Peanut Weed Control Systems Utilizing RE-40885[1]

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ABSTRACT

RE-40885 (5-(methylamino)-2-phenyl-4-3-(trifluoromethyl phenyl)-3(2*H*)-furanone), a newly developed herbicide with soil and foliar activity, was evaluated for weed control in peanuts (*Arachis hypogea* L.). RE-40885 applied to the soil or foliage provided excellent Florida beggarweed (*Desmodium tortuosum* (Sw.) DC.) and prickly sida (*Sida spinosa* L.) control at rates of 0.56 to 1.12 kg ai/ha. Sequential applications of RE-40885 were needed to achieve > 90% sicklepod (*Cassia obtusifolia* L.) control. Texas panicum (*Panicum texanum* Buckl.) was not adequately controlled by any of the RE-40885 treatments evaluated. Peanuts were not injured by RE-40885 at any of the evaluated rates or application times. The combination of RE-40885 and 2,4-DB applied early postemergence improved sicklepod control 8 weeks after planting when compared to either RE-40885 or 2,4-DB applied alone. The combination of RE-40885 and alachlor applied at peanut emergence improved morningglory (*Ipomoea* spp.) control 8 weeks after planting and increased peanut yield when compared to either applied alone. All treatments containing RE-40885 resulted in peanut yields that were significantly better than nontreated weedy control plots.

Key words: weed control, *Desmodium tortuosum*, *Cassia obtusifolia*, *Sida spinosa*, flurtamone.

Peanut weed control differs from that of many row crops, since selective, soil-applied herbicides for consistent broadleaf weed control have not been available. Peanut producers have relied on cultivation and multiple applications of foliar-applied herbicides for dicot weed control (2,5). Dinoseb (2-(1-methylpropyl)-4,6-dinitrophenol) was used by many farmers to control broadleaf weeds before its use was suspended in 1986 (1).

Florida beggarweed and sicklepod are the two most troublesome weeds infesting peanuts in the southeastern United States (2,7). Two reasons for this include poor control from commonly used peanut herbicides and an upright growth habit that allows them to grow above the crop canopy. Both weeds caused significant peanut yield reduction when allowed to interfere throughout the season (4). Each Florida beggarweed plant per 10 m^2 reduced yield 15.8 to 30.2 kg/ha and each sicklepod plant per 10 m^2 reduced yield 6.1 to 22.3 kg/ha. Peanut yield was not reduced when the crop was free of Florida beggarweed or sicklepod for 4 weeks after crop emergence and when vigorous crop growth was maintained for the remainder of the season (6). Sicklepod and Florida beggarweed plants that grew above the peanut canopy at harvest emerged within 4 to 6 weeks after planting. Sicklepod or Florida beggarweed plants that emerged 7 or more weeks after planting did not grow above the peanut foliage (6). This indicates that the duration of Florida beggarweed or sicklepod control needed from a soil-applied treatment is 4 to 6 weeks in peanuts.

RE-40885, a furanone herbicide with soil and foliar activity, has shown potential for providing selective control of Florida beggarweed, sicklepod and other broadleaf weeds in peanuts (8,10). RE-40885 causes bleaching of sensitive species and has a vinylogous amide substructure common to herbicides which produce similar visual symptoms. Herbicide symptoms and molecular structure strongly suggest activity is primarily due to inhibition of carotenoid biosynthesis (11).

The objective of this research was to determine the

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activity of RE40885 on several weed species when applied alone and in combination with other common peanut herbicides.

Materials and Methods

Procedures common to all experiments.

Experiments to evaluate the influence of RE-40885 on weed control in peanuts were conducted at the Southwest Georgia Branch Agricultural Experiment Station near Plains, Georgia in 1987 and 1988 on a Faceville sandy loam (Typic Paleudult) with a pH of 6.5. The plot area had a naturally heavy infestation of Florida beggarweed, sicklepod, prickly sida, Texas panicum and a moderate infestation of smallflower morningglory (*Jacquemontia tamnifolia* (L.) Griseb) and other morningglories (*Ipomoea* spp). Florunner peanuts were planted at 135 kg/ha on May 5, 1987 and on May 3 in 1988. Aldicarb ([2-methyl-2-(methylthio)propionaldehyde-o-(methylcarbamoyl)oxime]) was applied at 1.3 kg ai/ha in-furrow to control early season insects. Experiments were irrigated one day after planting with 2.0 cm of water and as needed for the remainder of the growing season with a lateral-move sprinkler irrigation system. The peanuts were grown under high management including proper fertilization, disease control, and insect control.

Preplant incorporated (PPI) and preemergence (PRE) treatments were applied with a tractor-mounted sprayer and at ground-cracking (at the time of peanut emergence) (AC) and early postemergence (POTE) applications were made using a hand-held CO_2 back-pack sprayer. Specific weed and crop growth stage at the time of AC and POTE application will be given for the experiments later. All applications were made in 280 L of water carrier/ha at a pressure of 180 KPa. The RE-40885 formulation used was an 80 wettable powder (WP) and 50 WP in 1987 and 1988, respectively. Each plot consisted of two peanut rows spaced 71 cm apart on a raised, 1.65 x 6.1 m bed.

The experiments utilized a randomized complete block design with three replications and were conducted in 1987 and 1988 in separate, adjacent plot areas. The statistical model included effects due to year (YR), replication within year, treatment (TRT), and year by treatment interaction (YR*TRT). The residual error was used to test TRT and YR*TRT effects. If the YR*TRT interaction was significant, the YR*TRT term was used as the error term for testing the overall TRT effects for both years. Treatments means were seperated by the Least Significant Difference test (LSD), with each LSD being calculated using the appropriate error term.

Florida beggarweed, sicklepod, prickly sida, morningglory, and Texas panicum control were visually evaluated 4, 7, and 10 weeks after planting (WAP) in 1987 and 4, 6, 8, and 15 WAP in 1988. Weed control was evaluated on a 0 to 100 scale, with 0 representing no control and 100 representing total weed control. Each experiment included nontreated weedy and weed-free control treatments which were not included in the visual evaluation data analysis. Weed-free control plots were periodically hand weeded throughout the growing season. Weed control was based on comparison of each plot to the nontreated weedy control plot within that replication. Peanut yields were obtained by mechanically digging both rows of each bed, drying for 3 days, harvesting, cleaning to remove dirt and foreign material, and weighing. All experiments were conducted in 1987 and repeated in 1988.

Determination of effect of rate and application time.

RE-40885 was applied PPI, PRE, AC, or POTE as well as PPI followed by an AC application and PPI followed by an AC followed by a POTE application. RE-40885 rates were 0.56, 0.84, or 1.12 kg/ha when applied PPI, PRE, or AC and 0.28, 0.56, or 0.84 kg/ha when applied POTE. In the sequential application treatments, RE-40885 was applied PPI at 0.56 or 0.84 kg/ha followed by an AC or POTE application or both, with 0.28 kg/ha RE-40885 used each time. Nonionic surfactant was added at 0.5% v/v to AC and POTE applications. Species evaluated were Florida beggarweed, sicklepod, prickly sida, and Texas panicum. Peanuts had germinated and were emerging and all weeds were in the cotyledon stages at the AC application time. Peanuts had 3 leaves, Florida beggarweed and sicklepod had 3 to 4 leaves, and Texas panicum had 2 to 5 leaves at the POTE application time.

The effect of RE-40885 rate was statistically examined with a linear contrast. The effect of herbicide application time was examined by comparing the PPI, PRE, AC, POTE, and PPI+AC applications at the 0.84 kg/ha rate. These treatments were separated by the LSD test at the 0.05 significance level.

RE-40885 combinations with alachlor and 2,4-DB.

Benefin (N-butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl) benzenamine) was applied PPI at 1.4 kg/ha to control annual grasses (primarily Texas panicum) in the entire experiment, with the exception of the nontreated weedy control. Texas panicum plants that escaped control were removed by hand pulling. RE-40885 treatments included rates of 0.56 kg/ha applied PPI or POTE and 0.84 kg/ha applied PPI or AC. Alachlor was applied AC at 2.8 kg/ha alone and in combination with 0.84 kg/ha RE-40885. RE-40885 plus alachlor was applied POTE at 0.56 plus 2.8 kg/ha, with and without 0.5% v/v nonionic surfactant. Treatments of 2,4-DB (4-(2,4-dichlorophenoxy) butanoic acid) at 0.28 kg/ha were applied POTE with and without 0.56 kg/ha of RE-40885. Control was visually evaluated for Florida beggarweed, sicklepod, and a mixture of morningglory species including smallflower morningglory, ivyleaf morningglory (*Ipomoea hederacea* (L.) Jacq.) and tall morningglory (*Ipomoea purpurea* (L.) Roth.). Peanuts were emerging and all weeds were in the cotyledon stage at the AC application time. Peanuts had 3 leaves, Florida beggarweed and sicklepod had 3 to 4 leaves, and the morningglory species had 1 to 4 leaves at the POTE application time.

Results and Discussion

RE-40885 caused no visible peanut response in any of the experiments (data not shown). RE-40885 herbicidal symptoms on sensitive weeds included the lack of emergence or bleaching of acropetal tissue. Other researchers have proposed that a primary mechanism of action is carotenoid synthesis inhibition (11), with the resulting lack of carotenoids allowing photodegradation of the chlorophyll complexes.

For ease of discussion, the data were grouped into an early evaluation (4 WAP) and a late evaluation (7 to 10 WAP) and the two evaluations were analyzed separately. Statistical analysis revealed a significant YR*TRT interaction, but the treatment effect using the YR*TRT mean square as the error term was significant. This indicated that although weed control in the experiment was different between the two years, the effect of a given treatment was significant above the year effect (3,9). Based on this analysis, the data from the two years were analyzed together, with the LSD for the visual evaluations being calculated using the appropriate error term. A linear contrast was used to determine the effect of increasing the RE-40885 rate on weed control.

Determination of effect of rate and application time.

Florida beggarweed control 4 and 8 WAP was excellent with all treatments, except 0.28 kg/ha applied POTE, providing > 90% control 8 WAP (Table 1). There was no significant RE-40885 rate or application time effect on Florida beggarweed control (Table 2).

Several treatments provided > 80% sicklepod control 4 WAP, but sequential applications were needed to maintain > 90% control 8 WAP (Table 1). PPI applications provided greater control than PRE applications when applied at 0.84 kg/ha (Table 2). This trend was also observed 4 WAP (Table 1). A nonsignificant linear rate contrast 8 WAP indicated that sicklepod control did not increase as RE-40885 rate was increased. This observation and the larger LSD value 8 WAP (Table 1) indicated that RE-40885 controlled sicklepod less consistently than Florida Beggarweed, however, sequential applications provided > 90% sicklepod control.

Prickly sida control 4 and 8 WAP was > 85% for all RE-40885 treatments except 0.28 and 0.56 kg/ha applied POTE (Table 1). Due to the sensitivity of prickly sida to RE-40885, no rate effect was observed (Table 2). PPI applications provided less prickly sida control at 0.84 kg/ha RE-40885 than the POTE or PPI+AC treatments, but the control was still good (87%).

Texas panicum was not satisfactorily controlled 8 WAP (Table 1). The highest rates of RE-40885 applied PPI, PRE, or AC resulted in > 75% Texas panicum control 4 WAP, but

Table 1. Weed control and peanut yield as influenced by various rates and application times of RE-40885 in 1987 and 1988.

Rate	Time[a] of Appl.	Florida beggarweed 4 WAP	Florida beggarweed 8 WAP	Sicklepod 4 WAP	Sicklepod 8 WAP	Prickly sida 4 WAP	Prickly sida 8 WAP	Texas panicum 4 WAP	Texas panicum 8 WAP	Peanut Yield
(kg/ha)		(%							)	(kg/ha)
0.56	PPI	95	100	77	72	90	87	64	20	3070
0.84	PPI	97	96	90	84	97	87	75	39	3070
1.12	PPI	100	98	94	67	97	91	86	59	3650
0.56	PRE	90	100	67	44	93	93	60	22	2630
0.84	PRE	95	94	74	64	100	97	72	41	3120
1.12	PRE	98	98	82	59	97	98	75	44	3350
0.56	AC	90	90	77	30	95	97	68	30	3080
0.86	AC	98	97	87	71	100	95	78	46	3350
1.12	AC	99	97	90	71	99	100	83	57	3450
0.28	POTE	58	66	56	43	40	63	17	10	2560
0.56	POTE	80	96	84	73	77	77	20	16	2930
0.84	POTE	88	95	83	77	88	95	13	13	2870
0.56+0.28	PPI+AC	98	100	87	74	99	100	41	42	3550
0.84+0.28	PPI+AC	100	100	85	79	95	93	74	57	3920
0.56+0.28 +0.28	PPI+AC +POTE	100	100	95	95	100	100	62	54	3880
CONTROL WEEDY[b]										1840
CONTROL WEEDFREE[b]										3090
LSD[c] (0.05)		10	14	13	23	9	10	26	21	686

[a]A non-ionic surfactant was added at 0.5% v/v to all AC and POTE treatments.

[b]Control weedy and weedfree treatments were not included in the weed control data analysis.

[c]LSD for weed control evaluations calculated using the YR*TRT term.

Table 2. Weed control 8 weeks after planting as influenced by rate and application time of RE-40885 in 1987 and 1988.

Factor	Florida beggarweed	Sicklepod	Prickly sida	Texas panicum
Rate[a] (kg/ha)	(%			)
0.56	97	49	96	24
0.84	96	73	93	42
1.12	98	66	96	54
linear contrast	ns	ns	ns	*
Application Time[b]	(%			)
PPI	97	84	87	39
PRE	94	64	97	41
AC	97	71	95	46
POTE	95	77	95	13
PPI+AC	100	74	100	42
(LSD 0.05)	5	15	10	23

[a]Weed control for a given rate averaged over PPI, PRE, and AC application times. Linear contrast used in analysis, with abbreviations: nonsignificant (ns) and significant at 0.05 level (*).

[b]Weed control for a given application time when RE-40885 was applied at 0.84 kg/ha. AC and POTE treatments were applied with 0.5% v/v non-ionic surfactant.

control had declined to < 60% by 8 WAP with these treatments. POTE applications provided significantly less Texas panicum control than PPI, PRE, or AC treatments (Table 2).

Peanut yield in this experiment was related to weed control (Table 1). Plots that received either sequential RE-40885 applications or the higher RE-40885 rate applied PPI or AC had the most complete weed control 8 WAP (100% Florida beggarweed, > 90% sicklepod and prickly sida, > 50% Texas panicum) and highest peanut yield. Several RE-40885 treatments, including the sequential treatments, resulted in higher yields than the weed-free controls, indicating no detrimental RE-40885 effect on peanuts.

RE-40885 combinations with alachlor and 2,4-DB. RE-40885 treatments provided 85-100% Florida beggarweed control (Table 3), with results being similar to the previously reported experiment. Alachlor at 2.80 kg/ha applied AC and 2,4-DB at 0.28 kg/ha applied POTE provided 81 and 39% Florida beggarweed control 8 WAP, respectively.

RE-40885 application resulted in sicklepod control 8 WAP that ranged from 54-74%. The addition of 2.80 kg/ha of alachlor applied AC or POTE (with or without surfactant) or 2,4-DB at 0.28 kg/ha applied POTE increased sicklepod control 8 WAP to > 90%. Alachlor or 2,4-DB applied alone provided <50% sicklepod control 8 WAP.

RE-40885 applied PPI or AC resulted in > 90% morningglory control 4 WAP, but this decreased to 71-84% 8 WAP. The addition of alachlor (2.8 kg/ha AC) or 2,4-DB (0.28 kg/ha POTE) to RE-40885 treatments at these application times increased morningglory control 8 WAP to

Table 3. Weed control and peanut yield from plots treated with RE-40885 applied alone and with other herbicides in 1987 and 1988.

Treatment[a]	Rate	Time of Appl.	Florida beggarweed		Sicklepod		Morningglory[b]		Peanut yield
			4 WAP	8 WAP	4 WAP	8 WAP	4 WAP	8 WAP	
	(kg/ha)		(—	—	—	%—	—	—)	(kg/ha)
BENEFIN	1.40	PPI	23	7	15	0	35	35	3060
RE	0.56	PPI	98	94	88	54	91	82	3600
RE	0.84	PPI	100	100	83	64	98	84	4190
RE+X	0.84	AC	100	100	88	74	96	71	3290
RE+ALA+X	0.84+2.80	AC	100	100	99	92	100	94	4160
ALA+X	2.80	AC	86	81	80	34	77	43	3140
RE+X	0.56	POTE	95	88	79	55	79	69	3370
RE+DB+X	0.56+0.28	POTE	96	97	94	91	100	92	3430
DB	0.28	POTE	30	39	52	47	100	95	2830
RE+ALA	0.56+2.80	POTE	98	85	94	93	92	87	3360
RE+ALA+X	0.56+2.80	POTE	99	98	92	90	97	87	3260
CONTROL WEEDY									2100
CONTROL WEEDFREE									3310
LSD[c] (0.05)			27	17	18	21	23	15	619

[a]All plots (except the nontreated weedy control) were treated with benefin at 1.40 kg/ha applied PPI. Abbreviations include RE-40885 (RE), alachlor (ALA), 2,4-DB (DB), and non-ionic surfactant at 0.5% v/v (X).

[b]Morningglory species included ivyleaf, tall, and smallflower species.

[c]Control plots were not included in the weed control data analysis. LSD calculated using YR*TRT term.

> 90%. Alachlor (2.80 kg/ha AC) and 2,4-DB (0.28 kg/ha POTE) provided 43 and 95% morningglory control 8 WAP, respectively.

The increase in sicklepod and morningglory control caused by RE-40885 when applied with alachlor can stem from a synergism of the two herbicide's active ingredients, or from a surfactant effect from the alachlor formulation. The alachlor formulation used was an emulsifiable concentrate. A comparison of 0.56 kg/ha RE-40885 + 2.80 kg/ha alachlor applied POTE either with or without surfactant showed no differences in weed control or peanut yield.

All treatments containing RE-40885 resulted in peanut yields that were significantly better than nontreated weedy control plots. The application of RE-40885 at 0.84 kg/ha PPI and RE-40885 + alachlor at 0.84 + 2.80 kg/ha AC resulted in a peanut yield greater than the weedfree control.

Summary

RE-40885 shows promise as a valuable tool for weed control in peanuts. It provided good control of several important broadleaf weeds without injury to peanuts. The order of species sensitivity from most to least sensitive was: Florida beggarweed > prickly sida > sicklepod = morningglories > Texas panicum. Under severe weed pressure RE-40885 can be applied sequentially to provide up to 100% Florida beggarweed and prickly sida control. Sequential applications were needed to achieve good sicklepod control; morningglory control 8 WAP was fair too good when RE-40885 was applied alone; and Texas Panicum control 8 WAP was poor for all RE-40885 treatments.

Based on these data, RE-40885 should be used in a weed control system that utilizes other herbicides to control Texas panicum. RE-40885 applied alone and in combination with presently labelled peanut herbicides provided broad spectrum weed control with a minimum number of applications. RE-40885 plus alachlor applied AC and RE-40885 plus 2,4-DB applied POTE demonstrated usefulness for broadleaf weed control in peanuts.

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