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Weed Control with Combinations of Selected Fungicides and Herbicides Applied Postmergence to Peanut (*Arachis hypogaea* L.)

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ABTRACT

Experiments were conducted from 1997 through 2001 in Georgia, Florida, North Carolina, and Texas to evaluate compatibility of selected postemergence herbicides and fungicides applied in tank mixtures. Control of broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash], goosegrass [*Eleusine indica* (L.) Gaertn.], large crabgrass [*Digitaria sanguinalis* (L.) Scop.], and Texas panicum (*Panicum texanum* Buckl.) by clethodim applied in tank mixtures with copper-based fungicides, fungicides containing chlorothalonil, azoxystrobin, and iprodione was reduced in 80, 69, 60, and 46% of comparisons, respectively, when compared to clethodim alone. Fluazinam, tebuconazole, and propiconazole did not reduce efficacy of clethodim. Efficacy was reduced more by fungicides when clethodim was applied in 230 L/ha spray volume compared with 94 L/ha. Efficacy of acifluorfen, bentazon, imazethapyr, and 2,4-DB applied with fungicides was also compared. Smooth pigweed (*Amaranthus hybridus* L.) control by 2,4-DB was reduced in at least two of three experiments when applied with chlorothalonil, copper-based fungicides, tebuconazole, azoxystrobin, and fluazinam. Iprodione did not affect efficacy of 2,4-DB. Control of smooth pigweed by imazethapyr was reduced when applied in combination with copper-based fungicides but not when applied with chlorothalonil, propiconazole, tebuconazole, fluazinam, propiconazole plus flutolanil, or propiconazole plus trifloxystrobin. Smooth pigweed control by acifluorfen was reduced in one of three experiments when applied with tebuconazole. Efficacy of acifluorfen was not affected by chlorothalonil, azoxystrobin, propiconazole, or fluazinam. Yellow nutsedge (*Cyperus esculentus* L.) control by bentazon was reduced by propiconazole plus chlorothalonil, propiconazole plus flutolanil, and copper-based fungicides. With the exception of fluazinam and chlorothalonil applied with 2,4-DB in one experiment, fungicides did not affect peanut injury following application of acifluorfen, clethodim, imazethapyr, or 2,4-DB.

Key Words: Disease management, pesticide compatibility, pesticide interaction, tank mixture.

Peanut (*Arachis hypogaea* L.) production in the United States is reliant on herbicides and fungicides for weed and disease control (Sherwood *et al.*, 1995; Wilcut *et al.*, 1995; Bailey, 2002). Timing of application of herbicides to control weeds and fungicides for control of foliar and soil-borne diseases often coincide. Applying these pesticides simultaneously would be advantageous if efficacy of one or more of the pesticides does not decrease or if peanut injury does not increase. Published research relative to compatibility of herbicides and fungicides is limited. In recent reviews relative to weed and disease management in peanut (Sherwood *et al.*, 1995; Wilcut *et al.*, 1995), compatibility of herbicides and fungicides was not addressed.

Selective graminicides are often applied in peanut for postemergence grass control (Grichar, 1991a; Wilcut *et al.*, 1995). Clethodim {(*E,E*)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} or sethoxydim {2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} are often applied later in the season to control annual and perennial grasses in peanut (Jordan and York, 2002). Clethodim controls perennial grasses more effectively than sethoxydim while they control annual grasses similarly (Jordan *et al.*, 1997; Jordan and York, 2002). Controlling annual and perennial grasses minimizes interference

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while increasing peanut digging and inversion efficiency.

A variety of broadleaf weeds, yellow nutsedge (*Cyperus esculentus* L.), and purple nutsedge (C. *rotundus* L.) infest peanut fields. Herbicides such as acifluorfen {5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid}, bentazon [3-(1-methylethyl)-(1*H*)-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide], imazapic {(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl)]-5-methyl-3-pyridinecarboxylic acid}, imazethapyr {2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imdazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid}, and 2,4-DB [2,4-(dichlorophenoxy)butanoic acid] are often applied postemergence. Efficacy of postemergence herbicides can be reduced when applied in mixtures with other agrichemicals (Hatzios and Penner, 1985; Grichar, 1991b; Myers and Coble, 1992; York *et al.*, 1993; Jordan, 1995; Corkern *et al.*, 1998; Tredaway *et. al.*, 1998). Although considerable published research exists concerning interactions among herbicides, few experiments have evaluated interactions among herbicides and fungicides.

Postemergence herbicide application can occur many times during the season and is dependant on weed spectrum, time of emergence, and effectiveness of herbicides applied before or at planting. The preharvest interval for clethodim is 40 d prior to peanut inversion (Select product label, Valent USA Corp., Walnut Creek, CA). Acifluorfen (Blazer product label, BASF Corp., Research Triangle Park, NC), bentazon (Basagran product label, BASF Corp., Research Triangle Park, NC), imazethapyr (Pursuit product label, BASF Corp., Research Triangle Park, NC), and 2,4-DB (Butyrac 200 product label, Aventis Crop Science, Research Triangle Park, NC) can be applied up to 75, 75, 85, and 45 d before harvest, respectively.

Fungicides are applied throughout the growing season to control leaf spot (*Cercosporidium personatum* Berk. & M.A. Curtis or *Cercospora arachidicola* Hori), southern stem rot (*Sclerotium rolfsii* Sacc.), Sclerotinia blight (*Sclerotinia minor* Jagger), and several other foliar and soil-borne pathogens in peanut(Bailey, 2002). Fungicidal programs for early leaf spot and southern stem rot are often applied based on 2 wk intervals or weather advisories (Bailey, 2002). Weed infestation and the need to maintain disease control often result in similar timings for herbicide and fungicide application. Determining if these pesticides are compatible could improve efficiency of pest management in peanut. The objective of this research was to determine if fungicides in combination with selected postemergence herbicides reduce weed control and/or increase injury to peanut.

Materials and Methods

Experiments were conducted on sandy loam and loamy sand soils during 1998 through 2001 in North Carolina, during1999 and 2000 in Georgia, and during 2000 and 2001 in Florida and Texas. Plot size was 2 by 5 m in North Carolina, 2 by 6 m in Florida, and 2 by 8 m in Georgia and Texas. Experiments were conducted in fallow areas or within a peanut crop depending upon year, location, and weed species. Georgia Green (Florida and Texas) and NC 12C (North Carolina) were the cultivars grown. All tests in Georgia were conducted in fallow areas. Fallow areas were disked several times and smoothed with a field cultivator 3 to 4 wk prior to test initiation. Natural weed infestations were evaluated at all locations.

Annual grass control. Herbicide and fungicide treatments varied by year, location, and weed species. Treatments in 1998 (two locations in North Carolina) consisted of clethodim applied alone or with chlorothalonil (tetrachloroisophthalonitrile) (Bravo Weather Stik, Syngenta Crop Protection, Greensboro, NC), tebuconazole {a-[2-(4-chlorophenyl)ethyl]- a-(1,1-dimethyl)-1*H*-1,2,4-triazole-1-ethanol} (Folicur, Bayer Crop Science, Kansas City, MO), iprodione [3-(3,5-dichlorophenyl)-*N*-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide] (Rovral, Bayer Crop Science, Kansas City, MO), fluazinam [3-chloro-*N*-(3-chloro-5-trifluoromethyl-2-pyridyl)-2,2,2-trifluoro-2,6-dinitro-*p*-toluidine] (Omega 500, Syngenta Crop Protection, Greensboro, NC), or copper salts of fatty acid resins (Tenn-Cop 5E, Griffin LLC, Valdosta, GA).

Treatments at two locations in North Carolina (1999) and during both years in Georgia (1999 and 2000) were clethodim applied alone or with chlorothalonil (Bravo Weather Stik and Bravo Ultex, Syngenta Crop Protection, Greensboro, NC and Echo, Whitakee Distribution Inc., Virginia Beach, VA), propiconazole{1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1*H*-1,2,4-triazole} (Tilt, Syngenta Crop Protection, Greensboro, NC) plus chlorothalonil (Tilt plus Bravo Weather Stik), tebuconazole, azoxystrobin {methyl (*E*)-2-[2-[6-(2-cyanophenoxy)pyrimidin-4-yloxy]phenyl]-3-methoxyacrylate} (Abound, Syngenta Crop Protection, Greensboro, NC), iprodione, copper hydroxide (metallic copper equivalent 35%) (Kocide, Griffin Corp., LLC, Valdosta, GA), or copper hydroxide plus mancozeb (manganese, zinc, and ethylenebisdithiocarbamte ion) (ManKocide, Griffin Corp., LLC, Valosta, GA). Treatments in North Carolina during 2001 included clethodim applied alone and with chlorothalonil (Bravo Weather Stik and Bravo Ultrex), tebuconazole, propiconazole, propiconazole plus chlorothalonil, and fluazinam.

Treatments in Texas during 2000 and 2001 included clethodim applied alone or with chlorothalonil (Bravo Weather Stik, Bravo Ultrex), tebuconazole, azoxystrobin, iprodione, propiconazole plus chlorothalonil, copper hydroxide, mancozeb (zinc ion and manganese ethylenebisdithiocarbamate) (Dithane F-45, Rohm and Haas Corp., Philadelphia, PA), copper hydroxide plus mancozeb, propiconazole plus trifloxystrobin {benzene acetic acid{(E,E)-alpha-(methoxyimino)-4-[[[[1-3-(trifluoromethyl)phenyl]ethylidene]amino]oxy]methyl]methyl ester}(Stratego, Syngenta Crop Protection, Greensboro, NC), propiconazole plus flutolanil {*N*-[3-(methylethoxy)phenyl]-2-(trifluoromethyl)benzamide}(Montero, Syngenta Crop Protection, Greensboro, NC), or copper salts of fatty acid resins.

Treatments were applied using CO_2-pressurized sprayers using regular flat fan nozzles (Spraying Systems Co., Wheaton, IL) calibrated to deliver 140 L/ha in North Carolina (1998 and 2001) and 184 L/ha in Texas. In 1999 in North Carolina and Georgia, treatments were applied in a spray volume of 94 L/ha using regular flat fan nozzles and at 230 L/ha using hollow cone nozzles (Spraying Systems Co., Wheaton, IL). Crop oil concentrate (Agri-Dex, Helena Chemical Co., Memphis, TN) at 1.0% (v/v) was applied with all treatments. Pesticides and rates in all experiments were clethodim (0.094 kg ai/ha), chlorothalonil (1.26 kg ai/ha), tebuconazole (0.20 kg ai/ha), azoxystrobin (0.44 kg ai/ha), iprodione (1.12 kg ai/ha), fluazinam (0.56 kg ai/ha), propiconazole (0.13 kg ai/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg ai/ha), copper hydroxide (1.26 kg ai/ha), copper hydroxide plus mancozeb (2.06 + 0.67 kg ai/ha), copper salts of fatty acid resins (2.8 kg ai/ha), mancozeb (1.7 kg ai/ha), propiconazole plus trifloxystobin (0.76 + 1.0 kg ai/ha), and propiconazole plus flutolanil (0.76 + 1.0 kg ai/ha).

Weed species in North Carolina during 1998 and 1999 and in Texas during 2000 was large crabgrass [*Digitaria sanguinalis* (L.) Scop.]. Texas panicum (*Panicum texanum* Buckl.) was present in Georgia and Texas (2001). Goosegrass [*Eleusine indica* (L.) Gaertn.] and broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash] were present in separate experiments in North Carolina during 2001. Density for all weeds ranged from 20 to 150 plants/m^2. Weed height at the time of pesticide application ranged from 8 to 20 cm.

Visual estimates of percent weed control were recorded 2 to 3 wk after treatment using a scale of 0 to 100 where 0 = no control and 100 = complete control. Foliar chlorosis, necrosis, and plant stunting were considered when making the visual estimates. Data were subjected to analyses of variance by species when fungicide treatments were similar. Additionally, data from Georgia and North Carolina were subjected to analyses of variance for a two (spray volume) by 10 (fungicide treatment) factorial treatment arrangement. Means of significant main effects and interactions were separated using Fisher's Protected LSD Test at $P \leq 0.05$.

Broadleaf weed/yellow nutsedge control. Combinations of herbicides and fungicides were evaluated in North Carolina and varied by location, year, weed species, and herbicide. Smooth pigweed control by 2,4-DB (Butyrac 200, Aventis Crop Science, Research Triangle Park, NC) alone or in combination with chlorothalonil (Bravo Weather Stik and Bravo Ultrex, Echo), tebuconazole, azoxystrobin, iprodione, fluazinam, chlorothalonil plus propiconazole, copper hydroxide, and copper hydroxide plus mancozeb was evaluated at two fields in 1999 located near Goldsboro, NC. Smooth pigweed control using acifluorfen (Lewiston in 2000 and 2001, Rocky Mount in 2001), imazethapyr (Goldsboro in 2000, Lewiston in 2000 and 2001, Rocky Mount in 2001), and 2,4-DB (Goldsboro in 2000) and yellow nutsedge control using bentazon (Lewiston in 2000 and 2001) were evaluated using the same fungicides. Iprodione, the chlorothalonil formulation Echo, copper salts of fatty acid resins, mancozeb, and propiconazole plus trifloxystrobin were included in 2000. In 2001, smooth pigweed control by imazethapyr at two locations and acifluorfen at one location was evaluated when these herbicides were applied alone or with chlorothalonil (Bravo Weather Stik and Bravo Ultrex), tebuconazole, propiconazole, fluazinam, and chlorothalonil plus propiconazole. Fungicide rates were the same as those applied in the annual grass control experiment. Acifluorfen, bentazon, imazethapyr, and 2,4-DB were applied at 0.38, 1.12, 0.07, and 0.28 kg ai/ha, respectively. Treatments were applied in 140 L/ha with a CO_2-pressurized sprayer using regular flat fan nozzles when smooth pigweed was 50 to 70 cm tall and yellow nutsedge was 10 to 20 cm tall. A nonionic surfactant (Induce, Helena Chemical Co., Memphis, TN) was included at 0.25% (v/v) with all treatments.

Visual estimates of percent weed control were recorded using the scale described for annual grass control. Data were subjected to analyses of variance for each species. Means were separated using Fisher's Protected LSD Test at $P \leq 0.05$.

Peanut Injury. Visual estimates of percent peanut injury 2 wk after application of clethodim and fungicides (Florida in 2000 and 2001 and Texas in 2000) and 4 wk after application (Florida in 2000 and 2001) were recorded using a scale of 0 = no injury to 100 = plant death. Treatments were applied as described previously in North Carolina and Texas. A spray volume of 187 L/ha was used in Florida. Peanut diameter was 18 to 30 cm at the time of application. Additionally, visual estimates of percent peanut injury 4 wk after treatment of acifluorfen, imazethapyr, or 2,4-DB applied alone or with fungicides were recorded in Florida. Visual estimates of percent peanut injury were also recorded 2 wk after treatment in a study conducted in North Carolina in 2000 where acifluorfen, imazethapyr, and 2,4-DB were applied alone or with chlorothalonil (Bravo Weather Stik) or tebuconazole. Pesticide rates and application variables were the same as those described for the weed control experiments. Chlorosis, necrosis, leaf bronzing, and plant stunting were considered when making the visual estimates. Data for these studies were subjected to analyses of variance and means separated using Fisher's Protected LSD test at $P \leq 0.05$.

Results and Discussion

Annual grass control. Variation in response to mixtures of clethodim with fungicides was noted among years, locations, spray volumes, and weed species (Tables 1, 2, and 3). Large crabgrass control with clethodim in North Carolina in 1998 was reduced by chlorothalonil and copper salts of fatty acid resins but was not affected by fluazinam, iprodione, or tebuconazole. At Yoakum, large crabgrass control was lower compared with clethodim alone when applied with either formulation of chlorothalonil, chlorothalonil plus propiconazole, azoxystrobin, and iprodione (Table 1). Texas panicum control at Yoakum in 2001 was reduced by 20% or more when clethodim was applied with chlorothalonil (Bravo Weather Stik and Bravo Ultrex) or chlorothalonil plus propiconazole. Propiconazole plus flutolanil and iprodione also reduced Texas panicum control.

The interaction of location by spray volume by fungi-

Table 1. Large crabgrass and Texas panicum control by clethodim applied alone and in combination with selected fungicides.[a,b]

Fungicide treatment		Control		
		Large crabgrass		Texas panicum
		NC	TX	TX
Common name	Tradename	1998[c]	2000	2001
None	None	96 a	95 ab	93 a
Chlorothalonil	Bravo Weather Stik	81 c	76 d	55 de
Chlorothalonil	Bravo Ultrex	80 cd	73 c	-
Chlorothalonil + propiconazole	Bravo WS plus Tilt	-	76 d	50 e
Tebuconazole	Folicur	92 ab	88 abc	90 ab
Azoxystrobin	Abound	-	83 cd	80 abc
Propiconazole + flutolanil	Tilt plus Montero	-	84 bcd	70 cd
Propiconazole + trifloxystrobin	Tilt plus Stratego	-	84 bcd	86 abc
Mancozeb	Dithane F-45	-	85 bcd	91 a
Iprodione	Rovral	96 a	79 cd	75 bc
Fluazinam	Omega 500	96 a	96 a	90 ab
Copper hydroxide	Kocide	-	94 ab	90 ab
Copper hydroxide + mancozeb	ManKocide	-	88 abc	84 abc
Copper salts of fatty acid resins	Tenn-Cop 5E	21 d	-	-

[a]Pesticide rates: clethodim (0.094 kg/ha), chlorothalonil (1.26 kg/ha), tebuconazole (0.20 kg/ha), azoxystrobin (0.44 kg/ha), iprodione (1.12 kg/ha), fluazinam (0.56 kg/ha), propiconazole (0.13 kg/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg/ha), copper hydroxide (1.26 kg/ha), copper hydroxide plus mancozeb (2.06 + 0.67 kg/ha), copper salts of fatty acid resins (2.8 kg/ha), mancozeb (1.7 kg/ha), propiconazole plus trifloxystrobin (0.76 + 1.0 kg/ha), and propiconazole plus flutolanil (0.76 + 1.0 kg/ha).

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

[c]Data are pooled over two locations.

cide treatment was not significant for large crabgrass control at Lewiston or Rocky Mount in North Carolina during 1999. However, main effects of both spray volume and fungicide treatment were significant. When pooled over locations and fungicide treatments, large crabgrass control by clethodim was reduced from 83% to 78% when spray volume was increased from 94 L/ha to 230 L/ha (data not shown). Previous research suggests that efficacy of graminicides can be lower when applied in higher spray volumes (Buhler and Burnside, 1984; Kells and Wanamarta, 1987; Lassiter and Coble, 1987).

When pooled over spray volumes at Lewiston or Rocky Mount, azoxystrobin and copper-based fungicides (Kocide and ManKocide) reduced large crabgrass control by clethodim when compared to clethodim applied alone (Table 2). Additionally, chlorothalonil (Bravo Ultrex but not Bravo Weather Stik or Echo) reduced efficacy at both locations. Iprodione reduced efficacy at Rocky Mount but not at Lewiston. Chlorothanlonil reduced efficacy of clethodim regardless of formulation or when chlorothalonil was applied with propiconazole at Rocky Mount.

The interaction of year by spray volume by fungicide treatment was significant for Texas panicum control in Georgia. All chlorothalonil formulations in Georgia reduced Texas panicum control compared with clethodim alone, with the exception of Bravo Ultrex at 94 L/ha in 1999 and Echo at 94 L/ha in 2000 (Table 2). Lassiter and Coble (1987) reported that bentazon reduced efficacy of sethoxydim to a greater extent when herbicides were applied sequentially in a spray volume of 374 L/ha rather than 94 L/ha. Efficacy of clethodim applied with pyrithiobac [sodium 2-chloro-(4,5-dimethoxypyrimidin-2-ylthio)benzoate] was lower when applied in 140 L/ha compared with 26 L/ha (Tredaway *et al.*, 1998). Both copper-based fungicides reduced control, with the greatest reduction noted when spray volume was increased. As was noted for large crabgrass, tebuconazole did not reduce Texas panicum control in Georgia (Tables 1 and 2).

Broadleaf signalgrass control by clethodim was not affected by any of the fungicide treatments in North Carolina in 2001 (Table 3). In contrast, goosegrass control by clethodim plus chlorothalonil-containing treatments (Bravo Weather Stik, Bravo Ultrex, chlorothalonil plus propiconazole) was reduced when compared with clethodim applied alone (Table 3). However, when applied with tebuconazole, propiconazole, or fluazinam, efficacy of clethodim was not affected. Previous research (Jordan, 1995) suggests that antagonism of graminicides by broadleaf herbicides can vary depending on the herbicide and weed species.

When comparing across years, locations, weed species, and spray volumes, annual grass control by clethodim was reduced in 80, 69, 60, and 46% of the comparisons when applied with copper-based fungicides (Kocide, ManKocide, Tenn-Cop 5E), fungicides containing chlorothalonil (Bravo Weather Stik, Bravo Ultrex, Bravo Weather Stik plus Tilt, Echo), azoxystrobin (Abound), and iprodione (Rovral), respectively (data not presented). Although not evaluated extensively in these studies, propiconazole plus flutolanil (Tilt plus Montero) also reduced efficacy of clethodim (Table 1). Fluazinam (Omega 500), tebuconazole (Folicur), and propiconazole (Tilt) did not reduce efficacy of clethodim in these experiments.

Broadleaf weed/yellow nutsedge control. The copper-based fungicides reduced efficacy of imazethapyr on smooth pigweed in Goldsboro and Lewiston in 2000, with the exception of copper salts of fatty acid resins at Lewiston (Table 4). Fluazinam also reduced control in Lewiston in 2000. Tebuconazole and the copper-based fungicide ManKocide reduced smooth pigweed control by acifluorfen at Lewiston in 2000 compared with

Table 2. Large crabgrass and Texas panicum control by clethodim alone and with selected fungicides applied in two spray volumes.[a]

Fungicide treatment		Control					
		Large crabgrass North Carolina[b]		Texas panicum, Georgia[c] Spray volume			
				94 L/ha	230 L/ha	94 L/ha	230 L/ha
Common name	Tradename	Lewiston	Rocky Mt	1999		2000	
		%					
None	None	88 a	97 a	94 ab	91 abc	99 a	95 abc
Chlorothalonil	Echo	84 ab	84 bcd	87 c	80 de	94 abc	85 d
Chlorothalonil	Bravo Weather Stik	82 ab	76 e	80 de	75 e	89 bcd	70 e
Chlorothalonil	Bravo Ultrex	79 b	76 e	92 abc	37 g	90 bcd	47 f
Chlorothalonil + propiconazole	Bravo Weather Stik plus Tilt	86 ab	78 de	90 bc	86 c	95 abc	87 cd
Tebuconazole	Folicur	86 a	90 ab	97 a	91 abc	99 a	95 abc
Azoxystrobin	Abound	79 b	74 e	95 ab	86 c	99 a	94 abc
Iprodione	Rovral	84 ab	86 bc	92 abc	86 c	99 a	96 ab
Copper hydroxide	Kocide	60 c	79 cde	47 f	20 i	84 d	30 g
Copper hydroxide + mancozeb	ManKocide	56 c	79 cde	52 f	27 h	50 f	28 g

[a]Pesticide rates: clethodim (0.094 kg/ha), chlorothalonil (1.26 kg/ha), tebuconazole (0.20 kg/ha), azoxystrobin (0.44 kg/ha), iprodione (1.12 kg/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg/ha), copper hydroxide (1.26 kg/ha), and copper hydroxide plus mancozeb (2.06 + 0.67 kg/ha).
[b]Means within a location followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$. Data are pooled over spray volumes of 94 and 230 L/ha at each location.
[c]Means within a year followed by the same letter are not significantly different according to Fisher's Protected LSD Test at $P \leq 0.05$.

acifluorfen alone. Acifluorfen in combination with chlorothalonil-containing fungicides, azoxystrobin, propiconazole, and fluazinam did not reduce efficacy.

Yellow nutsedge control by bentazon was reduced when applied with propiconazole plus flutolanil and copper-based fungicides in 2000 and with chlorothalonil plus propiconazole in 2001 (Table 5). Tebuconazole, azoxystrobin, propiconazole, propiconazole plus trifloxystrobin, and fluazinam did not reduce efficacy of bentazon in any year tested. Smooth pigweed control by 2,4-DB was reduced by all fungicide treatments except chlorothalonil alone and iprodione in 1999. In contrast, only the copper-based fungicide ManKocide reduced control compared with 2,4-DB alone in 2000.

Peanut injury. Chlorothalonil (Bravo Weather Stik, Bravo Ultrex), chlorothalonil plus propiconazole, propiconazole plus flutolanil, propiconazole plus trifloxystrobin, tebuconazole, azoxystrobin, and copper-based fungicides did not increase injury from acifluorfen, imazethapyr, or 2,4-DB compared with herbicides alone in experiments conducted in Florida (data not shown). In the study conducted in North Carolina, injury by acifluorfen or 2,4-DB plus chlorothalonil or tebuconazole was not increased over those herbicides applied alone (data not shown). In both studies, peanut injury was 15% or less regardless of the herbicide and fungicide combination.

In Texas, injury from fluazinam plus clethodim was

Table 3. Broadleaf signalgrass and goosegrass control by clethodim applied alone and in combination with selected fungicides.[a,b]

Fungicide treatment		Control	
Common name	Tradename	Broadleaf signal-grass[c]	Goose-grass[d]
		%	
None	None	100 a	97 a
Chlorothalonil	Bravo Weather Stik	98 a	83 b
Chlorothalonil	Bravo Ultrex	100 a	83 b
Chlorothalonil + propiconazole	Bravo Weather Stik plus Tilt	97 a	85 b
Tebuconazole	Folicur	100 a	96 a
Propiconazole	Tilt	100 a	95 a
Fluazinam	Omega 500	100 a	94 a

[a]Pesticide rates: clethodim (0.094 kg/ha), chlorothalonil (1.26 kg/ha), tebuconazole (0.20 kg/ha), fluazinam (0.56 kg/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg/ha).
[b]Means within a species followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$.
[c]Data are pooled over two locations in NC during 2001.
[d]Data are from one location in North Carolina during 2001.

Table 4. Smooth pigweed control by selected postemergence herbicides applied alone and with selected fungicides.[a,b]

Fungicide treatment		Control						
		Imazethapyr				Acifluorfen		
		Goldsboro	Lewiston	Rocky Mt.	Lewiston	Lewiston		Rocky Mt.
Common name	Tradename	2000	2000	2001	2001	2000	2001	2001
		----------	----------	%	----------	----------	%	----------
None	None	70 a	75 abc	68 a	100 a	58 a	40 a	83 a
Chlorothalonil	Bravo Weather Stik	70 a	72 abc	72 a	100 a	55 ab	47 a	83 a
Chlorothalonil	Bravo Ultrex	80 a	58 bc	65 a	100 a	45 abc	47 a	97 a
Chlorothalonil + propiconazole	Bravo Weather Stik + Tilt	85 a	78 ab	78 a	100 a	40 abc	52 a	89 a
Tebuconazole	Folicur	70 a	68 abc	72 a	100 a	37 bc	48 a	80 a
Azoxystrobin	Abound	70 a	68 abc	-	40 abc	-	-	-
Propiconazole	Tilt	-	-	77 a	100 a	-	-	97 a
Propiconazole + flutolanil	Tilt + Montero	70 a	63 abc	-	-	-	-	-
Propiconazole + trifloxystrobin	Tilt + Stratego	70 a	72 abc	-	-	-	-	-
Mancozeb	Dithane F-45	68 a	80 a	-	-	-	-	-
Fluazinam	Omega 500	70 a	57 c	73 a	100 a	50 ab	48 a	92 a
Copper hydroxide	Kocide	40 b	17 d	-	-	40 abc	-	-
Copper hydroxide + mancozeb	ManKocide	13 c	17 d	-	-	30 c	-	-
Copper salts of fatty acid resins	Tenn-Cop 5E	0 c	62 abc	-	-	48 abc	-	-

[a]Pesticide rates: imazethapyr (0.071 kg/ha), acifluorfen (0.38 kg/ha), chlorothalonil (1.26 kg/ha), tebuconazole (0.20 kg/ha), azoxystrobin (0.44 kg/ha), fluazinam (0.56 kg/ha), propiconazole (0.13 kg/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg/ha), copper hydroxide (1.26 kg/ha), copper hydroxide plus mancozeb (2.06 + 0.67 kg/ha), copper salts of fatty acid resins (2.8 kg/ha), mancozeb (1.7 kg/ha), propiconazole plus trifloxystrobin (0.76 + 1.0 kg/ha), and propiconazole plus flutolanil (0.76 + 1.0 kg/ha).

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

21% and exceeded that by clethodim alone (data not shown). Chlorothalonil (Bravo Weather Stik, Bravo Ultrex, propiconazole plus Bravo Weather Stik) injured peanut 8 to 9% when applied with clethodim as compared to 3% when clethodim was applied alone (data not shown). Azoxystrobin, tebuconazole, propiconazole plus flutolanil, propiconazole plus trifloxystrobin, mancozeb, fluazinam, and copper-based fungicides did not increase injury by clethodim (data not shown). Additional research is needed to determine if these differences in peanut injury affect peanut yield under weed-free conditions.

Collectively, data from these experiments suggest that growers should consider carefully the potential for decreased weed control when applying herbicides and fungicides in tank mixtures. In particular, copper-based fungicides were the most detrimental to herbicide efficacy when compared across herbicides and weed species. Although chlorothalonil-containing fungicides reduced efficacy of clethodim and 2,4-DB, they did not affect efficacy of acifluorfen, bentazon, and imazethapyr in most instances. Of the fungicides evaluated in these experiments, fluazinam and tebuconazole were compatible with most herbicides.

These studies addressed interactions among herbicides and fungicides relative to weed control. Additional research is needed to address these interactions relative to disease control. Growers should also consider recommendations relative to adjuvant selection and spray volume when deciding if herbicides and fungicides should be applied in tank mixtures.

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Table 5. Yellow nutsedge at Lewiston and smooth pigweed at Goldsboro by selected postemergence herbicides applied alone and with selected fungicides.[a,b]

Fungicide treatment		Control			
		Yellow nutsedge		Smooth pigweed	
		Bentazon		2,4-DB	
Common name	Tradename	2000	2001	1999	2000
		%			
None	None	55 abc	72 ab	63 a	40 ab
Chlorothalonil	Echo	-	62 a	-	-
Chlorothalonil	Bravo Weather Stik	45 b-e	68 abc	47 bc	43 a
Chlorothalonil	Bravo Ultrex	42 cde	78 a	40 cd	35 ab
Chlorothalonil + propiconazole	Bravo Weather Stik + Tilt	57 abc	55 c	42 bcd	43 a
Tebuconazole	Folicur	52 a-d	70 ab	45 bc	40 ab
Azoxystrobin	Abound	69 a	-	35 cd	45 a
Propiconazole	Tilt	-	63 bc	-	-
Propiconazole + flutolanil	Tilt + Montero	35 de	-	-	45 a
Propiconazole + trifloxystrobin	Tilt + Stratego	60 ab	-	-	37 ab
Mancozeb	Dithane F-45	50 a-d	-	-	47 a
Iprodione	Rovral	-	-	55 ab	-
Fluazinam	Omega 500	50 a-d	65 abc	47 bc	47 a
Copper hydroxide	Kocide	30e	-	28 d	23 bc
Copper hydroxide + mancozeb	ManKocide	35 de	-	29 d	8 cd
Copper salts of fatty acid resins	Tenn-Cop	28 e	-	-	45 a

[a]Pesticide rates: imazethapyr (0.071 kg/ha), acifluorfen (0.38 kg/ha), chlorothalonil (1.26 kg/ha), tebuconazole (0.20 kg/ha), azoxystrobin (0.44 kg/ha), iprodione (1.12 kg/ha), fluazinam (0.56 kg/ha), propiconazole (0.13 kg/ha), chlorothalonil plus propiconazole (0.84 + 0.063 kg/ha), copper hydroxide (1.26 kg/ha), copper hydroxide plus mancozeb (2.06 + 0.67 kg/ha), copper salts of fatty acid resins (2.8 kg/ha), mancozeb (1.7 kg/ha), propiconazole plus trifloxystrobin (0.76 + 1.0 kg/ha), and propiconazole plus flutolanil (0.76 + 1.0 kg/ha).
[b]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$.
[c]Data are pooled over two locations in 1999.

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