Comparison of Metolachlor and Dimethenamid for Yellow Nutsedge (*Cyperus esculentus* L.) Control and Peanut (*Arachis hypogaea* L.) Injury[1]

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ABSTRACT

Field experiments were conducted during 1996 and 1997 at four locations in Texas to evaluate metolachlor and dimethenamid for yellow nutsedge (*Cyperus esculentus* L.) control and peanut (*Arachis hypogaea* L.) injury. Dimethenamid and metolachlor were applied PPI or PRE at 0.6× to 2× the suggested label rates. Yellow nutsedge failed to develop at one location; however, early season yellow nutsedge control with dimethenamid and metolachlor were similar at one location, and at two other locations metolachlor provided greater nutsedge control than dimethenamid. Furthermore, late season yellow nutsedge control at the three locations was better with metolachlor than dimethenamid. Peanut stunting was 20% higher with metolachlor PRE at the 1× rate than dimethenamid PRE at the 1× rate at two locations when rated 4 or 12 wk after treatment (WAT). Peanut yields were variable but, at one location under weed-free conditions, plots receiving pendimethalin only had the highest yield. With excessive moisture and herbicide rates greater than recommended for field use, both dimethenamid and metolachlor caused peanut stunting. However, metolachlor provided better season-long yellow nutsedge control than dimethenamid.

Key Words: Chloroacetamide herbicides, groundnut, preemergence, preplant incorporated.

Yellow nutsedge is the most troublesome weed and the second most common weed in Texas peanut production (Dowler, 1998). It reduces peanut yields and quality by competing for light, water, and nutrients, and by interfering with pesticide applications and harvest operations (Holm *et al.*, 1977; Wilcut *et al.*, 1995).

Yellow nutsedge infestations continue to increase in many fields in Texas. This increase is due to (a) the use of dinitroaniline herbicides which do not affect yellow nutsedge, but control most grass and small-seeded broadleaf weeds allowing the yellow nutsedge to thrive; (b) spread to tubers by field equipment or by contamination of peanut seeds; and (c) the high reproductive capacity of yellow nutsedge (T. E. Boswell, M. G. Merkle, W. J. Grichar, J. S. Newman, and K. Norton, 1981, unpubl. data). Johnson and Mullinix (1997) reported that under fallow conditions yellow nutsedge population densities and tubers increased exponentially, even with intensive fallow weed management.

Yellow nutsedge can be controlled by a number of herbicides. Vernolate controls both yellow and purple (*Cyperus rotundus* L.) nutsedge (Hauser, 1965; Wilkinson, 1988); however, control is short-lived. Because this herbicide has a high vapor pressure, it must be incorporated soon after application for maximum effectiveness (Hauser, 1965; Wilkinson, 1988). In addition, vernolate can be subjected to enhanced degradation by soil microorganisms (Wilkinson, 1988), which can reduce the duration of weed control to only 4 or 5 wk (Wilkinson, 1988; Wilcut *et al.*, 1995).

Imazethapyr {2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid} and imazapic {($\pm$)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyrindinecarboxylic acid} are two imidazolinone herbicides which control yellow nutsedge (Wilcut *et al.*, 1994, 1995; Grichar and Nester, 1997). However, control of yellow nutsedge with imazethapyr has been inconsistent (Walls *et al.*, 1990; Wilcut *et al.*, 1995; Grichar and Nester, 1997). Imazapic controls yellow nutsedge more consistently than herbicides currently registered in peanut (Gooden and Wixson, 1992; Colvin and Brecke, 1993; Wilcut *et al.*, 1995; Grichar and Nester, 1997). Wilcut *et al.* (1992) reported that application method did not effect nutsedge control by imazapic. Imazapic controls yellow nutsedge at least 90% when applied at rates as low as 0.04 kg/ha (Grichar and Nester, 1997).

Dimethenamid is used in corn (*Zea mays* L.), soybean (*Glycine max* L.), grain sorghum [*Sorghum bicolor* (L.) Moench], and peanut (Anonymous, 1998). Dimethenamid controls several annual grasses (Williamson, 1993; Ahrens, 1994; Grichar *et al.*, 1996b; Mueller *et al.*, 1996; Foy and Witt, 1997), and control of some species with dimethenamid was reported to be equal or superior to

[1]This research was supported in part by grants from the Texas Peanut Producers Board.

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that with alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)acetamide] and metolachlor (Shrefler *et al.*, 1994; Geis, 1995). Dimethenamid at 1.7 kg/ha tended to be less effective than metolachlor at 2.0 kg/ha against yellow nutsedge (Keeling *et al.*, 1990).

Grichar *et al.* (1981) found metolachlor PPI controlled yellow nutsedge better than metolachlor PRE. Later work indicated that metolachlor POST followed by irrigation within 24 hr could be effective for yellow nutsedge control as well as reducing the chance of peanut injury from soil applications of metolachlor (Grichar *et al.*, 1996a).

Although chloroacetamide herbicides are commonly used, sporadic peanut injury attributed to metolachlor has been observed in the Southeastern U.S., Virginia, and Texas (Cardina and Swann, 1988; Wehtje *et al.*, 1988; Grichar *et al.*, 1996a). Injury by chloroacetamide herbicides may be, at least partially, a response to the herbicide rate, moisture conditions at planting, and soil organic matter and pH (Cardina and Swann, 1988; Wehtje *et al.*, 1988; Osborne *et al.*, 1995; Mueller *et al.*, 1999). Cardina and Swann (1988) reported that metolachlor often delayed peanut emergence and reduced peanut growth when irrigated following planting. However, yield loss was observed only when metolachlor was applied at a 3× rate.

Dimethenamid and metolachlor have been evaluated under varying field moisture conditions for soybean cultivar tolerance (Osborne *et al.*, 1992). At normal use rates and optimum soil moisture conditions, soybean was tolerant to these herbicides. However, at higher herbicide rates and excessive moisture, soybean was susceptible to injury (Osborne *et al.*, 1992, 1995). Osborne *et al.* (1992) concluded that under conditions of high rates of both herbicides, dimethenamid was more injurious to soybean than metolachlor.

Dimethenamid has been reported to be less injurious to peanut than metolachlor in studies conducted in the Southeast (Anonymous, 1992; Baughman and Ratliff, 1995). However, no information exists to support this claim for the southwestern peanut-growing region. Soils in the Southwest tend to be low in organic matter and have higher pH than southeastern soils (Buckman and Brady, 1969). Also, intense rainfall in Texas is normally associated with May planting which may concentrate herbicides in the peanut seedling root zone causing excessive injury. Therefore, this study was initiated to compare peanut and yellow nutsedge response to dimethenamid and metolachlor.

Materials and Methods

Field studies were conducted in Comanche County and Dawson County in 1996 and in the same field in Lavaca County in 1996 and 1997. The central Texas location in Comanche County was on a Demona fine sand (clayey, mixed, thermic Aquic Arenic Palenstalfs) containing less than 1% organic matter and a pH of 6.9. The west Texas location in Dawson County was on an Amarillo fine sandy loam (fine-loamy, mixed, thermic Aridic Palenstafs) with less than 1% organic matter and a pH of 7.2. The south Texas site in Lavaca County was on a Strabor loam fine sand (fine, mixed, thermic Aquic Palenstalfs) containing less than 1% organic matter and a pH of 7.0.

Peanut cv. GK-7 was planted in Lavaca County on 9 May 1996 and 18 June 1997; cv. AT-120 was planted in Dawson County on 30 April 1996; and cv. Florunner was planted in Comanche County on 15 May 1996. Seeding rate was 85 to 95 kg/ha at all locations. Plots were two rows wide, spaced 0.9 m apart, by 9.5 m in length with four replications. Pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] at 1.1 kg/ha was applied broadcast and incorporated over the test area at each location to control annual grasses and small-seeded broadleaf weeds. Sethoxydim {2-[-1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} was used POST to control escaped Texas panicum (*Panicum texanum* Buckl.) and southern crabgrass [*Digitaria ciliaris* (Rets.) Koel.]. Broadleaf weed escapes were never a problem.

Herbicide treatments were applied with a small plot, two-row compressed-air bicycle sprayer, equipped with three, SS-11002 flat-fan nozzles (Spraying Systems Co., Wheaton, IL). Nozzles were spaced 51 cm apart and operated to deliver a spray volume of 140 L/ha at 160 kPa. PPI treatments were applied and incorporated 5 cm deep with a tractor-driven power tiller prior to planting. PRE treatments were applied immediately after peanuts were planted. Approximately 50 mm of irrigation was applied within 48 hr of peanut planting to simulate heavy rainfall which may increase the potential for crop injury.

The Comanche County location was infested with moderate levels of yellow nutsedge (10 to 15 plants/m^2) while no nutsedge developed at the Dawson County location. In Lavaca County yellow nutsedge populations were high (20 to 30 plants/m^2) in both years.

The experiment design for all studies was a randomized complete block design with three to four replications. Herbicide treatments included PPI and PRE applications of dimethenamid at 0.8 (0.6×), 1.3 (1×), or 2.7 kg/ha (2×) and metolachlor at 1.7 (0.75×), 2.2 (1×), or 4.5 kg/ha (2×). A nontreated control was used as a comparison. The suggested use rate for dimethenamid in peanut is 1.3 kg/ha (Anonymous, 1998); however, many producers in west Texas are using 0.8 kg/ha (pers. observation). The suggested use rate for metolachlor in the Southwest is 2.2 kg/ha (Anonymous, 1998); however, most producers use 1.7 kg/ha (authors',pers. observations).

Peanut stunting and yellow nutsedge control were rated (0 = no weed control or peanut stunting, 100 = complete weed control or plant death) relative to the untreated check at 2 and 4 wk after herbicide application and at 4-wk intervals thereafter. Peanut yields were determined by digging each plot separately, air-drying in the field for 4 to 6 d, and harvesting individual plots with a stationary thresher. Weights were recorded after soil and trash were removed from the samples.

Data for nutsedge control and visual injury were arcsine transformed prior to analysis of variance but the original data were used for presentation. Data were subjected to an analysis of variance and means were separated by Fisher's Protected LSD test at $P = 0.05$. Data were presented by location because of significant ($P \leq 0.05$) location by treatment interactions.

Results and Discussion

Yellow Nutsedge Control. Yellow nutsedge populations did not develop at the Dawson County location (data not shown). In Comanche County, the 2× rate of dimethenamid PPI at 2.7 kg/ha, all metolachlor PPI applications, and metolachlor PRE at the 2× rate controlled at least 90% yellow nutsedge when rated 4 wk after treatment (WAT). All dimethenamid PRE applications controlled yellow nutsedge less than 70% (Table 1). When rated 16 WAT, all dimethenamid treatments provided < 50% yellow nutsedge control with the exception of the 1× and 2× rates applied PPI. Metolachlor PPI controlled 68 to 88% yellow nutsedge at 16 WAT while PRE applications of metolachlor controlled 70 to 85% nutsedge.

When rated 4 WAT in Lavaca County in 1996, dimethenamid controlled yellow nutsedge > 85% while metolachlor provided ≥ 98% control (Table 1). When rated 16 WAT in 1996, dimethenamid controlled yellow nutsedge < 65%. Metolachlor tended to be more effective than dimethenamid, controlling yellow nutsedge at least 71% regardless of the application method. In 1997, only the 2× rate of dimethenamid PPI or PRE controlled yellow nutsedge at least 81% (4 WAT) while all metolachlor treatments controlled yellow nutsedge at least 90% 4 WAT. At 16 WAT, all dimethenamid treatments controlled < 44% yellow nutsedge while metolachlor controlled > 70% nutsedge (Table 1). McLean *et al.* (1996) reported that in greenhouse studies dimethenamid at 1.7 kg/ha was as efficacious on yellow nutsedge as metolachlor at 2.2 kg/ha. In field studies, Grichar *et al.* (1996b) reported dimethenamid at 0.8 and 1.4 kg/ha provided early season nutsedge control comparable to metolachlor at 1.7 kg/ha under heavy yellow nutsedge pressure. However, when rated late season, metolachlor controlled 68% yellow nutsedge while dimethenamid controlled < 55% yellow nutsedge regardless of rate.

Lack of season-long yellow nutsedge control in Texas with dimethenamid may be related to soil persistence. Stiles *et al.* (1997) and Mueller *et al.* (1999) reported that soil concentrations of metolachlor were higher later in the season compared to dimethenamid. Mueller *et al.* (1999) determined that the herbicide dissipation data agreed with the efficacy data from Tennessee which had indicated that metolachlor provided consistent control of annual grasses longer into the growing season.

Peanut Injury. No peanut stunting from herbicides was noted in Comanche County with any of the treatments (data not shown). In Dawson County at 4 WAT, peanut stunting ranged from 8 to 35% with both dimethenamid and metolachlor (Table 2). Peanut stunting with dimethenamid was greatest with the 2× rate applied PPI or PRE (32%) while metolachlor at the 1× rate applied PRE or 2× rate applied PPI or PRE resulted in ≥ 28% peanut stunting (Table 2). When rated 12 WAT, the 2× rate of dimethenamid applied PPI or PRE, metolachlor at the 1× rate applied PRE and metolachlor at the 2× rate applied PPI or PRE resulted in ≥ 15% stunting.

In Lavaca County in 1996, 4 WAT, dimethenamid PRE at the 2× rate and metolachlor PPI or PRE at the 2× rate resulted in significant peanut stunting when compared with the untreated check (Table 2). In 1997, only metolachlor PRE at the 2× rate resulted in significant peanut stunting. No late season peanut stunting was noted in Lavaca County in either year. Cardina and Swann (1988) reported that in Georgia there was a suppression of early peanut growth linearly related to metolachlor rate. They concluded that later developing pods were not affected by metolachlor and over the pod development period the effects of metolachlor on early developing pods was probably masked by the greater contribution of later developing pods to final yield.

Peanut Yield. In Comanche County, dimethenamid

Table 1. Yellow nutsedge control with dimethenamid and metolachlor.

			Comanche Co.		Lavaca Co.			
			1996		1996		1997	
		Appl.	Weeks after treatment (WAT)					
Treatments[a]	Rate	timing[b]	4	16	4	16	4	16
			% control					
Dimethenamid	0.6×	PPI	63	31	86	50	53	10
	1×	PPI	78	78	95	64	63	20
	2×	PPI	90	73	99	35	91	44
	0.6×	PRE	65	36	96	58	40	0
	1×	PRE	31	48	97	38	46	20
	2×	PRE	46	38	100	41	81	28
Metolachlor	0.75×	PPI	90	68	98	74	96	74
	1×	PPI	90	88	100	83	99	76
	2×	PPI	91	70	99	78	99	93
	0.75×	PRE	75	70	99	71	93	75
	1×	PRE	78	79	99	71	98	83
	2×	PRE	90	85	100	77	99	89
Check	-	-	0	0	0	0	0	0
LSD (0.05)			15	27	13	22	12	23

[a]Dimethenamid at 0.6× of the suggested label rate = 0.8 kg/ha, 1× = 1.3 kg/ha, 2× = 2.7 kg/ha; metolachlor at 0.75× of the suggested label rate = 1.7 kg/ha, 1× = 2.2 kg/ha, 2× = 4.5 kg/ha.

[b]PPI = preplant incorporated; PRE = preemergence.

Table 2. Peanut stunting with dimethenamid and metolachlor.

			Dawson Co.		Lavaca Co.	
			1996		1996	1997
		Appl.	Weeks after treatment (WAT)			
Treatment	Rate[a]	timing[b]	4	12	4	
			% injury			
Dimethenamid	0.6×	PPI	12	7	0	0
	1×	PPI	8	7	1	0
	2×	PPI	32	25	1	3
	0.6×	PRE	18	9	0	0
	1×	PRE	13	7	4	0
	2×	PRE	32	15	5	3
Metolachlor	0.75×	PPI	13	12	3	0
	1×	PPI	8	8	0	0
	2×	PPI	35	16	6	3
	0.75×	PRE	17	5	1	0
	1×	PRE	33	27	0	0
	2×	PRE	28	26	15	4
Check	-	-	0	0	0	0
LSD (0.05)			16	15	4	4

[a]Dimethenamid at 0.6× of the suggested label rate = 0.8 kg/ha, 1× = 1.3 kg/ha, 2× = 2.7 kg/ha; metolachlor at 0.75× of the suggested label rate = 1.7 kg/ha, 1× = 2.2 kg/ha, 2× = 4.5 kg/ha.

[b]PPI = preplant incorporated, PRE = preemergence.

and metolachlor PPI at the 1× rate and metolachlor PRE at the 0.75× rate increased yields over the untreated check (Table 3). Although not significant, trends of reduced peanut yield with increasing herbicide rates were noted for metolachlor PRE. Dawson County yields reflect the absence of weed competition and the result of peanut injury on yield (Table 3). The untreated check yielded over 6200 kg/ha while all dimethenamid and metolachlor treatments yielded ≤5500 kg/ha. Metolachlor PRE at the 1× rate reduced peanut yield by 38% when compared with the untreated check.

In Lavaca County in 1996, none of the herbicide treatments resulted in any yield differences when compared to the untreated check (Table 3). In 1997, dimethenamid PRE at the 0.6× rate, dimethenamid PPI or PRE at the 2× rate, metolachlor PPI or PRE at the 0.75× rate, and metolachlor PPI at the 1× rate increased yields over the untreated check. Cardina and Swann (1988) reported that peanut yields were not suppressed with metolachlor except for a 3× rate which reduced peanut yields up to 14% when compared with the untreated check.

These studies show that metolachlor provided more consistent season-long yellow nutsedge control than dimethenamid. Generally metolachlor PPI will control yellow nutsedge better than PRE applications (Grichar *et al.*, 1996a, 1981). The 1× rate of metolachlor controlled yellow nutsedge comparable to the 2× metolachlor rate especially when applied PPI.

With excessive moisture and herbicide rates greater than recommended for field use, both dimethenamid and metolachlor caused peanut stunting. However, this did not always translate into yield reductions in the field (Cardina and Swann, 1988).

Table 3. Peanut yield following dimethenamid or metolachlor applications.

Treatment	Rate[a]	Appl. timing[b]	Comanche 1996	Dawson 1996	Lavaca 1996	Lavaca 1997
			kg/ha			
Dimethenamid	0.6×	PPI	2230	5070	2750	2220
	1×	PPI	2880	5160	3170	2510
	2×	PPI	2510	4340	2540	2550
	0.6×	PRE	2350	5440	3200	2800
	1×	PRE	1240	4750	2990	2220
	2×	PRE	2020	4660	2860	2560
Metolachlor	0.75×	PPI	2070	4550	3120	2620
	1×	PPI	2830	4700	2910	2930
	2×	PPI	2160	4320	2650	2300
	0.75×	PRE	2820	4690	2870	3030
	1×	PRE	2410	3940	3040	2070
	2×	PRE	2390	4160	2450	2010
Check	-	-	1790	6260	3060	2050
LSD (0.05)			890	990	NS	490

[a]Dimethenamid at 0.6× of the suggested label rate = 0.8 kg/ha, 1× = 1.3 kg/ha, 2× = 2.7 kg/ha; metolachlor at 0.75× of the suggested label rate = 1.7 kg/.ha, 1× = 2.2 kg/ha.

[b]PPI = preplant incorporated, PRE = preemergence.

Improved yellow nutsedge control does not always result in a corresponding increase in peanut yield. Johnson and Mullinix (1997) found no difference in peanut yield between moderate and intensive weed management systems although yellow nutsedge was controlled more effectively in the intensive management system. However, in a low weed management system where yellow nutsedge was not controlled, peanut yields were lower than in other systems. They concluded that, although yellow nutsedge may not be overly competitive in peanut, control was important because yellow nutsedge tubers can contaminate harvested peanut and reduce peanut quality even if yield effects were not evident.

Acknowledgments

Appreciation is extended to K. Jamison for manuscript preparation and to BASF Corporation, Novartis Crop Protection, and the Texas Peanut Producers Board for supporting this research.

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