7.2 . At the Joe Wier Farm, the soil type was a Neuces loamy fine sand (loamy, mixed, hyperthermic Aquic Arinic Palenstalfs) with less than 1% organic matter and a pH of 7.2. In west Texas, studies were conducted near Seminole in 1995, near O'Donnell in 1996, and near Lubbock in 1997. Soil type near Seminole and O'Donnell was an Amarillo fine sandy loam (fine-loamy, mixed, thermic Aridic Palenstalf) with less than 1% organic matter and a pH of 7.8. Soil type near Lubbock was an Amarillo sandy clay loam (fine-loamy, mixed, thermic Aridic Palenstalf) with less than 1% organic matter and a pH of 7.8. These experimental sites are representative of the major peanut-producing areas in south and west Texas.

GK-7 peanut was used at all south Texas locations except the CLDS Farm in 1997 where the cultivar AT-108 was used. Peanut seed at 100 kg/ha was planted approximately 5 cm deep immediately after PPI applications. In west Texas, Tamrun 88 was planted 5 cm deep at 100 kg/ha in a well-prepared seedbed using conventional equipment within 1 wk of herbicide application. PPI treatments in south Texas were incorporated immediately after application with a power-driven tiller operated at a 6-cm depth. In west Texas, PPI treatments were incorporated with a rolling cultivator to a depth of 3 to 5 cm. POST treatments were applied 3-4 wk after crop emergence.

The experimental design for all studies was a randomized complete block with three to four replications. Plots were two rows wide, spaced 97 cm apart, and 7.9 m long in south Texas and four rows wide, spaced 102 cm apart, and 9 m long in west Texas. Naturally occurring weed species composition and densities are identified in Table 1.

In south Texas, herbicides were applied with a compressed-air bicycle sprayer using Teejet 11002 (Spraying Systems Co., Wheaton, IL) flat fan nozzles that delivered a spray volume of 190 L/ha at 180 kPa. In west Texas, herbicides were applied using a tractor-mounted compressed-air sprayer using Teejet 8002 (Spraying Systems Co., Wheaton, IL) flat fan nozzles delivering 140 L/ha at 207 kPa. POST applications included an organosilicone-based surfactant [Kinetic HV, proprietary blend of polyalkyleneoxide modified polydimethylsiloxone and nonionic surfactant (99.5%) (Helena Chemical Co., Memphis, TN] 0.25% by volume in south Texas and a crop oil concentrate [Agri-Dex, an 83% paraffin-based petroleum oil with 17% polyoxyethlylated polyol fatty acid ester and polyol fatty acid ester (Helena Chemical Co., Memphis, TN)] at 1.25% by volume in west Texas. Weed control ratings were taken throughout the growing season; however, only late season ratings are presented. Visual estimates of weed control were based on a scale of 0% (no control or peanut injury) to 100% (complete control or death of the peanut) relative to the nontreated check. Peanut injury was estimated visually starting 2 wk after PPI treatments or 1 wk after POST treatments and were recorded throughout the growing season. Peanut stunting was the parameter used in making the visual injury estimates.

Herbicide treatments were with ethalfluralin applied PPI at 0.8 kg ai/ha alone or in combination with diclosulam at

Table 1. Annual weed species, density, and time of herbicide application at each south Texas location.

Location	Year	Weed species	Density	Timing
			no./m²	
CLDS Farm (south Texas)	1995	Texas panicum	8-10	PPI
	1996	Palmer amaranth	12-14	PPI
		Texas panicum	10-12	PPI
		Yellow nutsedge	16-20	PPI
	1997	Palmer amaranth	16-18	PPI
		Texas panicum	10-12	PPI
		Golden crownbeard	6-8	PPI
Lubbock (west Texas)	1997	Palmer amaranth	25-30	PPI
		Devil's-claw	4-6	PPI
		Yellow nutsedge	2-4	PPI
Mann (south Texas)	1996	Texas panicum	10-12	PPI
		Palmer amaranth	6-8	PPI
		Purple nutsedge	4-6	PPI
	1997	Yellow nutsedge	14-16	POST
		Palmer amaranth	4-6	PPI
		Texas panicum	6-8	PPI
O'Donnell (west Texas)	1996	Palmer amaranth	2-6	PPI
Seminole (west Texas)	1995	Purple nutsedge	3-4	PPI
Wier (south Texas)	1995	Yellow nutsedge	12-14	PPI
		Golden crownbeard	16-18	PPI
Yoakum (south-central Texas)	1995	Texas panicum	6	PPI
		Yellow nutsedge	10-20	PPI
	1996	Yellow nutsedge	15-20	POST
	1996	Texas panicum	8-10	POST
		Yellow nutsedge	30-40	POST

0.01, 0.02, 0.03, 0.04, and 0.06 kg ai/ha, and ethalfluralin at 0.8 kg ai/ha PPI followed by imazapic applied EPOST at 0.07 kg ai/ha. A nontreated check was included at each location. In the POST study, the herbicide treatments included diclosulam at 0.002, 0.006, 0.01, 0.02, and 0.03 kg ai/ha, imazapic (0.07 kg ai/ha) as the standard, and nontreated check. Ethalfluralin at 0.8 kg ai/ha was applied PPI prior to POST applications of diclosulam and imazapic.

Data collected included visual estimates of crop injury and weed control on a scale of 0 to 100% relative to the nontreated check, and peanut yield. Weed control and peanut injury were visually estimated early, mid-, and late season during each year. Late weed ratings taken approximately 3 wk prior to harvest are presented.

Peanut yields were obtained at four locations in south Texas. Yields were obtained by digging each plot separately, air-drying in the field for 5 to 8 d, and harvesting peanut pods with a combine. Weights were recorded after soil and foreign material were removed from the plot samples. Visible weed control data were subjected to arcsine transformation prior to analysis of variance, and significant differences among means for weed control and peanut yield were determined using Fisher's Protected LSD Test at the 5% level.

Since a treatment-by-year interaction occurred in soil-applied and POST studies that examined peanut injury, yellow nutsedge control and in peanut yield, data are presented by year. Since there were no year-by-treatment interactions for devil's claw, Texas panicum, Palmer amaranth, golden crownbeard, or morningglory species control, data were pooled over years.

Results and Discussion

Peanut Injury. Slight early season peanut injury (stunting) was observed in all 3 yr following diclosulam PPI applications. In 1995, diclosulam at 0.03 kg/ha caused 3% stunting at Yoakum when rated 40 d after treatment (DAT) while diclosulam at 0.04 kg/ha caused 3% stunting 17 DAT at Wier. In 1996, diclosulam at 0.03 and 0.06 kg/ha injured peanut 5 and 7%, respectively, 44 days DAT. In 1997, diclosulam at 0.02 and 0.03 kg/ha injured peanut 3 and 8%, respectively, when rated 21 DAT at the Mann Farm, while diclosulam at 0.06 kg/ha caused 8% stunting at the Lubbock location (data not shown). No peanut stunting was observed at harvest in any of the 3 yr nor was any stunting visible with diclosulam POST applications.

Texas Panicum Control. Diclosulam and imazapic improved Texas panicum control over ethalfluralin alone (Table 2). Dinitroaniline herbicides, such as ethalfluralin,

Table 2. Texas panicum and broadleaf weed control using soil-applied diclosulam in 1995-97.

Treatment	rate	Appl. timing	Texas panicum	Palmer amaranth	Golden crownbeard	Pitted morningglory	Devil's claw
			Weed species				
	kg ai/ha		% control				
Check	-	-	0	0	0	0	0
Diclosulam	0.01	PPI	97	95	100	99	91
Diclosulam	0.02	PPI	97	98	100	98	95
Diclosulam	0.03	PPI	99	99	100	99	96
Diclosulam	0.04	PPI	99	99	100	99	96
Diclosulam	0.06	PPI	99	100	100	100	99
Imazapic	0.07	POST	97	99	99	100	100
Ethalfluralin	0.84	PPI	87	77	-	-	38
LSD (0.05)			5	14	1	22	8

usually control large seeded annual grasses including Texas panicum (Wilcut *et al.*, 1994b, 1995). Imazapic applied POST controls small Texas panicum escaping earlier control efforts (Wilcut *et al.*, 1993).

Palmer Amaranth Control. All rates of diclosulam controlled Palmer amaranth ≥ 95% in south and west Texas which is comparable to control from imazapic (Table 2). Imazapic provided 99% Palmer amaranth control. In contrast, ethalfluralin alone controlled Palmer amaranth 77%. In earlier work, Grichar (1997) reported imazapic controlled Palmer amaranth 95 to 100% and spiny amaranth (*Amaranthus spinosus* L.) 72 to 91% (Grichar, 1994).

Golden Crownbeard Control. Diclosulam provided 100% golden crownbeard control regardless of rate, while imazapic controlled golden crownbeard 99% (Table 2). Imazapic has provided inconsistent golden crownbeard (pers. observation) especially in low rainfall or irrigation areas. It has been speculated that lower rainfall or irrigation amounts may have resulted in less imazapic root absorption. Richburg *et al.* (1995) reported less imazapic was absorbed by yellow nutsedge under lower rainfall conditions.

Pitted Morningglory Control. All herbicide treatments controlled pitted morningglory at least 98% (Table 2). Richburg (1997) reported that diclosulam controlled pitted morningglory in soybeans equal to or greater than imazaquin {2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-quinolinecarboxylic acid}. No differential response in control of *Ipomoea* morningglory species with imazapic has been reported (Wilcut *et al.*, 1994a, 1995; Richburg, *et al.*, 1995). In the southeast, morningglory control with imazapic has been greater than 80% in most instances (Richburg *et al.*, 1995; Webster *et al.*, 1997).

Devil's-Claw Control. Imazapic and all rates of diclosulam effectively controlled devil's-claw. Diclosulam at 0.01 kg/ha controlled devil's-claw 91% at 132 DAT while diclosulam at ≥ 0.02 kg/ha controlled devil's-claw ≥ 95%. Similarly, imazapic provided 100% devil's-claw control (Table 2).

Yellow Nutsedge Control. In 1995, diclosulam at 0.01 kg/ha provided poor yellow nutsedge control (25%) at Yoakum and moderate control (81%) at the Wier location (Table 3). Diclosulam at 0.02 kg/ha or greater controlled yellow nutsedge at least 94% at both locations, which was equal to control with imazapic.

At the Yoakum location in 1996, diclosulam at 0.01 kg/ha provided < 60% yellow nutsedge control while other diclosulam rates provided control similar to imazapic (Table 3). At the CLDS Farm location, all herbicide treatments controlled yellow nutsedge at least 88%. Yellow nutsedge control with imazapic was 94% (Table 3). In 1997 at Lubbock, all diclosulam rates controlled yellow nutsedge at least 91% while imazapic completely controlled yellow nutsedge.

Yellow nutsedge has generally been controlled 80% or more with diclosulam applied PPI or PRE at rates ≥ 0.03 kg/ha (Braxton *et al.*, 1997; Wilcut *et al.*, 1997). Imazapic generally has provided more consistent control of yellow nutsedge than imazethapyr (Grichar *et al.*, 1992; Richburg *et al.*, 1995; Dotray and Keeling, 1997). In greenhouse experiments, imazapic exhibited foliar and soil activity on purple and yellow nutsedge (Richburg *et al.*, 1994).

POST applications of diclosulam have provided inconsistent yellow nutsedge control (Table 4). At the Mann location, diclosulam at ≥ 0.01 kg/ha controlled yellow nutsedge at least 97%, while none of the diclosulam POST treatments provided acceptable control at the Yoakum location. Imazapic controlled yellow nutsedge at least 80% at both locations. At the Mann location, irrigation was applied after diclosulam application while at Yoakum, irrigation was applied prior to diclosulam application. Langston *et al.* (1997) reported that diclosulam applied POST provided good to excellent yellow nutsedge control; however, other researchers have observed inconsistent yellow nutsedge with diclosulam applied POST (J. Barrentine, pers. commun.).

Purple Nutsedge Control. In 1995, diclosulum controlled purple nutsedge 70-77% regardless of rate (Table 3). Imazapic controlled purple nutsedge 92%. In 1996, imazapic controlled purple nutsedge 93% while diclosulam at 0.02 kg/ha or greater controlled purple

Table 3. Yellow and purple nutsedge control with diclosulam soil applied in 1995-1997.

			Yellow nutsedge					Purple nutsedge	
		Appl.	1995		1996		1997	1995	
Treatment	Rate	timing	Yoakum	Wier	Yoakum	CLDS	Lubbock	Seminole	Mann
	kg ai/ha		% control					% control	
Check	-	-	0	0	0	0	0	0	0
Diclosulam	0.01	PPI	25	81	56	88	91	70	53
Diclosulam	0.02	PPI	96	95	94	96	98	77	75
Diclosulam	0.03	PPI	95	97	89	90	99	72	80
Diclosulam	0.04	PPI	99	94	98	99	95	72	73
Diclosulam	0.06	PPI	97	94	98	99	98	75	87
Imazapic	0.07	POST	99	99	89	94	100	92	93
LSD (0.05)			22	7	11	12	11	9	13

Table 4. Yellow nutsedge control with POST applications of diclosulam and imazapic.

Treatment	Rate	Location	
		Mann	Yoakum
	kg ai/ha	------ % ------	
Check	-	0	0
Diclosulam	0.002	70	38
Diclosulam	0.006	80	30
Diclosulam	0.010	100	38
Diclosulam	0.020	100	30
Diclosulam	0.030	97	34
Imazapic	0.070	100	80
LSD (0.05)		23	24

nutsedge 75 to 87% (Table 3). Diclosulam at 0.01 kg/ha failed to adequately control purple nutsedge (53%).

Peanut Yield. All herbicide treatments increased peanut yield over the nontreated check at Yoakum and CLDS Farm in 1996 while no differences were noted at the Wier location (Table 5). Diclosulam at 0.02 and 0.03 kg/ha and imazapic increased peanut yield over the nontreated check at the CLDS Farm in 1997 (Table 5).

Table 5. Influence of diclosulam on peanut yield.

Treatment	Rate	Yield			
		1995		1996	1997
		Yoakum	Wier	CLDS	CLDS
	kg ai/ha	------ kg/ha -----		kg/ha	kg/ha
Check	-	1508	2353	1033	2544
Diclosulam	0.01	2141	2649	2020	3342
Diclosulam	0.02	2456	1959	2287	3511
Diclosulam	0.03	2364	2324	-	3564
Diclosulam	0.04	2339	2430	-	3173
Diclosulam	0.06	2458	1865	-	2854
Imazapic	0.07	2259	2331	2482	3467
LSD (0.05)		632	935	956	918

These experiments indicated that diclosulam provides a broad spectrum of weed control similar to imazapic. While imazapic controls a broad spectrum of troublesome weeds, the major limitation for imazapic in southwest peanut production is the follow crop restrictions (Batts *et al.*, 1995; York and Wilcut, 1995). Major crops rotated with peanut in Texas include corn, cotton, grain sorghum, and various vegetable crops. Proposed label restrictions with diclosulam may limit its use in south and central Texas where corn or grain sorghum may be grown in rotation with peanut. However, diclosulam may be used in west Texas where most rotations are peanut followed by cotton.

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