Weed Technology. 2002. Volume 16:724–730

Weed Management with Diclosulam in Peanut (*Arachis hypogaea*)[1]

ANDREW J. PRICE, JOHN W. WILCUT, and CHARLES W. SWANN[2]

Abstract: Field experiments were conducted at three locations in North Carolina in 1998 and 1999 and one location in Virginia in 1998 to evaluate weed management systems in peanut. Treatments consisted of diclosulam alone preemergence (PRE), or diclosulam plus metolachlor PRE alone or followed by (fb) bentazon plus acifluorfen postemergence (POST). These systems were also compared with commercial standards of metolachlor PRE fb bentazon plus acifluorfen POST or imazapic POST. Our data indicate that diclosulam PRE plus metolachlor PRE in conventional tillage peanut production usually controlled common lambsquarters, common ragweed, prickly sida, and entireleaf morningglory. But control of spurred anoda, goosegrass, ivyleaf morningglory, large crabgrass, and pitted morningglory by this system was inconsistent and may require additional POST herbicide treatments. Systems that included diclosulam plus metolachlor PRE consistently provided high yields and net returns.

Nomenclature: Acifluorfen, bentazon, diclosulam, imazapic, metolachlor; common lambsquarters, *Chenopodium album* L. #[3] CHEAL; common ragweed, *Ambrosia artemisiifolia* L. # AMBEL; entireleaf morningglory, *Ipomoea hederacea* var. *integruiscula* Grey # IPOHG; goosegrass, *Eleusine indica* (L.) Gaertn. # ELEIN; ivyleaf morningglory, *Ipomoea hederacea* (L.) Jacq # IPOHE; large crabgrass, *Digitaria sanguinalis* L. Scop. # DIGSA; pitted morningglory, *Ipomoea lacunosa* L. # IPOLA; prickly sida, *Sida spinosa* L. # SIDSP; spurred anoda, *Anoda cristata* L. # ANVCR; peanut, *Arachis hypogaea* L. 'NC 10C', 'NC 12C'.

Additional index words: Economic analysis.

Abbreviations: fb, followed by; POST, postemergence; PPI, preplant incorporated; PRE, preemergence.

INTRODUCTION

Weed management in peanut traditionally requires soil-applied preplant-incorporated (PPI) or preemergence (PRE) herbicides and generally at least one application of postemergence (POST) herbicide combinations (Bailey et al. 1999a; Bridges et al. 1994; Wilcut et al. 1994). Annual grasses, common lambsquarters, common ragweed, common cocklebur (*Xanthium strumarium* L.), *Ipomoea* spp., *Amaranthus* spp., and yellow nutsedge (*Cyperus esculentus* L.) are some of the most common weeds found in peanut production in the southeastern United States (Bridges et al. 1994). Control of this weed complex requires multiple herbicide treatments (Askew et al. 1999; Bailey et al. 1999a, 1999b; Scott et al. 2002; Wilcut and Swann 1990; Wilcut et al. 1991; York et al. 1995).

Soil-applied herbicides registered for application in southeastern U.S. peanut include diclosulam, dimethenamid, ethalfluralin, flumioxazin, imazethapyr, metolachlor, and pendimethalin. Ethalfluralin and pendimethalin PPI control annual grasses and small-seeded broadleaf weeds; however, they do not control large-seeded broadleaf weeds commonly found in southeastern U.S. peanut fields, including common ragweed, eclipta (*Eclipta prostrata* L.), annual *Ipomoea* species, and prickly sida (Askew et al. 1999; Bridges et al. 1994; Scott et al. 2002; Wilcut and Swann 1990; Wilcut et al. 1990, 1994). These weeds often require multiple applications of POST herbicides for season-long control (Bailey et al. 1999a, 1999b; Wilcut and Swann 1990). Imazethapyr soil applied or POST does not control common ragweed or eclipta (Wilcut et al. 1991; York et al. 1995).

Approximately 70% of the North Carolina–Virginia peanut hectarage receives a soil treatment of metolachlor, which controls annual grasses and provides partial control of common lambsquarters, *Amaranthus* spp., and

[1] Received for publication May 2, 2001, and in revised form March 9, 2002.

[2] Graduate Research Assistant and Professor, Crop Science Department, P.O. Box 7620, North Carolina State University, Raleigh, NC 27695-7620; Professor, Tidewater Agricultural Experiment Station, Suffolk, VA 23437. Corresponding author's E-mail: john_wilcut@ncsu.edu.

[3] Letters following this symbol are a WSSA-approved computer code from *Composite List of Weeds,* Revised 1989. Available only on computer disk from WSSA, 810 East 10th Street, Lawrence, KS 66044-8897.

yellow nutsedge (Bridges et al. 1994; Wilcut et al. 1994). A broad-spectrum soil-applied herbicide applied in conjunction with metolachlor would be beneficial in reducing the types and number of herbicides applied and the number of trips through the field (Bailey et al. 1999a, 1999b).

Diclosulam is a new triazolopyrimidine sulfonanilide soil-applied herbicide recently registered for PPI and PRE treatment in peanut (Anonymous 2000, Scott et al. 2001). Ethalfluralin PPI plus diclosulam PPI or PRE has shown activity on a broad spectrum of weeds, including common lambsquarters, eclipta, entireleaf morningglory, pitted morningglory, and yellow nutsedge (Bailey et al. 1999a, 1999b, 2000; Baughman et al. 2000; Dotray et al. 2000; Main et al. 2000; Prostko et al. 1998; Scott et al. 2002). Peanut cultivars have shown excellent tolerance to diclosulam (Bailey et al. 2000; Main et al. 2000). Because metolachlor is the most commonly used soil-applied herbicide in peanut (Bridges et al. 1994), diclosulam needs to be evaluated in metolachlor-based systems. Therefore, studies were conducted to evaluate weed control, crop response, peanut yield, and economic returns from herbicide systems containing diclosulam plus metolachlor PRE.

MATERIALS AND METHODS

Field experiments were conducted at the Upper Coastal Plain Research Station near Rocky Mount, NC, in 1998, the Peanut Belt Research Station located near Lewiston, NC, in 1998 and 1999, and the Tidewater Agricultural Research and Extension Center near Suffolk, VA, in 1998. Soil was a Norfolk loamy sand (fine-loamy, siliceous, thermic Typic Kandiudults) with 1.1% organic matter and pH 5.8 at Rocky Mount in 1998, 1.1% organic matter and pH 5.9 at Lewiston in 1998 and 1999, and 1.5% organic matter and pH 6.1 at Suffolk in 1998. These soil types are representative of the major peanut-producing areas of the United States.

The Virginia market-type peanut cultivars planted were NC 7 at Rocky Mount, NC 10C at Lewiston, and NC-V 11 at Suffolk. These three cultivars are among the most commonly grown in the North Carolina–Virginia region (Spears 2000). Peanuts were planted 5 cm deep in smooth seedbeds, at 120 to 130 kg/ha in 91-cm rows. Seeding rates were typical for southeastern U.S. peanut and according to Cooperative Extension Service recommendations (Jordan 2000). Pest management programs other than herbicide programs were based on Cooperative Extension Service recommendations (Bailey 2000; Brandenburg 2000).

The weed species evaluated included common lambsquarters, common ragweed, entireleaf morningglory, goosegrass, ivyleaf morningglory, large crabgrass, pitted morningglory, prickly sida, and spurred anoda. At the time of POST treatments, broadleaf weeds were between the cotyledon and the four-leaf growth stage, grasses were between the cotyledon and the three-tiller growth stage, and all weeds had various densities (see table footnotes). POST treatments were applied approximately 3 wk after peanut emergence. This application timing is typical of commercial POST systems in peanut (Wilcut et al. 1994).

Soil-applied herbicide treatments included diclosulam applied PRE at 17.5, 27, and 52 g ai/ha alone and in mixture with metolachlor PRE at 1.4 kg ai/ha. Additional diclosulam treatments included metolachlor PRE at 1.4 kg/ha plus diclosulam PRE at 17.5 or 27 g/ha followed by (fb) acifluorfen at 0.28 g ai/ha plus bentazon at 0.56 kg ai/ha POST. Treatments of metolachlor PRE at 1.4 kg/ha fb acifluorfen at 0.28 g/ha plus bentazon at 0.56 kg/ha POST or metolachlor PRE at 1.4 kg/ha fb imazapic at 72 g ai/ha POST were included as representatives of current commercial standards. For comparison, a nontreated check was also included in the treatment selection. Nonionic surfactant[4] at 0.25% (v/v) was included with all POST applications. Clethodim late POST at 0.14 kg ai/ha plus crop-oil concentrate[5] at 1% (v/v) were applied to all North Carolina plots except the untreated check to provide season-long control of annual grasses, including broadleaf signalgrass [*Bracharia platyphylla* (Griseb.) Nash], goosegrass, large crabgrass, and Texas panicum (*Panicum texanum* Buckl.). This treatment was needed to facilitate harvest because the fibrous root systems of annual grasses interfere with digging and harvesting operations (Wilcut et al. 1994). The experimental design was a randomized complete block with three replications. Plot size was four 91-cm rows that were 6.1 m in length at all locations. The center two rows of each plot were harvested in mid-October each year using conventional harvesting equipment.

Visual estimates of weed control were recorded early (mid-June) and late (late August) in the season just before harvest (Frans et al. 1986). Because weed control at the end of the season influenced peanut yield and harvest efficiency, only late-season evaluations of weed

[4] Induce nonionic low foam wetter or spreader adjuvant containing 90% nonionic surfactant (alkylarylopolyoxyalkane ether and isopropanol) and free fatty acids and 10% water. Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38137.

[5] Agri-dex, 83% paraffin base petroleum oil and 17% surfactant blend. Helena Chemical Company, Suite 500, 6075 Poplar Avenue, Memphis, TN 38137.

Table 1. Influence of herbicide systems on common lambsquarters and common ragweed control at one Virginia and three North Carolina locations in 1998 and 1999.[a]

Herbicide system	Common lambsquarters[b] Rocky Mount, 1998	Lewiston, 1998	Virginia, 1998	Lewiston, 1999	Common ragweed Rocky Mount, 1998	Virginia, 1998	Lewiston, 1999
	% control						
Diclosulam 17.5 g ai/ha	90 ab[c]	98 a	62 e	92 a	100 a	100 a	58 d
Diclosulam 27 g/ha	95 ab	100 a	62 e	100 a	100 a	100 a	76 bcd
Diclosulam 52 g/ha	97 a	98 a	73 de	100 a	100 a	100 a	93 a
Diclosulam 17.5 g/ha + metolachlor[d]	92 ab	96 a	72 de	100 a	100 a	100 a	88 ab
Diclosulam 27 g/ha + metolachlor	93 ab	97 a	85 c	100 a	100 a	100 a	95 a
Diclosulam 52 g/ha + metolachlor	96 ab	100 a	90 c	100 a	100 a	100 a	85 abc
Diclosulam 17.5 g/ha + metolachlor fb acifluorfen plus bentazon[e]	97 a	100 a	100 a	100 a	100 a	100 a	91 ab
Diclosulam 27 g/ha + metolachlor fb acifluorfen plus bentazon	99 a	100 a	100 a	100 a	100 a	100 a	97 a
Metolachlor fb acifluorfen + bentazon	92 ab	100 a	97 b	100 a	100 a	100 a	27 e
Metolachlor fb imazapic	79 b	98 a	82 cd	96 a	100 a	97 b	66 cd

[a] Abbreviations: fb, followed by; POST, postemergence; PRE, preemergence.

[b] Weed densities: common lambsquarters (1–12/m^2), common ragweed (1–16/m^2). All weeds had between cotyledon and four true leaves.

[c] Mean separations followed by the same letter are not significantly different. Mean separations were performed using Fisher's protected LSD test at P = 0.05.

[d] Metolachlor PRE was applied at 1.4 kg/ha.

[e] Rates of POST herbicides: acifluorfen and bentazon were applied at 0.28 and 0.56 kg/ha, respectively. Imazapic was applied at 0.071 kg/ha. Clethodim was applied late POST at 0.14 kg ai/ha on all plots except the untreated checks.

control are presented (Wilcut et al. 1994). Peanut injury was evaluated 2 and 5 wk after planting. Because injury was 2% or less at the first evaluation, with no differences between soil-applied treatments, and injury was 10% or less at the second evaluation and was typical for POST herbicide treatment crop injury (Prostko and Baughman 1999), no injury data will be discussed (data not shown).

Net returns to land and management were determined by substituting the cost of each herbicide system for weed control and average yield in a North Carolina farm budget (Brown 2000). All costs, with the exception of those used for weed control, were based on this budget generator. The production costs included cultural and pest management procedures, equipment and labor, interest on operating equipment, harvest operations such as drying and hauling, and general overhead costs. Quotes of herbicide and adjuvant costs were obtained from two North Carolina agricultural suppliers and averaged. Costs of herbicide application were $4.28/ha per application, on the basis of estimates developed by the Department of Agriculture and Resource Economics at North Carolina State University. Herbicide system costs represent the sum of all application, herbicide, and adjuvant costs. Net returns were calculated by multiplying yield per hectare by 100% of the price support ($0.67/kg) and subtracting the total production costs for each treatment.

Data were tested for homogeneity of variance by plotting residuals. An arcsine square-root transformation did not improve variance homogeneity, thus nontransformed data were used in the analysis and presentation for clarity. Data from the nontreated control were deleted before analysis to stabilize variance because visually estimated weed control ratings were set to 0, and peanut yield could not be harvested because of weed biomass interference with machinery. Analysis of variance was conducted using the general linear models procedure in SAS (SAS 1998) to evaluate the effect of the various herbicide treatments on crop injury, weed control, and crop yield. Sums of squares were partitioned to evaluate location and year effects that were considered a single random variable. Main effects and interactions were tested by the appropriate mean square associated with the random variable (McIntosh 1983). Mean separations were performed using Fisher's protected LSD test at P = 0.05.

RESULTS AND DISCUSSION

Weed Control. *Common lambsquarters.* There was a location by treatment interaction, thus data are presented by location. At three of the four locations, diclosulam PRE at all rates provided at least 90% control of common lambsquarters, with no differences in control with the higher rates of diclosulam treatments (Table 1). Common lambsquarters in Virginia was controlled by diclosulam PRE 62 to 73% with no differences among treatments. The addition of metolachlor to the two higher rates of diclosulam PRE improved control by at least 12 percentage points at the Virginia location. Because common lambsquarters, at all locations in North Carolina,

Table 2. Influence of herbicide systems on prickly sida, spurred anoda, entireleaf morningglory, and ivyleaf morningglory control at one Virginia and three North Carolina locations in 1998 and 1999.[a]

Herbicide system	Prickly sida[b]		Spurred anoda		Entireleaf morningglory		Ivyleaf morningglory	
	Lewiston, 1998	Virginia, 1998	Lewiston, 1998	Virginia, 1998	Rocky Mount, 1998	Lewiston, 1999	Lewiston, 1998	Virginia, 1998
	% control							
Diclosulam 17.5 g ai/ha	63 b[c]	100 a	26 f	100 a	100 a	70 de	12 f	90 bc
Diclosulam 27 g/ha	74 b	100 a	43 ef	100 a	100 a	95 ab	37 d	92 abc
Diclosulam 52 g/ha	97 a	100 a	71 cd	100 a	100 a	90 abc	67 c	100 a
Diclosulam 17.5 g/ha + metolachlor[d]	95 a	100 a	70 cd	100 a	97 b	85 bcd	18 ef	87 c
Diclosulam 27 g/ha + metolachlor	97 a	100 a	81 bc	100 a	100 a	98 ab	30 de	97 ab
Diclosulam 52 g/ha + metolachlor	97 a	100 a	58 de	100 a	100 a	100 a	43 d	97 ab
Diclosulam 17.5 g/ha + metolachlor fb acifluorfen plus bentazon[e]	100 a	100 a	93 ab	100 a	100 a	80 cde	93 a	97 ab
Diclosulam 27 g/ha + metolachlor fb acifluorfen plus bentazon	100 a	100 a	88 b	100 a	100 a	97 ab	94 a	100 a
Metolachlor fb acifluorfen + bentazon	100 a	95 b	52 de	100 a	100 a	62 e	81 bc	85 c
Metolachlor fb imazapic	100 a	100 a	100 a	100 a	100 a	93 ab	92 ab	85 c

[a] Abbreviations: fb, followed by; POST, postemergence; PRE, preemergence.

[b] Weed densities: prickly sida (1–12/m^2), spurred anoda (1–5/m^2), entireleaf morningglory (1–15/m^2), ivyleaf morningglory (1–25/m^2). All weeds had between cotyledon and four true leaves.

[c] Mean separations followed by the same letter are not significantly different. Mean separations were performed using Fisher's protected LSD test at $P = 0.05$.

[d] Metolachlor PRE was applied at 1.4 kg/ha.

[e] Rates of POST herbicides: acifluorfen and bentazon were applied at 0.28 and 0.56 kg/ha, respectively. Imazapic was applied at 0.071 kg/ha. Clethodim was applied late POST at 0.14 kg ai/ha on all plots except the untreated checks.

was controlled with diclosulam PRE treatments, control was not further improved by addition of metolachlor or POST herbicides. Metolachlor plus diclosulam PRE fb acifluorfen plus bentazon POST provided common lambsquarters control of 97 to 100% depending on location, whereas metolachlor PRE fb imazapic POST provided common lambsquarters control ranging from 79 to 98% depending on location. Metolachlor PRE fb acifluorfen plus bentazon POST controlled common lambsquarters a minimum of 92% at all locations. Thus, imazapic POST was less effective for consistent common lambsquarters control when compared with diclosulam PRE plus POST systems or acifluorfen plus bentazon POST systems.

Common ragweed. There was a location by treatment interaction, thus data are presented by location. All herbicide systems controlled common ragweed 100% at the Rocky Mount and Virginia locations in 1998 (Table 1). But in Lewiston in 1999, a control of > 80% required diclosulam PRE at 52 g/ha alone or any rate of diclosulam plus metolachlor PRE with or without POST herbicides. Because of the excellent control provided by diclosulam PRE in North Carolina, the addition of POST herbicides was not beneficial. Metolachlor PRE fb acifluorfen plus bentazon POST provided 100% common ragweed control in the Virginia and Rocky Mount locations; however, control in Lewiston was 27%. Metolachlor PRE fb imazapic POST provided common ragweed control of ≥ 97% the in Virginia and Rocky Mount locations, whereas it provided 66% control in Lewiston.

Prickly sida. There was a location by treatment interaction, thus data are presented by location. Diclosulam PRE at 17.5 g/ha provided prickly sida control of 63 and 100% in North Carolina and Virginia, respectively (Table 2). Control at Lewiston was increased to 74 and 97% as the diclosulam rate increased to 27 g/ha and 52 g/ha, respectively. Metolachlor plus diclosulam PRE at any rate provided prickly sida control of at least 95% at both locations, and control was not further increased by POST herbicides. Weed management systems that used metolachlor PRE fb acifluorfen plus bentazon POST or imazapic POST controlled at least 95% of the prickly sida population.

Spurred anoda. There was a location by treatment interaction, thus data are presented by location. Spurred anoda control with diclosulam PRE was inconsistent (Table 2). Diclosulam PRE at all rates controlled spurred anoda 71% or less at Lewiston in 1998 but controlled 100% of the population in Virginia. Addition of metolachlor to diclosulam PRE at the two lower diclosulam rates improved spurred anoda control in North Carolina to ≥ 70%. Metolachlor plus diclosulam PRE fb POST herbicides controlled spurred anoda ≥ 88% in Lewiston,

Table 3. Influence of herbicide systems on pitted morningglory, goosegrass and large crabgrass control at one Virginia and three North Carolina locations in 1998 and 1999.[a]

Herbicide system	Pitted morningglory[b]			Goosegrass[c]			Large crabgrass	
	Lewiston, 1998	Virginia, 1998	Lewiston, 1999	Rocky Mount, 1998	Virginia, 1998	Lewiston, 1998	Virginia, 1998	Lewiston, 1999
	% control							
Diclosulam 17.5 g ai/ha	14 f[d]	92 bcd	55 c	97 cd	53 c	98 b	95 b	100 a
Diclosulam 27 g/ha	35 de	95 abc	82 ab	97 cd	65 c	99 ab	95 b	100 a
Diclosulam 52 g/ha	67 c	100 a	80 ab	99 abc	82 b	100 a	100 a	99 b
Diclosulam 17.5 g/ha + metolachlor[e]	19 ef	90 bcd	79 abc	97 cd	100 a	100 a	100 a	100 a
Diclosulam 27 g/ha + metolachlor	28 def	98 ab	94 a	100 a	100 a	100 a	100 a	100 a
Diclosulam 52 g/ha + metolachlor	42 d	98 ab	89 ab	99 ab	100 a	100 a	100 a	100 a
Diclosulam 17.5 g/ha + metolachlor fb acifluorfen plus bentazon[f]	96 a	97 ab	77 abc	98 bc	100 a	100 a	100 a	100 a
Diclosulam 27 g/ha + metolachlor fb acifluorfen plus bentazon	95 a	100 a	82 abc	99 ab	100 a	100 a	100 a	100 a
Metolachlor fb acifluorfen + bentazon	83 bc	87 cd	63 bc	93 c	100 a	100 a	100 a	100 a
Metolachlor fb imazapic	95 ab	87 d	91 a	100 a	100 a	100 a	100 a	100 a

[a] Abbreviations: fb, followed by; POST, postemergence; PRE, preemergence.

[b] Weed densities: pitted morningglory (20–35/m^2), goosegrass (1–20/m^2), large crabgrass (20–35/m^2). Pitted morningglory had between cotyledon and four true leaves. Goosegrass and large crabgrass were between the cotyledon and the three-tiller growth stage.

[c] The level of goosegrass and large crabgrass control provided by all systems was not adequate in North Carolina, and the reported control is attributed to the late POST treatment of clethodim on all North Carolina plots.

[d] Mean separations followed by the same letter are not significantly different. Mean separations were performed using Fisher's protected LSD test at $P = 0.05$.

[e] Metolachlor PRE was applied at 1.4 kg/ha.

[f] Rates of POST herbicides: acifluorfen and bentazon were applied at 0.28 and 0.56 kg/ha, respectively. Imazapic was applied at 0.071 kg/ha. Clethodim was applied late POST at 0.14 kg ai/ha on all plots except on the untreated checks.

whereas metolachlor PRE fb imazapic POST controlled 100% of the spurred anoda population.

Entireleaf morningglory. There was a location by treatment interaction, thus data are presented by location. At Rocky Mount in 1998, all systems controlled ivyleaf morningglory at least 97%, and differences among treatments are unlikely to be of biological importance (Table 2). At Lewiston in 1999, diclosulam PRE at the two higher rates provided 70 to 95% control of entireleaf morningglory. Similar results were reported in Texas (Dotray et al. 2000) and in strip-tillage peanut in North Carolina (Price and Wilcut 2002). Additional inputs of other herbicides did not improve control. Metolachlor PRE fb acifluorfen plus bentazon POST was less effective than diclosulam PRE–containing systems, whereas metolachlor PRE fb imazapic POST provided control comparable with the better diclosulam systems.

Ivyleaf and pitted morningglory. There was a location by treatment interaction, thus these data are presented by location. Ivyleaf and pitted morningglory control with diclosulam PRE alone or in combination with metolachlor was inconsistent (Tables 2 and 3). Diclosulam PRE at all rates alone or with metolachlor provided less than 80% control of ivyleaf or pitted morningglory at the three North Carolina locations. However, diclosulam provided greater than 90% control at the Virginia location. The addition of metolachlor to diclosulam PRE did not increase control for either morningglory species at any location. Metolachlor plus diclosulam PRE at 17.5 g/ha fb acifluorfen plus bentazon POST provided 93% or greater control at all locations except at Lewiston in 1999, where control was 77%. Control was independent of diclosulam rate. Metolachlor PRE fb acifluorfen plus bentazon POST provided 63 to 87% control depending on location. This control was less than that by systems that included diclosulam, except at Lewiston in 1999, where control was equivalent. Metolachlor PRE fb imazapic POST controlled ivyleaf and pitted morningglory 85 to 95%. The most consistent control of both ivyleaf and pitted morningglory was obtained with metolachlor plus diclosulam PRE at 27 g/ha fb acifluorfen plus bentazon POST.

Goosegrass. There was a location by treatment interaction, thus data are presented by location. Diclosulam PRE at 17.5 g/ha controlled goosegrass 53 to 82% in Virginia, with the highest level of control obtained with the 52 g/ha rate of diclosulam (Table 3). All metolachlor systems controlled goosegrass 100% in Virginia. The level of goosegrass control provided by all systems was not adequate in North Carolina, and all plots received a late POST treatment of clethodim, which resulted in at least 97% control of goosegrass late in the season.

Table 4. Influence of herbicide systems on peanut yield at one Virginia and three North Carolina locations in 1998 and 1999.[a]

Herbicide system	Yield: Rocky Mount, 1998	Lewiston, 1998	Virginia, 1998	Lewiston, 1999
	kg/ha			
Diclosulam 17.5 g ai/ha	5,040 b[b]	3,350 ab	4,140 abc	3,890 cd
Diclosulam 27 g/ha	5,520 ab	3,660 ab	3,500 c	3,860 d
Diclosulam 52 g/ha	4,990 b	3,430 ab	3,960 bc	4,400 abc
Diclosulam 17.5 g/ha + metolachlor[c]	5,620 ab	3,220 b	5,180 a	4,610 a
Diclosulam 27 g/ha + metolachlor	5,640 ab	3,730 ab	5,070 ab	4,530 a
Diclosulam 52 g/ha + metolachlor	5,730 a	4,030 a	5,160 a	4,390 abcd
Diclosulam 17.5 g/ha + metolachlor fb acifluorfen plus bentazon[d]	5,900 a	4,100 a	5,140 a	4,510 a
Diclosulam 27 g/ha + metolachlor fb acifluorfen plus bentazon	5,230 ab	3,830 ab	5,060 ab	4,440 ab
Metolachlor fb acifluorfen + bentazon	5,450 ab	3,800 ab	4,260 abc	3,930 bcd
Metolachlor fb imazapic	5,370 ab	3,860 ab	4,070 abc	4,400 abc

[a] Abbreviations: fb, followed by; POST, postemergence; PRE, preemergence.

[b] Mean separations followed by the same letter are not significantly different. Mean separations were performed using Fisher's protected LSD test at P = 0.05.

[c] Metolachlor PRE was applied at 1.4 kg/ha.

[d] Rates of POST herbicides: acifluorfen and bentazon were applied at 0.28 and 0.56 kg/ha, respectively. Imazapic was applied at 0.071 kg/ha. Clethodim was applied late POST at 0.14 kg ai/ha on all plots except the untreated checks.

Large crabgrass. There was a location by treatment interaction, thus data are presented by location. Diclosulam PRE at all three rates controlled large crabgrass 95% in Virginia (Table 3). The level of large crabgrass control provided by all systems was not adequate in North Carolina, and the reported 99% control is again attributed to the late POST treatment of clethodim on all North Carolina plots.

Peanut Yield. There was a location by treatment interaction for peanut yield, thus data are presented by location. Peanut treated with diclosulam PRE at any rate yielded similarly at each location (3,500 to 5,520 kg/ha), except at Lewiston in 1999, where the highest rate (52 g/ha) provided higher yields when compared with the 27-g/ha rate (Table 4). Addition of metolachlor to diclosulam PRE at all rates increased yields in 6 out of 12 comparisons. The addition of POST herbicides to metolachlor plus diclosulam PRE systems increased yields in only one out of eight comparisons. Metolachlor PRE fb acifluorfen plus bentazon POST provided yields equivalent to those containing diclosulam PRE plus me-

Table 5. Interaction of herbicide systems on herbicide application cost and economic net returns at one Virginia and three North Carolina locations in 1998 and 1999.[a]

Herbicide system	Herbicide cost[b]	Economic net returns: Rocky Mount, 1998	Lewiston, 1998	Virginia, 1998	Lewiston, 1999
		$/ha			
Diclosulam 17.5 g ai/ha	19.06	1,893 b[c]	761 b	1,285 ab	1,122 b
Diclosulam 27 g/ha	26.28	2,204 ab	958 b	849 b	1,094 b
Diclosulam 52 g/ha	46.65	1,829 b	781 b	1,130 ab	1,438 ab
Diclosulam 17.5 g/ha + metolachlor[d]	45.33	2,262 ab	648 b	1,966 a	1,580 a
Diclosulam 27 g/ha + metolachlor	52.55	2,264 ab	982 ab	1,882 a	1,518 a
Diclosulam 52 g/ha + metolachlor	72.92	2,307 ab	1,166 ab	1,922 a	1,407 ab
Diclosulam 17.5 g/ha + metolachlor fb acifluorfen plus bentazon[e]	80.83	2,407 a	1,202 a	1,900 a	1,475 ab
Diclosulam 27 g/ha + metolachlor fb acifluorfen plus bentazon	88.05	1,953 b	1,013 ab	1,837 a	1,422 ab
Metolachlor fb acifluorfen + bentazon	61.77	2,125 ab	1,016 ab	1,331 ab	1,107 b
Metolachlor fb imazapic	92.82	2,040 ab	1,031 ab	1,171 ab	1,392 ab

[a] Abbreviations: fb, followed by; POST, postemergence; PRE, preemergence.

[b] Herbicide costs were calculated by summing application, herbicide, and adjuvant costs.

[c] Mean separations followed by the same letter are not significantly different. Mean separations were performed using Fisher's protected LSD test at P = 0.05.

[d] Metolachlor PRE was applied at 1.4 kg/ha.

[e] Rates of POST herbicides: acifluorfen and bentazon were applied at 0.28 and 0.56 kg/ha, respectively. Imazapic was applied at 0.071 kg/ha. Clethodim was applied late POST at 0.14 kg ai/ha on all plots except the untreated checks.

tolachlor PRE fb acifluorfen plus bentazon POST in seven out of eight comparisons. Metolachlor PRE fb imazapic POST provided yields equivalent to those of the highest-yielding diclosulam systems.

Economic Return. Net returns from each herbicide system followed the same general trend as did peanut yield (Table 5). Peanut treated with diclosulam PRE at any rate provided similar returns (761 to 2,204 $/ha) at each location. Addition of metolachlor PRE to diclosulam PRE at all rates increased returns in 3 out of 12 comparisons with diclosulam PRE alone. Addition of POST herbicides to metolachlor plus diclosulam PRE systems increased returns in three out of eight comparisons. Metolachlor PRE fb acifluorfen plus bentazon POST provided returns equivalent to those from diclosulam plus metolachlor PRE fb acifluorfen plus bentazon POST in seven out of eight comparisons. Metolachlor PRE fb imazapic POST provided net returns equivalent to the highest net returns from diclosulam systems.

POST herbicides used in this study did not always increase weed control for diclosulam plus metolachlor PRE systems. Addition of metolachlor to diclosulam PRE increased weed control for some weed species. Our data indicate that diclosulam PRE plus metolachlor PRE in conventional tillage peanut production usually controlled common lambsquarters, common ragweed, prickly sida, and entireleaf morningglory. But control of spurred anoda, ivyleaf morningglory, and pitted morningglory by this system was inconsistent and may require additional POST herbicide treatments. Peanut yields and net returns were reflective of levels of weed management. Systems that included diclosulam PRE plus metolachlor PRE consistently provided high yields and high net returns.

ACKNOWLEDGMENTS

We thank Dr. Cavell Brownie for providing statistical assistance. We also thank the station personnel at the Peanut Belt Research Station and the Upper Coastal Plain Research Station in North Carolina, and the Tidewater Agriculture Experiment Station in Virginia for assistance.

LITERATURE CITED

Anonymous. 2000. Strongarm product label. Indianapolis, IN: Dow AgroSciences LLC. 5 p.

Askew, S. D., J. W. Wilcut, and J. R. Cranmer. 1999. Weed management in peanut (*Arachis hypogaea*) with flumioxazin preemergence. Weed Technol. 13:594–595.

Bailey, J. 2000. Peanut disease management in 2000. *In* D. L. Jordan, ed. 2000 Peanut Information. North Carolina Cooperative Extension Service Publication. pp. 71–86.

Bailey, W. A., J. W. Wilcut, D. L. Jordan, C. W. Swann, and V. B. Langston. 1999a. Weed management in peanut (*Arachis hypogaea*) with diclosulam preemergence. Weed Technol. 13:450–456.

Bailey, W. A., J. W. Wilcut, D. L. Jordan, C. W. Swann, and V. B. Langston. 1999b. Response of peanut (*Arachis hypogaea*) and selected weeds to diclosulam. Weed Technol. 13:771–776.

Bailey, W. A., J. W. Wilcut, J. F. Spears, T. G. Isleib, and V. B. Langston. 2000. Diclosulam does not influence yields in eight Virginia market-type peanut (*Arachis hypogaea*) cultivars. Weed Technol. 14:402–405.

Baughman, T. A., P. A. Dotray, W. J. Gricher et al. 2000. Strongarm and Dual Magnum combinations for weed control in Texas peanut. Proc. South. Weed Sci. Soc. 53:36.

Brandenburg, R. L. 2000. Peanut insect management. *In* D. L. Jordan, ed. 2000 Peanut Information. North Carolina Cooperative Extension Service Publication AG-331. pp. 69–77.

Bridges, D. C., C. K. Kvien, J. E. Hook, and C. R. Stark Jr. 1994. Weeds and herbicides of the Virginia-Carolina peanut market area. Appendix 3.1. *In* D.C. Bridges, ed, An Analysis of the Use and Benefits of Pesticides in U.S.-Grown Peanut: III Virginia-Carolina Production Region. Tifton, GA: National Environmentally Sound Production Agriculture Laboratory. pp. 1–39.

Brown, A. B. 2000. 1999 Outlook and situation. *In* D. L. Jordan, ed. 2000 Peanut Information. North Carolina Cooperative Extension Service Publication AG-331. pp. 1–4.

Dotray, P. A., B. L. Porter, J. W. Keeling, T. A. Baughman, W. J. Gricher, E. P. Prostko, and R. G. Lemon. 2000. Weed management in Texas peanut with diclosulam. Proc. South. Weed Sci. Soc. 53:35.

Frans, R., R. Talbert, D. Marx, and H. Crowley. 1986. Experimental design and techniques for measuring and analyzing plant response to weed control practices. *In* N. D. Camper, ed. Research Methods in Weed Science. 3rd ed. Champaign, IL: South. Weed Sci. Soc. pp. 37–38.

Jordan, D. L. 2000. Peanut production practices. *In* D. L. Jordan, ed. 2000 Peanut Information. North Carolina Cooperative Extension Service Publication AG-331. pp. 8–18.

Main, C. L., J. A. Tredaway, and G. E. MacDonald. 2000. Weed management systems for control of Florida beggarweed (*Desmodium tortuosum*) and sicklepod (*Senna obtusifolia*). Proc South. Weed Sci. Soc. 53:33–34.

McIntosh, M. S. 1983. Analysis of combined experiments. Agron. J. 75:153–155.

Price, A. J. and J. W. Wilcut. 2002. Weed management with diclosulam in strip-tillage peanut (*Arachis hypogaea*). Weed Technol. 16:29–36.

Prostko, E. P. and T. A. Baughman. 1999. Peanut Herbicide Symptomology Guide. Texas Agricultural Extension Service SCS-1999-05. College Station, TX: Texas A&M University.

Prostko, E. P., R. G. Lemon, and R. A. Whitney. 1998. Weed control in peanuts with diclosulam. Proc. South. Weed Sci. Soc. 51:59.

Scott, G. H., S. D. Askew, and J. W. Wilcut. 2001. Economic evaluation of diclosulam and flumioxazin systems in peanut (*Arachis hypogaea*). Weed Technol. 15:360–364.

Scott, G. H., S. D. Askew, J. W. Wilcut, and A. C. Bennett. 2002. Economic evaluation of HADSS™ computer program in North Carolina peanut. Weed Sci. 50:91–100.

Spears, J. F. 2000. Peanut supply and quality. *In* D. L. Jordan, ed. 2000 Peanut Information. North Carolina Cooperative Extension Service Publication AG-331. pp. 4–7.

[SAS] Statistical Analysis Systems. 1998. SAS/STAT User's Guide. Release 7.00. Cary, NC: Statistical Analysis Systems Institute. 1028 p.

Wilcut, J. W. and C. W. Swann. 1990. Timing of paraquat applications for weed control in Virginia-type peanuts (*Arachis hypogaea*). Weed Sci. 38:558–562.

Wilcut, J. W., F. R. Walls Jr., and D. N. Horton. 1991. Imazethapyr for broadleaf weed control in peanuts (*Arachis hypogaea*). Peanut Sci. 18:26–30.

Wilcut, J. W., G. R. Wehtje, and T. V. Hicks. 1990. Evaluation of herbicide systems in minimum and conventional tillage peanuts (*Arachis hypogaea*). Weed Sci. 38:243–248.

Wilcut, J. W., A. C. York, and G. R. Wehtje. 1994. The control and interaction of weeds in peanut (*Arachis hypogaea*). Rev. Weed Sci. 6:177–205.

York, A. C., J. W. Wilcut, C. W. Swann, D. L. Jordan, and F. R. Walls Jr. 1995. Efficacy of imazethapyr in peanut (*Arachis hypogaea*) as affected by timing of application. Weed Sci. 43:107–116.