Influence of Selected Fungicides on Efficacy of Clethodim and 2,4-DB

Gurinderbir S. Chahal[1], David L. Jordan[1]*, Barbara B. Shew[2], Rick L. Brandenburg[3], James D. Burton[4], David Danehower[5], and Peter M. Eure[6]

ABSTRACT

A range of fungicides and herbicides can be applied to control pests and optimize peanut yield. Experiments were conducted in North Carolina to define biological and physicochemical interactions when clethodim and 2,4-DB were applied alone or with selected fungicides. Pyraclostrobin consistently reduced large crabgrass [*Digitaria sanguinalis* (L.) Scop.] control by clethodim. Chlorothalonil and tebuconazole plus trifloxystrobin reduced large crabgrass control by clethodim in two of four experiments while prothioconazole plus tebuconazole and flutriafol did not affect control. Palmer amaranth [*Amaranthus palmeri* S. Wats] control by 2,4-DB was not affected by these fungicides. Although differences in spray solution pH were noted among mixtures of clethodim plus crop oil concentrate or 2,4-DB and fungicides, the range of pH was 4.40 to 4.92 and 6.72 to 7.20, respectively, across sampling times of 0, 6, 24, and 72 h after solution preparation. Permanent precipitates were formed when clethodim, crop oil concentrate, and chlorothalonil were co-applied at each sampling interval. Permanent precipitates were not observed when clethodim and crop oil concentrate were included with other fungicides or when 2,4-DB was mixed with fungicides. Significant positive correlations were noted for Palmer amaranth control by 2,4-DB and solution pH but not for clethodim and solution pH.

Key Words: Pesticide compatibility, precipitates, solution pH.

Peanut (*Arachis hypogaea* L.) is an important crop in North Carolina and the southeastern United States (Brown, 2013). The relatively poor competitive ability of peanut necessitates season-long weed control to obtain maximize yield (Jordan, 2013; Wilcut *et al.*, 1995). In addition to adverse effects of weed interference, diseases, insects, and nematodes can also be deleterious to yield. Mechanized production systems utilize a wide range of agrochemicals to manage peanut growth and development and minimize the impact of pests on peanut yield and quality (Lynch and Mack, 1995; Sherwood *et al.*, 1995; Wilcut *et al.*, 1995).

Monocotyledonous weeds, including annual and perennial grasses and sedges, as well dicotyledonous weeds are prevalent in peanut in the United States (Webster, 2009; Wilcut *et al.*, 1995). Comprehensive herbicide programs are employed to manage weeds and minimize interference and prevent yield loss (Wilcut *et al.*, 1995). Herbicides are often co-applied either prior to planting, immediately following planting, or after peanut and weeds have emerged to achieve optimum yield (Wilcut *et al.*, 1995). Grasses are especially troublesome in peanut due to the requirement of digging and inversion associated with harvest because the dense, fibrous root systems of grasses can cause pods to be stripped from the peanut vines (Wilcut *et al.*, 1995). Clethodim and sethoxydim control annual and perennial grasses when applied postemergence to peanut (Jordan, 2013). Palmer amaranth and other broadleaf weeds can be found throughout the major peanut production regions of the southeastern United States (Horak and Loughin, 2000). Although soil-applied herbicides are effective on Palmer amaranth (Grichar and Colburn, 1996; Grichar *et al.*, 1999), season-long control is generally not adequate with soil-applied herbicides alone (Grichar, 2008). In addition to other postemergence herbicides, 2,4-DB is often applied several times during the growing season to suppress *Amaranthus* species and sicklepod [*Senna obtusifolia* (L.) Irwin and Barneby] (Jordan, 2013; Wilcut *et al.*, 1995).

Fungicides are applied routinely to peanut to control the foliar diseases early leaf spot (caused by *Cercospora arachidicola* Hori) and late leaf spot (caused by *Cercosporidium personatum* Berk. & Curtis) and the soil-borne diseases stem rot (caused by *Sclerotium rolfsii* Sacc.), rhizoctonia limb rot (caused by *Rhizoctonia solani*), and Sclerotinia blight (caused by *Sclerotinia minor* Jagger) (Brenneman *et al.*, 1994; Culbreath *et al.*, 2008; Shew, 2013; Smith *et al.*, 1992). Although variation is

[1]Former Graduate Research Assistant and Professor, respectively, Department of Crop Science, Box 7620, North Carolina State University, Raleigh, NC 27695.

[2]Research Assistant Professor, Department of Plant Pathology, Box 2510, North Carolina State University, Raleigh, NC 27695.

[3]William Neal Reynolds Professor, Department of Entomology, Box 7613, North Carolina State University, Raleigh, NC 27695.

[4]Associate Professor, Department of Horticultural Sciences, Box 7609, North Carolina State University, Raleigh, NC 27695.

[5]Former Associate Professor, Department of Crop Science, Box 7620, North Carolina State University, Raleigh, NC 27695.

[6]Former Graduate Research Assistant, Department of Crop Science, Box 7620, North Carolina State University, Raleigh, NC 27695.

*Corresponding author email: david_jordan@ncsu.edu

noted, fungicides are applied either singly or in combination beginning approximately 45 days after peanut emergence and continuing throughout the remainder of the growing season (Sherwood *et al.*, 1995; Shew, 2013; Smith and Littrell, 1980).

A diversity of pesticide active ingredients is available for use in peanut production systems (Brandenburg, 2013; Jordan, 2013; Shew, 2013). Pests often occur simultaneously during the peanut growing season, and timing of application for many agrochemicals overlap (Brandenburg, 2013; Jordan, 2013; Shew, 2013). Therefore, there is often a possibility to co-apply herbicides and fungicides in peanut production systems. This approach is preferable if peanut is not injured, pest control is not compromised, and physicochemical compatibility exits. Research has been conducted to define interactions between herbicides (Burke *et al.*, 2004; Culpepper *et al.*, 1998; Wehtje *et al.*, 1992) and herbicides and fungicides (Jordan *et al.*, 2003; Lancaster *et al.*, 2005a, 2005b, 2008). Although interactions described in the literature have been defined for some herbicide-fungicide mixtures (Lancaster *et al.*, 2008), reports on the interactions of herbicides and prothioconazole plus tebuconazole, tebuconazole plus trifloxystrobin, and flutriafol with clethodim or 2,4-DB have not been reported.

Defining interactions among agrochemicals is important in assisting growers and their advisors in making decisions on co-application of these products. Therefore, the objectives of this study were to define interactions when clethodim and 2,4-DB are applied alone or in combination with fungicides not previously reported in the literature and to determine if changes in physicochemical characteristics of spray solutions occur that could influence efficacy.

Materials and Methods

Interactions of herbicides with fungicides in the field. Research was conducted in North Carolina during 2008 and 2009 at the Upper Coastal Plain Research Station located near Rocky Mount. Soil was a Goldsboro fine sandy loam (fine-loamy, siliceous, subactive, thermic Aquic Paleudults). Efficacy of clethodim and 2,4-DB was evaluated in separate experiments in non-crop areas. Plot size was 2.4 by 5 m.

Treatments consisted of clethodim (Select Max, Valent Corp., Walnut Creek, CA) at 140 g ai/ha applied alone or in combination with chlorothalonil (Bravo Weather Stik, Syngenta Crop Protection, Inc., Greensboro, NC) at 840 g ai/ha, flutriafol (Topguard fungicide, Cheminova Inc., Research Triangle Park, NC) at 64 g ai/ha, pyraclostrobin (Headline, BASF Corp., Research Triangle Park, NC) at 170 g ai/ha, prothioconazole plus tebuconazole (Provost, Bayer CropScience LP, Research Triangle Park, NC) at 80 + 160 g ai/ha, and tebuconazole plus trifloxystrobin (Absolute, Bayer CropScience LP, Research Triangle Park, NC) at 67 + 67 g ai/ha. Clethodim alone or with fungicides was applied with crop oil concentrate (Agri-Dex, Helena Chemical Company, Collierville, TN) at 1.0% (v/v).

Palmer amaranth control by 2,4-DB (Butyrac 200, Albaugh Inc., Ankeny, IA) at 280 g ai/ha applied alone or with these fungicides was also evaluated. Adjuvant was not included. Pesticides were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L/ha using flat-fan nozzles (TeeJet TP8002 flat-fan spray nozzles, Spraying Systems Co., Wheaton, IL) at 275 kPa.

Large crabgrass control by clethodim was evaluated in two separate fields at Rocky Mount during 2008 and in one field during 2009 when plants were of 15 to 20 cm in height. Palmer amaranth control by 2,4-DB was evaluated at Rocky Mount in two separate fields during both 2008 and 2009. Palmer amaranth was 25 to 30 cm in height at timing of application.

Visual estimates of percent weed control were recorded 21 days after treatment using a scale of 0 to 100% where 0 = no weed control and 100 = complete weed control (Frans *et al.*, 1986). Foliar chlorosis, necrosis, and plant stunting were considered when making the visual estimates.

Physicochemical compatibility of herbicides with other agrochemicals. Laboratory experiments were conducted to compare physicochemical compatibility of the herbicide combinations at rates and spray volume described in the field experiments. In contrast to field experiments where a municipal water source was used, deionized water at pH 6.3 was used in the laboratory experiments. Agrochemicals were mixed in the following order: flowables (chlorothalonil, flutriafol, prothioconazole plus tebuconazole, and tebuconazole plus trifloxystrobin), emulsifiable concentrates (clethodim and pyraclostrobin), and soluble liquids (crop oil concentrate 2,4-DB). Herbicide solutions were prepared in a final volume of 80 ml in sterilized plastic specimen cups (Specimen cup120 ml-53 ST ORG CAP, Fisher Scientific, Fairlawn, NJ) of 120 ml capacity. After mixing different agrochemicals, solution was vortexed (Vortex Genie 2, Fisher Scientific, Fairlawn, NJ) immediately and examined for precipitates followed by determining pH using a portable pH meter (Oakton portable pH meter, Fisher Scientific, Fairlawn, NJ). Solutions

Table 1. Control of large crabgrass 21 days after the application when clethodim was applied alone or in combination with selected fungicides.[a,b]

Fungicides	2008 Field 1	2008 Field 2	2009
	%		
None	94 ab	88 a	84 a
Chlorothalonil	91 abc	84 a	69 b
Flutriafol	90 bc	88 a	76 ab
Prothioconazole plus tebuconazole	90 bc	86 a	75 ab
Pyraclostrobin	88 c	75 b	36 d
Tebuconazole plus trifloxystrobin	95 a	81 ab	54 c

[a]Means within a location followed by the same letter are not significantly different according to Fisher's Protected LSD test at $p \leq 0.05$.

[b]Chlorothalonil, clethodim, flutriafol, prothioconazole plus tebuconazole, pyraclostrobin, and tebuconazole plus trifloxystrobin applied at 840, 140, 64, 80 + 160, 170, and 67 + 67 g/ha, respectively. Crop oil concentrate at 1.0% (v/v) was applied with clethodim alone or with fungicides.

were allowed to sit for 6 h after the time of mixing, examined visually with the naked eye for precipitates, vortexed, and re-examined for precipitates followed by pH determination. Similarly, mixtures were allowed to sit for 24 and 72 h after the initial solution preparation using the same procedure. Presence or absence of precipitates were determined visually and described as yes or no, respectively. Any visual depositions on the bottom of the specimen cup or the presence of suspended solids in the solution were considered as precipitates. Two types of precipitates, temporary and permanent, were noticed when herbicides were mixed with other agrochemicals. Temporary precipitates went back into solution on vortexing while permanent precipitates did not go into solution after vortexing.

Statistical analysis. The experimental design was a randomized complete block with treatments replicated four times in the experiments evaluating large crabgrass and Palmer amaranth control. The experimental design in the laboratory experiment was a completely randomized design with two replications and the experiment was repeated once. Data for visual estimates of percent weed control and solution pH were subjected to ANOVA using the PROC GLM procedure of SAS (Statistical Analysis Systems, version 9.1, SAS Institute Inc., Cary, NC) using expected mean squares to test fixed and random effects. Means of significant main effects and interactions were separated using Fisher's Protected LSD test at $p \leq 0.05$. F-statistic and Pearson correlation coefficients between pooled weed control for each herbicide and solution pH determined at four time intervals were calculated using the PROC CORR procedure in SAS.

Results and Discussion

Interactions of herbicides with fungicides in the field. The interaction of experiment (year and location combinations) and treatments was significant for large crabgrass control by clethodim, therefore, data are presented for each experiment. When compared to clethodim alone, application of clethodim with pyraclostrobin reduced large crabgrass control in all three experiments by 6 to 48 percentage points (Table 1). The reduction in control was greater in 2009 than 2008 and this may be due to higher rainfall during the 2008 growing season which resulted in plants undergoing less stress after combinations of clethodim and fungicides were applied. Reduction in grass control by graminicides caused by other pesticides is often exacerbated when plants are under water stress (Burke *et al.*, 2004; Wanamarta and Penner, 1989).

Although control was not affected during 2008, applying chlorothalonil with clethodim decreased control from 84% to 69% compared with clethodim alone in 2009 (Table 1). Lancaster *et al.* (2005a) reported that large crabgrass control was reduced when clethodim was applied with chlorothalonil and pyraclostrobin. Applying clethodim with tebuconazole plus trifloxystrobin reduced large crabgrass in 2009 but did not affect control during 2008 compared with clethodim alone (Table 1). Control with clethodim was not affected by prothioconazole plus tebuconazole or flutriafol. Tebuconazole often does not reduce control with clethodim (Jordan *et al.*, 2003; Lancaster *et al.*, 2005a). The influence of prothioconazole plus tebuconazole or tebuconazole plus trifloxystrobin as well as flutriafol on efficacy of clethodim has not been reported previously.

The interaction of experiment by treatment was significant for Palmer amaranth control with 2,4-DB;

Table 2. Control of Palmer amaranth 21 days after application of 2,4-DB applied alone or in combination with selected fungicides.[a,b]

	2008		2009	
Fungicides	Field 1	Field 2	Field 1	Field 2
	%			
None	71 ab	80 ab	83 ab	75 b
Chlorothalonil	64 b	78 b	85 a	74 b
Flutriafol	73 a	81 ab	84 ab	76 b
Prothioconazole plus tebuconazole	70 ab	83 a	80 b	74 b
Pyraclostrobin	70 ab	78 b	85 a	80 a
Tebuconazole plus trifloxystrobin	69 ab	80 ab	86 a	75 b

[a]Means within a location followed by the same letter are not significantly different according to Fisher's Protected LSD test at $p \leq 0.05$.
[b]Chlorothalonil, flutriafol, prothioconazole plus tebuconazole, pyraclostrobin, tebuconazole plus trifloxystrobin, and 2,4-DB applied at 840, 64, 80 + 160, 170, 67 + 67, and 280 g/ha, respectively. Adjuvant was not applied with 2,4-DB alone or with fungicides.

therefore, data are presented for each experiment. In one experiment in 2009, control with 2,4-DB increased when pyraclostrobin was included compared with 2,4-DB alone (Table 2). Palmer amaranth control by 2,4-DB was not affected by chlorothalonil, flutriafol, prothioconazole plus tebuconazole, or tebuconazole plus trifloxystrobin. Lancaster *et al.* (2005b) reported that co-application of pyraclostrobin with 2,4-DB reduced entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray) control compared with 2,4-DB alone.

Physicochemical compatibility of herbicides with other agrochemicals. Interactions of sampling time by treatments were noted for solution pH for clethodim and 2,4-DB combinations, therefore, data are presented for each sampling time. The average pH of solution with clethodim plus crop oil concentrate was 4.42, 4.49, 4.61, and 4.53 at 0, 6, 24, and 72 h sampling intervals, respectively (Table 3). When compared with initial pH of the aqueous solution (pH = 6.30), clethodim plus crop oil concentrate reduced solution pH regardless of fungicide across all sampling intervals. Including chlorothalonil, flutriafol, and prothioconazole plus tebuconazole with clethodim plus crop oil concentrate increased solution pH at 0, 6, and 24 h sampling times compared to clethodim plus crop oil concentrate. When compared to solution with clethodim plus crop oil concentrate, the addition of pyraclostrobin and tebuconazole plus trifloxy-

Table 3. Solution pH determined when clethodim and 2,4-DB were applied alone or in combination with selected fungicides at four sampling intervals.[a,b,c]

	Hours after mixing			
Fungicide	0	6	24	72
	pH			
Clethodim				
None	4.42 e	4.49 e	4.61 c	4.53 ab
Chlorothalonil	4.71 b	4.69 b	4.69 b	4.53 ab
Flutriafol	4.64 c	4.64 c	4.73 b	4.58 a
Prothioconazole plus tebuconazole	4.92 a	4.92 a	4.90 a	4.58 a
Pyraclostrobin	4.59 d	4.59 d	4.57 c	4.51 b
Tebuconazole plus trifloxystrobin	4.63 c	4.60 cd	4.59 c	4.40 c
2,4-DB				
None	6.99 c	6.95 c	6.84 d	6.78 c
Chlorothalonil	6.78 f	6.77 e	6.75 e	6.70 e
Flutriafol	7.05 b	7.03 b	6.99 b	6.88 b
Prothioconazole plus tebuconazole	6.84 e	6.84 d	6.83 d	6.72 d
Pyraclostrobin	7.20 a	7.15 a	7.13 a	6.92 a
Tebuconazole plus trifloxystrobin	6.96 d	6.94 c	6.87 c	6.79 c

[a]Means within a time interval and herbicide followed by the same letter are not significantly different according to Fisher's Protected LSD test at $p \leq 0.05$. Data are pooled over experiments.
[b]Clethodim alone or with fungicides included crop oil concentrate at 1.0% (v/v).
[c]Chlorothalonil, clethodim, flutriafol, prothioconazole plus tebuconazole, pyraclostrobin, tebuconazole plus trifloxystrobin, and 2,4-DB applied at 840, 140, 64, 80 + 160, 170, 67 + 67, and 280 g/ha, respectively.

Table 4. Presence or absence of precipitates on mixing of clethodim and 2,4-DB with other selected fungicides at four sampling intervals. [a,b,c]

Fungicide	Hours after mixing			
	0	6	24	72
	precipitates			
Clethodim				
None	N	N	N	N
Chlorothalonil	Y^	Y^	Y^	Y^
Flutriafol	Y*	Y*	Y*	Y*
Prothioconazole plus tebuconazole	Y*	Y*	Y*	Y*
Pyraclostrobin	Y*	Y*	Y*	Y*
Tebuconazole plus trifloxystrobin	N	N	Y*	Y*
2,4-DB				
None	N	N	N	N
Chlorothalonil	Y*	Y*	Y*	Y*
Flutriafol	Y*	Y*	Y*	Y*
Prothioconazole plus tebuconazole	Y*	Y*	Y*	Y*
Pyraclostrobin	Y*	Y*	Y*	Y*
Tebuconazole plus trifloxystrobin	Y*	Y*	Y*	Y*

[a]Data are pooled over experiments. *Indicates temporary precipitates. ^Indicates permanent precipitates. Y means presence of precipitates. N means no precipitates were observed.

[b]Clethodim alone or with fungicides included crop oil concentrate at 1.0% (v/v).

[c]Chlorothalonil, clethodim, flutriafol, prothioconazole plus tebuconazole, pyraclostrobin, tebuconazole plus trifloxystrobin, and 2,4-DB applied at 840, 140, 64, 80 + 160, 170, 67 + 67, and 280 g/ha, respectively.

strobin increased solution pH at 0 and 6 h sampling times.

The average solution pH value of 2,4-DB alone was 6.99, 6.93, 6.84, and 6.78 at 0, 6, 24, and 72 h sampling times, respectively (Table 3). When compared with 2,4-DB alone, solution pH was slightly increased across sampling times when flutriafol and pyraclostrobin were included in the mixture. In contrast, chlorothalonil decreased solution pH compared with 2,4-DB alone at all sampling times. Also, solution pH slightly decreased at 0, 6, and 72 h sampling intervals when prothioconazole plus tebuconazole was added to solution with 2,4-DB. When compared with 2,4-DB alone, tebuconazole plus trifloxystrobin decreased solution pH at 0 h sampling time only.

Combinations of clethodim with flutriafol, prothioconazole plus tebuconazole, and pyraclostrobin formed temporary precipitates; however, inclusion of chlorothalonil produced permanent precipitates across all sampling intervals (Table 4). Precipitates were formed with all 2,4-DB combinations with fungicides but solutions were reestablished after vortexing at each sampling interval (Table 4). No precipitates were formed in solution with 2,4-DB alone across sampling intervals.

Correlations for large crabgrass control by clethodim, pooled over experiments, and solution pH across sampling times, were not significant (p-values ranging from 0.3162 to 0.9934, data not shown in tables). However, significant positive correlations were noted for pooled Palmer amaranth control by 2,4-DB combinations and solution pH determined at four sampling times (p-values ranging from 0.0173 to 0.0529 with coefficients ranging from 0.81 to 0.88, data not shown in tables).

In summary, field experiments demonstrated that pyraclostrobin consistently reduced large crabgrass control by clethodim. In many instances, combinations of clethodim plus crop oil concentrate with chlorothalonil and tebuconazole plus trifloxystrobin reduced large crabgrass control by clethodim alone. The fungicides flutriafol and prothioconazole plus tebuconazole had the least affect on clethodim efficacy. Fungicides did not reduce Palmer amaranth control by 2,4-DB. Although several combinations of clethodim or 2,4-DB with fungicides formed temporary precipitates at different time intervals, the only permanent precipitates were formed when chlorothalonil, clethodim, and crop oil concentrate were mixed. Large crabgrass control by clethodim was not correlated with solution pH although significant correlations of Palmer amaranth control by 2,4-DB and solution pH were noted.

Acknowledgements

This research was supported financially by the North Carolina Peanut Growers Association and USAID Peanut CRSP grant LAG-G-00-96-90013-00. Gary Little and staff at the Upper Coastal Plain Research Station provided technical assistance.

Literature Cited

Brandenburg, R.L. 2013. Peanut insect management. Pages 81–100 *in* 2013 Peanut Information. North Carolina Coop. Ext. Ser. Publication AG-331.

Brenneman, T.B., H.R. Sumner, L.R. Chandler, J.M. Hammond, and A.K. Culbreath. 1994. Effect of application techniques on performance of propiconazole for peanut disease control. Peanut Sci. 21:134-138.

Brown, A.B. 2013. Virginia type peanuts: Situation and outlook. Page 4 *in* 2013 Peanut Information. North Carolina State University Coop. Ext. Ser. Publication AG-331.

Burke, I.C., A.J. Price, J.W. Wilcut, D.L. Jordan, A.S. Culpepper, and J.T. Ducar. 2004. Annual grass control in peanut (*Arachis hypogaea*) with clethodim and imazapic. Weed Technol. 18:88-92.

Culbreath, A.K., R.C. Kemerait Jr., and T.B. Brenneman. 2008. Management of leaf spot diseases of peanut with prothioconazole applied alone or in combination with tebuconazole or trifloxystrobin. Peanut Sci. 35:149-158.

Culpepper, A.S., A.C. York, K.M. Jennings, and R.B. Batts. 1998. Interaction of bromoxynil and postemergence graminicides on large crabgrass (*Digitaria sanguinalis*). Weed Technol. 12:554-559.

Frans, R.E., R. Talbert, D. Marx, and H. Crowley. 1986. Experimental design and techniques for measuring and analyzing plant responses to weed control practices. *In* N.D. Camper (ed.) Research Methods in Weed Science. South. Weed Sci. Soc., Champaign, IL. pp. 29-46.

Grichar, W.J. and A.E. Colburn. 1996. Flumioxazin for weed control in Texas peanuts (*Arachis hypogaea* L.). Peanut Sci. 23:30-36.

Grichar, W.J., P.A. Dotray, and D.C. Sestak. 1999. Diclosulam for weed control in Texas peanut. Peanut Sci. 26:23-28.

Grichar, W.J. 2008. Herbicide systems for control of horse purslane (*Trianthema portulacastrum* L.), smellmelon (*Cucumis melo* L.), and Palmer amaranth (*Amaranthus palmeri* S. Wats) in peanut. Peanut Sci. 35:38-42.

Horak, M.J. and T.M. Loughin. 2000. Growth analysis of four *Amaranthus* species. Weed Sci. 48:347-355.

Jordan, D.L. 2013. Peanut weed management. Pages 45–80 *in* 2013 Peanut Information. North Carolina Coop. Ext. Ser. Publication AG-331.

Jordan, D.L., A.S. Culpepper, W.J. Grichar, J.T. Ducar, B.J. Brecke, and A.C. York. 2003. Weed control with combinations of selected fungicides and herbicides applied postemergence to peanut (*Arachis hypogaea* L.). Peanut Sci. 30:1-7.

Lancaster, S.H., D.L. Jordan, A.C. York, I.C. Burke, F.T. Corbin, Y.S. Sheldon, J.W. Wilcut, and D.W. Monks. 2005a. Influence of selected fungicides on efficacy of clethodim and sethoxydim. Weed Technol. 19:397-403.

Lancaster, S.H., D.L. Jordan, A.C. York, J.W. Wilcut, R.L. Brandenburg, and D.W. Monks. 2005b. Interaction of late-season morningglory (*Ipomoea* spp.) management practices in peanut (*Arachis hypogaea* L.). Weed Technol. 19:803-808.

Lancaster, S.H., D.L. Jordan, and P.D. Johnson. 2008. Influence of graminicide formulation on compatibility with other pesticides. Weed Technol. 22:580-583.

Lynch, R.E. and T.P. Mack. 1995. Biological and biotechnical advances for insect management in peanut. *In* H.E. Pattee and H.T. Stalker, eds. Advances in Peanut Science Stillwater: Am. Peanut Res. and Educ. Soc. pp. 95-159.

Sherwood, J.L., M.K. Beute, D.W. Dickson, V.J. Elliot, R.S. Nelson, C.H. Opperman, and B.B. Shew. 1995. Biological and biotechnical control in Arachis diseases. *In* H.E. Pattee and H.T. Stalker, eds. Advances in Peanut Science Raleigh: Am. Peanut Res. and Educ. Soc. pp. 160-206.

Shew, B.B. 2013. Peanut disease management. Pages 101–131 *in* 2013 Peanut Information. North Carolina Coop. Ext. Ser. Publication AG-331.

Smith, F.D., P.M. Phipps, and R.J. Stipes. 1992. Fluazinam: A new fungicide for control of Sclerotinia blight and other soilborne pathogens of peanut. Peanut Sci. 19:115-120.

Smith, D.H. and R.H. Littrell. 1980. Management of peanut foliar diseases with fungicides. Plant Dis. 64:356-361.

Wanamarta, G. and D. Penner. 1989. Identification of efficacious adjuvants for sethoxydim and bentazon. Weed Technol. 3:60-66.

Webster, T.M. 2009. Weed survey- southern states. Proc. South. Weed Sci. Soc. 62:509-524.

Wehtje, G., J.W. Wilcut, and J.A. McGuire. 1992. Paraquat behavior as influenced by 2,4-DB in peanut (*Arachis hypogaea* L.) and selected weeds. Peanut Sci. 19:51-55.

Wilcut, J.W., A.C. York, W.J. Grichar, and G.R. Wehtje. 1995. The biology and management of weeds in peanut (*Arachis hypogaea*). *In* H.E. Pattee and H.T. Stalker, eds. Advances in Peanut Science. Stillwater: Am. Peanut Res. and Educ. Soc. pp. 207-224.