Herbicide Systems for Control of Horse Purslane (*Trianthema portulacastrum* L.), Smellmelon (*Cucumis melo* L.), and Palmer Amaranth (*Amaranthus palmeri* S. Wats) in Peanut

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ABSTRACT

Field studies were conducted during the 2003 through 2005 growing seasons to evaluate soil-applied herbicides alone or in combination with postemergence (POST) herbicides for horse purslane, smellmelon, and Palmer amaranth control in peanut. Pendimethalin alone applied preplant incorporated (PPI) failed to control any of the three weeds (< 70% control). Pendimethalin in combination with diclosulam, followed by imazethapyr applied preemergence (PRE), or followed by either acifluorfen or imazapic applied postemergence (POST) controlled all three weed species at least 80%. The soil-applied herbicides flumioxazin, imazethapyr, S-metolachlor, or dimethenamid applied alone failed to control horse purslane and smellmelon (< 75%). Pendimethalin controlled Palmer amaranth less than 42% while flumioxazin at 0.07 kg/ha or dimethenamid at 1.12 kg/ha controlled Palmer amaranth less than 75%. Imazethapyr alone or pendimethalin applied PPI followed by imazethapyr applied PRE or imazapic applied POST controlled Palmer amaranth at least 99%. Pendimethalin applied PPI was present in all herbicide systems that yielded greater than the untreated check. In addition, 80% or greater control of at least 2 of 3 weed species resulted in the highest yields, with the exception of pendimethalin followed by acifluorfen.

Key Words: Acifluorfen, *Arachis hypogaea* L., bentazon, broadleaf weeds, diclosulam, early postemergence, imazapic, imazethapyr, lactofen, late postemergence, 2,4-DB, over-the-.

Weed problems may reduce producer income in several different ways. Herbicide costs range from \$37 to \$124/ha with a net cost to U.S. peanut producers in excess of \$70 million annually (Wilcut *et al.*, 1995). Weeds also increase the need for additional tillage operations with a net loss to producers of \$7 to \$20/ha (Wilcut *et al.*, 1995). Weeds that escape control then cost producers another \$49 to \$124/ha due to yield reductions and \$7 to \$62/ha due to quality reductions (Bryson, 1989; Bridges, 1992). Reductions in harvesting efficiency associated with pod loss is estimated to range from \$7/ha in Alabama to \$17/ha in Oklahoma and South Carolina (Bridges, 1992). Estimated total income losses from poor weed control, yield and quality reductions, increased cultural inputs, and reduced harvesting efficiency range from \$132/ha in Texas to \$391/ha in Florida (Bridges, 1992).

Horse purslane occurs in tropical and subtropical areas throughout the world (Balyan and Bahn, 1986). It has cylindrical green leaves and the seeds germinate at 20 to 45 C (Chandra and Sahai, 1979). Seeds have essentially no dormancy and can germinate soon after they mature, thus allowing multiple generations in a single growing season (Balyan and Bhan, 1986). Although common purslane (*Portulaca oleracea* L.), a similar species, was rated as one of the ten most common weeds found in Texas peanut fields as early as 1989 (Elmore, 1989), horse purslane only recently has become a problem in certain peanut growing areas of south Texas (author's personal observation). This weed can be a stronger competitor with peanut early in the growing season than common purslane due to a more upright growth habit than that of common purslane (Grichar, 1993). In competition studies, horse purslane reduced mung bean [*Vigna radiate* (L.) R. Wilcdz.] yields by 50 to 60% when left untreated (Balyan and Malik, 1989). In earlier work on peanuts, Grichar (1993) reported a yield increase with POST herbicides over the untreated check in only one or two years when horse purslane was present.

Hand hoeing is a common practice for horse purslane control in mung bean in India (Balyan and Bhan, 1986). However, very little research has been conducted on control with herbicides. Fomesafen controlled horse purslane 57 to 87% in mung bean (Balyan and Malik, 1989). Grichar (1993) reported that acifluorfen, lactofen, and 2,4-DB controlled horse purslane at least 78% in peanut. It was also shown that tank-mixing these herbicides with other broadleaf herbicides did not improve

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horse purslane control over aciflurofen, lactofen, or 2,4-DB applied alone.

Smellmelon is becoming more of a problem in south Texas peanut production fields and has become a problem in several crops along the Texas Gulf coast (author's personal observation). The range of smellmelon stretches from Georgia to the southern part of California and as for north as Arkansas (SWSS, 1999). Smellmelon can be a problem at peanut harvest as the melon can become broken apart when run through the combine and increase drying time because of the high moisture content of the melon itself (author's personal observation). In IMI-tolerant corn (*Zea mays* L.), Thompson *et al.* (2005) reported that imazapic at 0.07 and 0.14 kg ai/ha applied either preemergence (PRE), early POST, or late POST controlled smellmelon greater than 90%. Tingle and Chandler (2004) reported that smellmelon control was at least 93% with low-, medium-, and high-input herbicide systems. In cotton (*Gossypium hirsutum* L.), glyphosate systems have provided effective smellmelon control (Livingston *et al.*, 2004; Livingston, 2006). Tingle *et al.* (2000) reported when smellmelon was allowed to compete with cotton for at least 6 weeks, yield was reduced 7% compared to the weed free but when smellmelon was allowed to compete for 10 to 12 weeks cotton yield was reduced 22 and 27%, respectively.

Palmer amaranth is not ranked as the number one weed or even as a principal weed in major crops, but it is a common weed in many major crops around the world (Grichar, 1997). The pigweeds (*Amaranthus* spp.) are listed as one of the 10 most common weeds in most all major peanut-growing states in the United States, with Palmer amaranth among the 10 most common weeds in Georgia, Missippi, and South Carolina (Webster, 2005). Palmer amaranth is listed as the most troublesome weed in peanut in Georgia and South Carolina (Webster, 2005). The current distribution of Palmer amaranth is the southern half of the United States (Anonymous, 1990). In Texas, Palmer amaranth can be found in all areas of the state (Correll and Johnston, 1979). It is a severe problem in many fields in the southern part of the state when not properly controlled (Grichar, 1997).

Monoculture production systems and the repeated use of the same or similar herbicides have led to herbicide resistance in weeds (Culpepper *et al.*, 2006; Peterson, 1999; VanGessel, 2001). *Amaranthus* species are very sensitive to ALS-inhibiting herbicides and possess characteristics that predispose them to have herbicide resistant biotypes such as high genetic variability, prolific seed production, and efficient pollen and seed distribution (Lovell *et al.*, 1996). The use of soil-applied and POST herbicides with alternative sites of action is necessary to reduce the rate of development of herbicide-resistant weed populations (Shaner *et al.*, 1997).

Although horse purslane and smellmelon are not a severe problem in all peanut growing areas of the state, more efficacy data is needed on herbicide systems which provide effective control. The objectives of this research were to evaluate several soil-applied herbicides alone and in combination with POST herbicides for horse purslane, Palmer amaranth, and smellmelon control and peanut yield response to control of these weed species.

Materials and Methods

Field studies were conducted at the Texas Agricultural Experiment Station research site near Yoakum, TX in 2003 through 2005 on a Tremona loamy fine sand (thermic aquic Arenic Paleustalfs) with less than 1% organic matter and pH of 7.0 to 7.2. The experimental design was a randomized complete block with three replications. Each plot consisted of two rows spaced 97 cm apart and 7.6 m long. All field plots were naturally infested with high populations of horse purslane (6 to 8 plants/m^2), smellmelon (6 to 8 plants/m^2), and Palmer amaranth (4 to 6 plants/m^2). Sprinkler irrigation was applied on a 2- to 3-wk schedule throughout the growing season as needed. Tamrun 96 peanut were planted at a rate of 100 kg/ha and managed for optimum yield according to Texas Cooperative Extension guidelines (Lemon *et al.*, 2001).

Herbicide treatments included pendimethalin at 1.12 kg ai/ha applied PPI, flumioxazin at 0.07 and 0.1 kg ai/ha applied PRE, pendimethalin applied PPI followed by flumioxazin at 0.1 kg/ha applied PRE, imazethapyr at 0.07 kg ai/ha applied PRE, pendimethalin applied PPI followed by imazethapyr applied PRE, pendimethalin plus diclosulam at 0.026 kg ai/ha applied PPI, S-metolachlor at 1.4 kg ai/ha applied PRE, pendimethalin applied PPI followed by S-metolachlor applied PRE, dimethenamid at 1.12 kg ai/ha applied PRE, pendimethalin applied PPI followed by dimethenamid applied PRE, pendimethalin applied PPI followed by POST applications of acifluorfen at 0.42 kg ai/ha, bentazon at 1.12 kg ai/ha, diclosulam at 0.026 kg ai/ha, imazapic at 0.07 kg ai/ha, imazethapyr at 0.07 kg ai/ha, 2,4-DB at 0.28 kg ai/ha, lactofen at 0.22 kg ai/ha, and a split application of imazapic with one-half (0.035 kg ai/ha) applied early POST plus a second application (0.035 kg/ha) applied three wks later (late POST).

Pendimethalin was incorporated immediately after application prior to peanut planting with a tractor-driven rotary tiller that had an incorporation depth of 6 cm. PRE herbicides were applied immediately after peanut planting. Rainfall or irrigation followed within 7–10 d to activate PRE herbicides. POST herbicides were applied three to four wks after planting when all weeds were 10 to 20 cm in height. Early POST applications of imazapic were made approximately three wks after planting when weeds were approximately 10 cm tall with the late POST application of imazapic approximately three wks later when weeds were 10 to 15 cm tall. An untreated check was included each year.

Acifluorfen, bentazon, diclosulam, lactofen, and 2,4-DB treatments included a crop oil concentrate[1] at 2.3 L/ha while imazapic and imazethapyr included a non-ionic surfactant[2] at 0.25% v/v. Herbicides were applied with a compressed-air backpack sprayer equipped with Teejet 11002 DG flat fan spray tips[3] that delivered a spray volume of 190 L/ha at 180 kPa. Clethodim at 0.18 kg ai/ha was applied over the entire test area when annual grasses were at the six- to eight-leaf stage with a tractor-mounted sprayer to control Texas panicum (*Panicum texanum* Buckl.). Weed control was estimated visually on a scale of 0 to 100 (0 indicating no control and 100 indicating complete control), relative to the untreated check. Weed control ratings taken four wks after LPOST herbicide application are presented. Peanut yields were obtained by digging each plot separately, air-drying in the field for 4 to 7 d, and harvesting peanut pods from each plot with a combine. Weights were recorded after soil and foreign material were removed from plot samples.

Data were subjected to analysis of variance and means were separated using Fisher's protected LSD test at P=0.05. Weed efficacy data were arcsine square-root transformed before analysis, but only the nontransformed data are reported because transformation did not affect data interpretation. There were no significant year by treatment interactions, so data are combined over years.

[1]Agri-Dex (blend of 83% paraffin-based petroleum oil and 17% surfactant), Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38137.

[2]X-77, 90% nonionic surfactant, Loveland Industries, P.O. Box 1289, Greeley, CO 80632.

[3]11002 DG flat fan spray tips, Teejet Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60188.

Results and Discussion

Palmer Amaranth Control.

Pendimethalin provided less than 42% control of Palmer amaranth while flumioxazin at 0.07 and 0.1 kg/ha provided 72 and 85% control, respectively (Table 1). Imazethapyr applied PRE provided 100% control of Palmer amaranth while dimethenamid and S-metolachlor alone controlled 74 and 90%, respectively. The addition of pendimethalin applied PPI to dimethenamid, flumioxazin, imazethapyr, or S-metolachlor applied PRE did not improve control over the PRE herbicides used alone. However, the addition of a POST herbicide following pendimethalin applied PPI improved Palmer amaranth control over pendimethalin alone. In earlier work using only POST herbicides, imazapic at 0.04 to 0.07 kg/ha controlled Palmer amaranth at least 95% when applied EPOST while imazethapyr provided at least 90% control in 2 of the 3 yr (Grichar, 1997). The poor control in one year was attributed to taller Palmer amaranth at time of EPOST treatments. Acifluorfen at 0.42 and 0.56 kg ai/ha controlled Palmer amaranth at least 94% in 2 of 3 test years while lactofen controlled Palmer amaranth 99% in two years and 80% the other year (Grichar, 1997). Bentazon usually does not control pigweed species (Buchanan *et al.*, 1982; Grichar, 1994; Wilcut *et al.*, 1994). The partial control of Palmer amaranth with the POST application of bentazon may actually be the interference from smellmelon and horse purslane and the poor control of those weeds with bentazon (author's personal opinion).

Amaranthus spp. can be controlled with the dinitroaniline herbicides such as pendimethalin (Wilcut *et al.*, 1994); however, metolachlor PPI or PRE controls pigweed less consistently than dinitroaniline herbicides (Wilcut, 1991; Wilcut *et al.*, 1994). Dimethenamid is used in corn, soybean (*Glycine max* L.), grain sorghum [*Sorghum bicolor* (L.) Moench], and peanut (Anonymous, 1998) and controls several broadleaf weeds including nightshade species (*Solanum* spp.), pigweed species, and common lambsquarters (*Chenopodium album* L.) (Gaeddert *et al.*, 1997; Owen *et al.*, 1998; Tonks *et al.*, 1999). In field potato (*Solanum tuberosum* L.) studies, dimethenamid effectively controlled annual grasses but provided less consistent annual broadleaf weed control (Arnold and Gregory, 1994; Arnold *et al.*, 1998; Sarpe *et al.*, 1994). Other potato studies have shown that dimethenamid controlled common lambsquarters, redroot pigweed (*Amaranthus retroflexus* L.), and hairy nightshade (*Solanum sarrachoidas* Sendter) better than metolachlor or pendimethalin (Tonks *et al.*, 1999).

Table 1. Horse purslane, Palmer amaranth, and smellmelon control and peanut response with soil-applied herbicides alone or in combination with POST herbicides.[a,b]

Treatment[c]	Rate	Appl.timing	Control AMAPA	Control CUMME	Control TRTPO	Yield
	kg/ha			%		kg/ha
Check	-	-	0	0	0	2470
Pendimethalin (P)	1.12	PPI	41	41	67	2370
Flumioxazin	0.07	PRE	72	63	73	2010
Flumioxazin	0.10	PRE	85	52	64	3170
(P) fb flumioxazin	1.12 fb 0.10	PPI fb PRE	91	78	73	3140
Imazethapyr	0.07	PRE	100	63	65	2910
(P) fb imazethapyr	1.12 fb 0.07	PPI fb PRE	100	86	96	4410
(P) + diclosulam	1.12 + 0.03	PPI	91	80	93	3910
S-metolachlor	1.40	PRE	90	57	59	2440
Dimethenamid	1.12	PRE	74	47	51	2750
(P) fb *S*-metolachlor	1.12 fb 1.40	PPI fb PRE	95	68	89	3930
(P) fb dimethenamid	1.12 fb 1.12	PPI fb PRE	88	60	76	3370
(P) fb acifluorfen	1.12 fb 0.42	PPI fb POST	96	90	93	2570
(P) fb bentazon	1.12 fb 1.12	PPI fb POST	77	60	75	2650
(P) fb diclosulam	1.12 fb 0.03	PPI fb POST	87	64	84	4170
(P) fb imazapic	1.12 fb 0.07	PPI fb POST	99	84	88	4530
(P) fb imazapic fb imazapic	1.12 fb 0.035 fb 0.035	PPI fb POST fb LPOST	99	98	83	3980
(P) fb imazethapyr	1.12 fb 0.07	PPI fb POST	95	69	80	4280
(P) fb 2,4-DB	1.12 fb 0.28	PPI fb POST	82	85	80	4420
(P) fb lactofen	1.12 fb 0.22	PPI fb POST	100	89	92	4110
LSD (0.05)			22	31	32	1320

[a]Abbreviations: fb, followed by; P, pendimethalin; PPI, preplant incorporated; PRE, preemergence; POST, postemergence; LPOST, late postemergence.

[b]Bayer code for weeds: AMAPA, Palmer amaranth; CUMME, smellmelon; TRTPO, horse purslane.

[c]Split application of imazapic with 0.035 kg/ha applied three to four weeks after planting and 0.035 kg/ha applied approximately three weeks later.

Smellmelon Control.

Pendimethalin, flumioxazin, imazethapyr, S-metolachlor, or dimethenamid failed to control smellmelon (< 65%) when used alone (Table 1). When pendimethalin was applied in combination with diclosulam or followed by flumioxazin or imazethapyr applied PRE, smellmelon control was increased over pendimethalin alone. However, this was not the case with S-metolachlor or dimethenamid as the addition of pendimethalin did not improve control over these three herbicides used alone.

When pendimethalin was followed by acifluorfen, imazapic, lactofen, or 2,4-DB applied POST, smellmelon control was at least 84% (Table 1). Imazapic at 0.04 to 0.07 kg/ha controlled greater than 90% smellmelon in corn regardless whether applied PRE, EPOST, or LPOST (Thompson *et al.*, 2005). Grichar *et al.* (2001) reported that imazapic provided consistent control (≥ 85%) of citronmelon (*Citrullus lanatus* var. *citroides*).

Horse Purslane Control.

Pendimethalin, flumioxazin, imazethapyr, S-metolachlor, or dimethenamid controlled horse purslane no better than 73% control when used alone (Table 1). Pendimethalin in combination with diclosulam or followed by imazethapyr applied PRE controlled horse purslane at least 93%. Pendimethalin followed by POST applications of acifluorfen or lactofen controlled horse purslane at least 92% while pendimethalin followed by POST applications of diclosulam, imazapic, imazethapyr, or 2,4-DB controlled 80 to 88%. Grichar (1993) reported that acifluorfen and lactofen alone, or combinations of these herbicides with 2,4-DB controlled horse purslane at least 70% when rated 21 days after treatment (DAT) but no greater than 75% when rated up to 115 DAT.

Peanut Yield.

With the exception of pendimethalin followed by a POST application of acifluorfen, herbicide systems which controlled at least two of the three weed species 80% or greater produced peanut yields which were greater than the untreated check (Table 1). Low yields were usually the result poor control of at least one of the three weeds present in the test plots. High smellmelon densities in plots with poor smellmelon control resulted in smellmelon vines as well as the tight fibrous root system of the plant becoming intertwined with the peanut plant and digging equipment during the digging operation. As a result, many peanut pods were stripped from the peanut plant during digging. Peanut pods that become detached from the plant remain unharvested in or on the soil (Buchannan *et al.*, 1982).

In conclusion, pendimethalin in combination with diclosulam, followed by imazethapyr applied PRE or acifluorofen, imazapic, 2,4-DB, or lactofen applied POST effectively controlled all three broadleaf weed species (>80%). The use of a soil-applied herbicide alone was not effective in providing control of the three broadleaf weed species. Growers need to be aware of the broadleaf weed species present in their fields and select the appropriate herbicide program for the respective weed.

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