# Economic Assessment of Herbicide Systems for Minimum-Tillage Peanuts[1]

John W. Wilcut*[2], Glenn R. Wehtje[3], Daniel L. Colvin[4], and Michael G. Patterson[3]

**ABSTRACT**

Field experiments were conducted in 1983 and 1984 on a Dothan loamy sand at Headland, AL to evaluate herbicide systems for minimum tillage peanut *(Arachia hypogaea* L. Florunner) production. The influence of minimum tillage-herbicide systems on weed control, peanut yield, market grade, and net returns were examined. Two minimum tillage-herbicide systems provided greater yield and higher net returns with equivalent control of Texas panicum *(Panicum texanum* Buckle.) and Florida beggarweed [*Desmodium tortuosum* (SW.)DC] as compared to a conventional tillage-herbicide system. One of these systems included oryzalin [4-(dipropylamino)-3, 5-dinitrobenzenesulfonamide] and paraquat (1, 1'-dimethyl-4,4'bipyridinium ion) applied preemergence followed by an early postemergence application of acetochlor [2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)acetamide] and dinoseb [2-(1-methylpropyl)-4,6-dinitrophenol] and a postemergence-directed application of cyanazine (2-[[4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino]-2-methylpropanenitrile). The other system included benefin [N-butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine] and metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2)methoxy-1-methylethyl)acetamide) applied preplant-incorporated within-the-row followed by an early postemergence application of dinoseb and ethalfluralin [N-ethyl-N-)2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benzenamine] and a postemergence-directed application of paraquat. Herbicide inputs for these two minimum tillage-herbicide systems were greater than for the conventional tillage-herbicide system.

Key Words: Net returns, *Panicum texanum, Desmodium tortuosum.*

Limited research to date has been published on minimum tillage peanut production (2, 3). The lack of interest and research on minimum tillage peanuts until the last few years is probably due to the perceived inflexibility of traditional cultural practices (11). These practices typically include moldboard plowing and burying of all crop residues and trash. These practices are generally considered mandatory for disease control (5).

Colvin *et al.* (2) reported that conventional tillage was superior to minimum tillage based upon yields from studies conducted at Marianna, FL in 1984 but not in 1985. They concluded that full season conventional peanuts were the most profitable to the producer. In Alabama, Colvin *et al.* (3) reported that a herbicide system of paraquat (0.28 kg ai/ha) and oryzalin (1.68 kg ai/ha) applied preemergence followed by a ground-cracking application of paraquat (0.28 kg ai/ha) and a postemergence application of naptalam (2.4 kg ai/ha) plus dinoseb (1.12 kg ai/ha) provided good weed control and a cost effective system for minimum tillage peanut production. However, no economic data were presented to substantiate this conclusion. To date, there has been no research published concerning the economic analysis of net returns comparing minimum tillage-herbicide systems with conventional tillage-herbicide systems for peanut production.

With this in mind, the objectives of this study were to evaluate minimum tillage peanut production, specifically examining weed control, yield, and net returns.

## Materials and Methods

Field experiments were conducted during 1983 and 1984 at Headland, AL on a Dothan loamy sand soil (Plinthic Paleudult). The experiments were conducted on different but adjacent sites each year. Experimental design was a randomized complete block with four repli-

[1]Published as Alabama Agricultural Experiment Station Journal Series Paper 3-871292.

[2]Asst. Prof., Tidewater Res. Center, Virginia Polytechnic Institute and State Univ., Suffolk, VA 23437.

[3]Assoc. Prof. and Asst. Prof., Dep. Agronomy and Soils, AL Agric. Exp. Stn., Auburn University, AL 36849.

[4]Asst. Prof., Dep. Agronomy, University of Florida, Gainesville, FL.

cations. Florunner peanuts were planted in twin 18-cm rows on 91-cm centers and seeded at a rate of 128 kg/ha. Plots were 3.6 m by 6.1 m in size. The experimental area had most recently been in peanut and corn production and was seeded with rye (*Secale cereale* L.) in the fall prior to initiation of the experiment. The area was treated with 0.56 kg ai/ha of paraquat approximately 2 weeks prior to peanut planting to kill the rye cover and existing weeds.

Conventional tilled peanuts were planted in a well-prepared flat seedbed using conventional equipment. For minimum-tillage peanuts, tilled planting strips (40 cm wide) were prepared using a Brown-Harden Ro-Till[5] planter, with the planter units removed. The Ro-Till[5] consists of a subsoil shank that penetrates the soil to a depth of approximately 36 cm. Twin sets of fluted coulters (the one nearer the shank being larger in diameter than the other) were mounted on either side of the shanks. The subsoiler shank opens the soil and destroys plowpans beneath the row, and the fluted coulters smooth the soil and break large clods. Rolling crumblers were mounted immediately behind the fluted coulters and served to further smooth and shape the seedbed.

Planting was a separate operation due to equipment limitations. The twin-row pattern was achieved by using a tool-bar-mounted twin-row planter with the twin-row planter units situated 91 cm apart center-to-center on the tool bar.

Herbicides used in this study included benefin, alachlor, dinoseb plus naptalam(2-[(1-naphthalenylamino)carbonyl]benzoic acid],pendimethalin (N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine), paraquat, acetochlor, dinoseb, cyanazine, chloramben (3-amino-2,5-dichlorobenzoic acid), oryzalin, ethalfluralin, sethoxydim (2)[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclo-hexen-1-one), metolachlor, glyphosate [N-(phosphonomethyl)glycine] plus alachlor [2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide], 2,4-DB [4-(2,4-dichlorophenoxy)butanoic acid], and vernolate (S-propyl dipropylcarbamothiate). The systems used and rates applied are described in Table 1. These represent some of the most successful systems as determined by previous studies (2, 3, 8, 9, 10).

**Table 1. Weed control systems used for growing peanuts under conventional tillage (system 1) and minimum tillage (systems 2-18).**

| Weed control system | Herbicide application method<br>PPI | PPII | PRE | EPOT | PDS | POT | Cultivation |
|---|---|---|---|---|---|---|---|
| | (kg ai/ha) | | | | | | (no.) |
| 1 | Benefin (1.7) | ---- | --- | Alachlor (3.4)<br>Naptalam (1.1) +<br>Dinoseb (0.6) | ---- | ---- | 2 |
| 2 | --- | ---- | Pendimethalin (1.7)<br>Paraquat (0.6) | Paraquat (0.3) | ---- | Naptalam (2.2) +<br>Dinoseb (1.1) | - |
| 3 | --- | ---- | Pendimethalin (1.7)<br>Paraquat (0.6) | Acetochlor (1.7)<br>Dinoseb (1.7) | Cyanazine (1.7) | ---- | - |
| 4 | --- | ---- | Pendimethalin (1.7) | Alachlor (3.4)<br>Naptalam (1.1) +<br>Dinoseb (0.6) | ---- | 2,4-DB (0.3)<br>Dinoseb (1.7) | - |
| 5 | --- | ---- | Pendimethalin (1.7) | Chloramben (2.2)<br>Dinoseb (3.4) | ---- | ---- | 2 |
| 6 | --- | Benefin (1.7) | --- | Dinoseb (3.4) | Paraquat (0.3) | ---- | - |
| 7 | --- | Pendimethalin (2.2) | --- | Dinoseb (3.4) | Paraquat (0.3) | ---- | - |
| 8 | --- | ---- | Oryzalin (1.7)<br>Paraquat (0.6) | Paraquat (0.3) | ---- | Naptalam (2.2) +<br>Dinoseb (1.1) | - |
| 9 | --- | ---- | Oryzalin (1.7) | Alachlor (3.4)<br>Naptalam (1.1) +<br>Dinoseb (0.6) | ---- | 2,4-DB (0.03)<br>Dinoseb (1.7) | - |
| 10 | --- | ---- | Oryzalin (1.7)<br>Paraquat (0.6) | Acetochlor (1.7)<br>Dinoseb (1.7) | Cyanazine (1.7) | ---- | - |
| 11 | --- | ---- | Ethalfluralin (1.7) | Dinoseb (3.4)<br>Ethalfluralin (0.6) | ---- | Sethoxydim (0.3)<br>Chloramben (2.2) | - |
| 12 | --- | Benefin (1.7)<br>Metolachlor (2.2) | --- | Dinoseb (3.4)<br>Ethalfluralin (0.6) | Paraquat (0.3) | ---- | - |
| 13 | --- | Ethalfluralin (0.6) | --- | Dinoseb (3.4)<br>Ethalfluralin (0.6) | ---- | Paraquat (0.3) | - |
| 14 | --- | ---- | Ethalfluralin (1.7)<br>Metolachlor (1.7) | Naptalam (2.2)<br>Dinoseb (1.1) | ---- | 2,4-DB (0.3) | - |
| 15 | --- | ---- | Glyphosate (1.2) +<br>Alachlor (2.9) | Naptalam (2.2) +<br>Dinoseb (1.1) | ---- | 2,4-DB (0.3)<br>Dinoseb (1.7) | - |
| 16 | --- | ---- | Alachlor (3.4) | Sethoxydim (0.6)<br>Naptalam (2.2) +<br>Dinoseb (1.1) | ---- | Sethoxydim (0.6) | - |
| 17 | --- | ---- | Metolachlor (2.2)<br>Paraquat (0.6) | Dinoseb (3.4) | ---- | 2,4-DB (0.3) | - |
| 18 | --- | Benefin<br>Vernolate | --- | Dinoseb (3.4) | ---- | 2,4-DB (0.3) | - |
| 19 | Weed free check | | | | | | |
| 20 | Weedy check | | | | | | |

PPI, PPII, PRE, EPOT, PDS, and POT designate preplant-incorporated, preplant-incorporated within-the-row, preemergence, early postemergence, postemergence-directed shielded spray, and postemergence applications, respectively.

The experimental area contained a heavy infestation of Texas panicum and Florida beggarweed. Fertility, cultural and other pest management practices were as recommended by the Alabama Cooperative Extension Service for optimum peanut production.

[5]Brown Manufacturing Co., Inc., Ozark, AL 36360.

The major modification of minimum tillage-herbicide systems was the inclusion of volatile dinitroaniline herbicides incorporated within the peanut row. These treatments have been termed "preplant-incorporated within-the-row." In addition, cyanazine and paraquat were applied as an early postemergence-directed shielded spray to several minimum tillage treatments.

Herbicide inputs consisted of combinations of preplant-incorporated (PPI), preplant-incorporated within-the-row (PPII), preemergence (PRE), early postemergence (EPOT), postemergence-directed (PDS), and postemergence (POT) spray applications. Two timely cultivations were included in conventional tillage-herbicide system 1 and minimum tillage-herbicide system 5. Minimum-tillage is different from no-tillage in that minimum tillage is the minimum soil manipulation necessary for crop production (6). Two timely cultivations have been shown to increase weed control, yield, and net returns for conventional tilage peanut production (9, 10). Cultivations were flat with standard two-row cultivation equipment (sweeps) positioned parallel to the soil surface and approximately 10 cm deep. Cultivation was applied, when in the opinion of the researcher, the weed infestation could not be removed at a later date without risk of yield reduction. The preplant-incorporated (PPI) treatment was applied 1 to 3 days prior to planting and incorporated to a depth of 13 cm by one pass with a power driven vertical action tiller. The preplant-incorporated within-the-row treatments -PPII) were applied with a sprayer mounted to a Brown-Harden RO-TILL. Crumbler baskets attached behind subsoil shanks mounted on the RO-TILL served to incorporate the herbicide. Preemergence (PRE) treatments were made within 4 days after planting; early postemergence (EPOT) treatments were applied within 4 days of crop emergence; postemergence-directed (PDS) and postemergence (POT) treatments were applied 35 to 42 days after planting. Texas panicum and Florida beggarweed were in the cotyledon to two-leaf stage during early postemergence treatments. Postemergence and postemergence-directed treatments were applied when peanut plants were 15 to 25 cm in diameter. Texas panicum was in the four-to six-leaf stage and Florida beggarweed in the cotyledon to four-leaf stage. All herbicides were applied with a tractor-mounted conventional-boom type sprayer using compressed air as the propellant in a volume of 140 L/ha.

Weed control was visually assessed on the bases of weed density and vigor. Peanuts were harvested from the center two rows of each plot using conventional harvesting equipment. An enterprise budget was prepared for each plot using the Oklahoma State University crop budget generator (7) as modified for Alabama by the Department of Agricultural Economics and Rural Sociology, Auburn University. All costs, with the exception of those used for weed control, were based on this budget generator. Herbicide prices were based on an average cost quoted by three agricultural chemical dealers from the peanut producing area in Alabama. The production costs included cultural and pest management procedures, equipment and labor, interest on operating capital, harvest operations included drying and hauling, and general overhead costs. Gross receipts were calculated allowing the sale of a maximum of 1700 kg/ha for 1983 and 1630 kg/ha for 1984 at 100% of price support ($0.61/kg). These truncation points were determined to be 49% of an average state yield of 3470 kg/ha in 1983 and 3300 kg/ha in 1984. The value of yields in excess of the price support was set at $0.28/kg and $0.16/kg for 1983 and 1984, respectively. These are termed peanut additionals. Cost of maintaining the weed-free control was calculated and included in the analysis.

Weed control ratings, peanut yield, grade, and net returns were subjected to analyses of variance, and means were tested for differences by Fisher's protected LSD test at the 5% level of probability. Analyses of variance revealed no difference between years; consequently, data were combined for presentation.

# Results and Discussion

*Weed control.* Midseason ratings revealed that five systems (systems 1, 2, 8-10) provided Texas panicum control comparable to the weed free check (Table 2). Ranking of weed control by systems did not change appreciably between mid- and late-season rating. Greatest level of Texas panicum control ($\geq$ 88% through the late rating) was achieved with six systems. These included the conventional tillage-herbicide system (system 1) and

**Table 2. Mean visual ratings of Texas panicum and Florida beggarweed control by weed control systems for 1983 and 1984 near Headland, Alabama.**

| Weed control system | Weed control rating[a] Texas panicum Mid-season | Texas panicum Late-season | Florida beggarweed Mid-season | Florida beggarweed Late-season |
|---|---|---|---|---|
| | (%) | | | |
| 1 | 98 | 97 | 85 | 86 |
| 2 | 89 | 86 | 87 | 73 |
| 3 | 80 | 71 | 95 | 97 |
| 4 | 75 | 58 | 92 | 74 |
| 5 | 83 | 81 | 95 | 89 |
| 6 | 79 | 70 | 96 | 84 |
| 7 | 82 | 65 | 94 | 86 |
| 8 | 93 | 92 | 95 | 86 |
| 9 | 89 | 88 | 89 | 92 |
| 10 | 89 | 92 | 95 | 99 |
| 11 | 86 | 87 | 95 | 94 |
| 12 | 87 | 93 | 96 | 91 |
| 13 | 66 | 64 | 95 | 80 |
| 14 | 77 | 72 | 71 | 72 |
| 15 | 49 | 26 | 82 | 59 |
| 16 | 88 | 95 | 88 | 78 |
| 17 | 59 | 50 | 87 | 61 |
| 18 | 63 | 49 | 81 | 61 |
| 19 | 100 | 100 | 100 | 100 |
| 20 | 0 | 0 | 0 | 0 |
| LSD | 11 | 12 | 8 | 14 |

[a]Fisher's protected LSD test ($P \leq 0.05$).

five minimum tillage-herbicide systems (systems 8, 9, 10, 12 and 16), all of which were comparable to the weed-free check. Systems 8, 9 and 10 all included oryzalin as the dinitroaniline herbicide for grass control instead of benefin. System 12 had benefin plus metolachlor incorporated only within-the-row, followed by ethalfluralin at early postemergence and paraquat applied as a postemergence-directed treatment for control of Texas panicum.

Paraquat provides good control when it is applied to Texas panicum that is less than 6 cm in height (8). However, paraquat has no residual activity and is best used as a supplement to a fairly comprehensive weed control system (8). System 16 relied primarily on sethoxydim applied early postemergence and again postemergence. Sethoxydim has also been shown to provide excellent control of Texas panicum (4, 9). Alachlor applied preemergence provides some limited control of Texas panicum (9, 10). The conventional system (system 1) generally provides consistent and excellent control of Texas panicum (9, 10).

Systems 9 and 10 are identical to systems 3 and 4 except that oryzalin was applied instead of pendimethalin. In both systems, oryzalin provided greater Texas panicum control than pendimethalin. While system 8 was not significantly better than system 2, system 8 containing oryzalin provided control equivalent to that of the weed-free check while system 2 with pendimethalin did not.

Most systems providing greatest midseason control of Florida beggarweed also provided greatest control late in the season. Best control of Florida beggarweed (99% as of the late rating) was achieved by a minimum tillage-herbicide system (system 10). System 10 included ethalfluralin and paraquat applied preemergence and acetochlor and dinoseb applied early postemergence followed by a postemergence-directed aplication of cyanazine. Comparable control was achieved with the conventional tillage-herbicide system (system 1) and seven minimum tillage-herbicide systems (systems 3, 5, 7, 8, 9, 11 and 12). All of these systems provided excellent full season control of Florida beggarweed.

*Peanut yield.* Greatest yield was achieved with two minimum tillage-herbicide systems, (systems 10 and 12). Both systems utilized dinoseb applied early postemergence and a postemergence-directed spray of cyanazine for system 10 and paraquat for system 12. System 12 included the modified PPII application of benefin plus metolachlor and ethalfluralin applied EPOT, while system 10 had a preemergence application of oryzalin plus paraquat and acetochlor EPOT. Both systems provided better yield than the conventional tillage-herbicide system (system 1). No visual difference in foliar disease incidence could be detected between conventional and minimum tillage peanuts.

Peanut yield equivalent to systems 10 and 12 was also achieved by systems 5, 7, 8, 11, 15 and 18. However, yield of these systems was not significantly higher than yield achieved from the conventional tillage-herbicide system (system 1).

*Net returns.* Studies (9, 10) previously conducted in Alabama have found a conventional tillage-herbicide system (system 1) to consistently provide maximum net returns, yield, and weed control for conventional tilled peanuts in areas heavily infested with Texas panicum. In this study, however, net returns obtained from three minimum tillage-herbicide systems (systems 10, 12 and 18) were equivalent to the conventional tillage-herbicide system 1. Systems 12 and 18 had a PPII application of benefin plus metolachlor or vernolate, while system 10 had a preemergence application of oryzalin plus paraquat. Systems 10 and 12 had early postemergence and postemergence-directed applications in addition to the preemergence treatment, while system 18 utilized PPII, early postemergence and postemergence applications.

Net returns equivalent to the conventional tillage-herbicide system (system 1) were achieved by minimum tillage-herbicide systems 2-8, 11, 13, 15 and 17. All herbicide systems provided higher net returns than the weed free check. Increased herbicide inputs did not necessarily reflect increased net returns (Table 3). However, the top three systems (systems 10, 12, 18) required a larger herbicide input than the conventional tillage-herbicide system 1.

**Table 3. Mean peanut yields and net returns as influenced by weed control systems for 1983 and 1984 near Headland, Alabama[a].**

| Weed control system | Peanut yield | Net returns | Herbicide cost |
|---|---|---|---|
| | (kg/ha) | ($/ha) | ($/ha) |
| 1 | 3630 | 321 | 75 |
| 2 | 3700 | 316 | 110 |
| 3 | 3570 | 287 | 120 |
| 4 | 3640 | 299 | 107 |
| 5 | 3810 | 324 | 103 |
| 6 | 3740 | 316 | 86 |
| 7 | 3790 | 299 | 78 |
| 8 | 3810 | 319 | 114 |
| 9 | 3470 | 232 | 111 |
| 10 | 4270 | 358 | 125 |
| 11 | 3790 | 289 | 149 |
| 12 | 4280 | 368 | 120 |
| 13 | 3630 | 299 | 86 |
| 14 | 3190 | 205 | 93 |
| 15 | 3800 | 294 | 132 |
| 16 | 3560 | 245 | 243 |
| 17 | 3570 | 287 | 104 |
| 18 | 3950 | 334 | 84 |
| 19 | 4090 | -163 | --- |
| 20 | 3270 | 235 | --- |
| LSD | 490 | 81 | --- |

[a]Fisher's protected LSD test ($P \leq 0.05$).

Minimum tillage-herbicide systems 10 and 12 provided higher net returns and yield and equivalent control of Texas panicum and Florida beggarweed than did the conventional tillage-herbicide system 1. Minimum tillage-herbicide system 18 provided higher net returns and yield but less weed control than the conventional tillage-herbicide system. Colvin *et al.* (3) reported that minimum tillage-herbicide systems may provide good weed control and cost effectiveness. Their best minimum tillage-herbicide systems required several applications, i.e. preemergence, ground-cracking (equivalent to early postemergence application) and postemergence treatments. Our research also indicates that growing peanuts with minimum tillage requires more intensive weed control management. As with conventionally grown peanuts (9, 10), minimum tillage peanuts require several herbicide applications over time to insure maximum yield, net returns and adequate weed control.

## Literature Cited


1. Boote, K. J. 1982. Growth stages of peanut. Peanut Sci. 9:35-40.
2. Colvin, D. L., B. J. Brecke and W. L. Currey. 1986. Weed control and economic evaluation of full-season-double cropped, conventional and minimum tillage peanuts. Proc. South. Weed Sci. Soc. 39:55.
3. Colvin, D. L., G. R. Wehtje, M. Patterson and R. H. Walker. 1985. Weed management in minimum-tillage peanuts *(Arachis hypogaea)* as influenced by cultivar, row spacing, and herbicides. Weed Sci. 33:233-237.
4. Grichar, W. J. and T. E. Boswell. 1986. Postemergence grass control in peanut *(Arachis hypogaea).* Weed Sci. 34:587-590.
5. Henning, R. J., A. H. Allison and L. D. Tripp. 1982. Cultural practices. pp. 123-138 *in* H. E. Pattee and C. T. Young (eds.). Peanut Science and Technology. Am. Peanut Res. and Educ. Soc., Inc., Yoakum, TX 77995.
6. Turner, J. H. (ed.). 1983 Fundamentals of No-Till Farming. Chevron Chemical Co. San Francisco, CA. 148 pp.
7. Walker, R. L. and D. D. Kletke. 1971. User's Manual, Oklahoma State Univ. Crop Budget Generator. Prog. Rpt. p. 656.
8. Wehtje, G., J. A. McGuire, R. H. Walker and M. G. Patterson. 1986. Texas panicum *(Panicum texanum)* control in peanuts *(Arachis hypogaea)* with paraquat. Weed Sci. 34:308-311.
9. Wilcut, J. W., G. R. Wehtje and M. G. Patterson. 1987. Economic assessment of weed control systems for peanuts *(Arachis hypogaea).* Weed Sci. 35:433-437.
10. Wilcut, J. W., G. R. Wehtje and R. H. Walker. 1987. Economics of weed control in peanuts *(Arachis hypogaea)* with herbicides and cultivations. Weed Sci. 35:711-715.
11. Worsham, A. D. 1985. No-till tobacco *(Nicotiana tabacum)* and peanuts *(Arachis hypogaea).* pp. 101-126 *in* A. F. Wiese (ed.). Weed Control in Limited-Tillage Systems. Weed Sci. Soc. Am. Champaign, IL 61820.


Accepted January 18, 1988