Chapter VII

Wheat (*Triticum aestivum*) Cultivar Tolerance to AE F130060 03

Abstract: Greenhouse and field experiments were conducted under weed-free conditions in 2000 and 2001 to investigate the responses of ten soft red winter wheat cultivars to POST applications of the experimental herbicide AE F130060 03 applied at 15 g ai/ha with the crop safener AE F107892 at 30 g ai/ha. AE F130060 03 injured wheat 7 to 12% and reduced height 11 to 14% at 3 WAT across all cultivars but did not reduce biomass of any cultivar in the greenhouse. In field experiments, AE F130060 03 injured wheat 11 to 32%, reduced tiller number of all cultivars except Roane, Coker 9663, and VA98W-593, and reduced height of all cultivars except USG 3209 and VA98W-593 at 3 WAT. By 9 WAT, tiller number and height of treated wheat was similar to nontreated wheat. AE F130060 03 did not influence moisture content or kernel weight of any cultivar. Although yields of treated wheat were at least 81% of yields of nontreated wheat in either year, reductions in grain yield due to AE F130060 03 application occurred in FFR 518 and Coker 9663 in 2000 and AgriPro Patton and VA98W-593 in 2001.

Nomenclature: AE F130060 03 {8.3:1.7 mixture of AE F130060 00, proposed common name mesosulfuron-methyl, 2-[(4,6-dimethoxypyrimidin-2-*yl* carbamoyl)sulfamoyl]-4-methanesulfonamido)-*p*-toluic acid, plus AE F115008 00, proposed common name iodosulfuron-methyl-sodium, 4-iodo-2-[3-(4-methoxy-6-methyl-1,3,5-triazin-2-*yl*)ureidosulfonyl]benzoic acid}; AE F107892, proposed common name mefenpyr diethyl, 1-(2,4-dichlorophenyl)-4,5-dihydro-5-methyl-1*H*-pyrazole-3,5-dicarboxylic acid; diclofop-methyl; Italian ryegrass, *Lolium multiflorum* Lam.

LOLMU #[29]; winter wheat, *Triticum aestivum* L. 'AgriPro Patton', 'AGS 2000', 'Coker 9663', 'FFR 518', 'Pioneer 2643', 'Pioneer 26R24', 'Roane', 'Sisson (VA96W-250)', 'USG 3209', 'VA98W-593'.

Additional index words: differential cultivar response.

Abbreviations: POST, postemergence; WAP, wk after planting; WAT, wk after treatment.

INTRODUCTION

Crop cultivars may exhibit differential responses to herbicides. In order for an herbicide to be adopted by producers, crop tolerance must be established and the potential for increased sensitivity to an herbicide on certain crop cultivars must be defined. In vegetable crops, sweet corn (*Zea mays* L.) cultivars respond differently to chloroacetamide and thiocarbamate herbicides (Bennett and Gorski 1989). Motsenbocker and Monaco (1993) observed season-long injury and yield reductions in five of six sweet potato (*Ipomoea batatas* L.) clones treated with metribuzin. In tomato, differential tolerance to metribuzin was seen between 'Fireball' and 'Heinz 1706' (Stephenson et al. 1976). Broccoli cultivars 'Pinnacle' and 'Mercedes' were most tolerant to preemergence applications of oxyfluorfen, while 'Embassy' and 'Early Dawn' were the least tolerant (Harrison and Farnham 2001). In pepper, tolerance to bentazon was found in 'Bohemian Chile' hot pepper while other cultivars were sensitive (Baltazar and Monaco 1984).

In agronomic crops such as field corn, Green (1998) reported that 'GA209' was sensitive to bentazon and four sulfonylurea herbicides. Eberlein et al. (1989) found that corn cultivars 'A619', 'A641', and 'ND246' were highly

[29]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.

sensitive to the experimental sulfonylurea herbicide DPX-M6316 while ‘A671’, ‘A632’, and ‘B73’ were highly tolerant. In peanut research, ‘Early Bunch’ and ‘Southern Runner’ peanut cultivars were reported to exhibit greater sensitivity to paraquat than ‘Florunner’ (Brecke 1989). In contrast, Wehtje et al. (1991) reported no difference in response by Florunner, NC 7, Southern Runner, or ‘Sunrunner’ to paraquat while Bailey et al. (2000) found no differential response of eight Virginia-type peanut cultivars to diclosulam.

Differential cultivar tolerance to herbicides has also been observed in winter wheat. Shaw and Wesley (1991) found greatest early-season wheat injury from BAY SMY 1500, an ethylthio analog of metribuzin (Shaw et al. 1996), in soft red winter wheat cultivars ‘Pioneer 2551’ and ‘Coker 983’. However, increased injury did not translate into reductions in grain yield. Baker and Peeper (1990) found differential patterns of response to BAY SMY 1500 and cyanazine between hard red winter wheat cultivars. Of 15 hard red winter wheat cultivars treated with metribuzin, ‘Lindon’ and ‘Vona’ were the most sensitive while ‘TAM W 101’ and ‘Osage’ were the most tolerant (Runyan et al. 1982). In soft red winter wheat, Shroeder et al. (1985) found significant yield reductions in eight wheat cultivars treated with metribuzin at 0.6 or 1.1 kg ai/ha, but no yield reduction in any of the cultivars treated with metribuzin at 0.3 kg/ha.

Italian ryegrass (*Lolium multiflorum* Lam.) is a major production concern for U. S. winter wheat growers. Although diclofop-methyl has controlled Italian ryegrass, repeated use of this herbicide has selected Italian ryegrass biotypes that are resistant to diclofop-methyl and other herbicides with similar modes-of-action. AE F130060 03 is an 8.3:1.7 mixture of the two experimental sulfonylurea herbicides AE F130060 00 and AE F115008 00. AE F130060 00 (proposed common name mesosulfuron-methyl) has activity primarily against monocotyledonous weed species while AE F115008 00 (proposed common name iodosulfuron-methyl-sodium) acts primarily against dicotyledonous weed species

(Anonymous 2002a; Anonymous 2002b). Postemergence (POST) applications of this sulfonylurea mixture at 15 to 18 g ai/ha have controlled Italian ryegrass and several winter annual dicotyledonous weed species and can be applied to wheat when used with the crop safener and adjuvant AE F107892 (proposed common name mefenpyr diethyl) (Anderson et al. 2002; Bailey et al. 2002; Crooks et al. 2002; Hand et al. 2002). AE F107892 was developed in 1993 as a crop safener for fenoxaprop-P-ethyl, but is also an effective safener for certain other chemical classes (Hopkins 1997).

Although AE F107892 substantially reduces the sensitivity of winter wheat to AE F130060 03, early-season wheat injury has still been observed (Bailey et al. 2002). These observations raised the question of whether soft red winter wheat cultivars differ in their response to AE F130060 03. Therefore, the objective of this research was to investigate responses of selected soft red winter wheat cultivars to POST applications of AE F130060 03.

MATERIALS AND METHODS

Greenhouse Experiments

Greenhouse experiments were conducted at the Glade Road Research Facility in Blacksburg, VA in 2000 and 2001. Ten seed of each of ten soft red winter wheat cultivars were sown 0.8 cm deep in 10- by 10-cm square pots filled with growth medium[30]. Seedlings were watered daily and fertilized weekly with water-soluble fertilizer[31] and maintained under natural lighting for the duration of the experiment.

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[30]Metro-Mix 500, Scotts-Sierra Horticultural Products Co., Marysville, OH 43040.

[31]Peters Professional General Purpose 20-20-20. Scotts-Sierra Horticultural Products Company, 14111 Scottslawn Rd., Marysville, OH 43041.

[6]Allen Machine Works. 607 E. Miller Road, Midland, MI 48640.

A two (treatment) by ten (winter wheat cultivar) factorial experiment was used to investigate possible differential response to AE F130060 03 in the wheat cultivars. Treatments included AE F130060 03 at 15 g/ha plus AE F107892 at 30 g ai/ha or nontreated. Wheat cultivars included Roane, Sisson (VA96W-250), FFR 518, USG 3209, AgriPro Patton, AGS 2000, Coker 9663, Pioneer 2643, Pioneer 26R24, or VA98W-593. These ten cultivars are highly adapted to the coastal plain region of Virginia and are ranked among the top yielding cultivars in Virginia Tech wheat performance trials (Brann et al. 2000). AE F130060 03 was applied POST to each cultivar at the three- to four-leaf stage using a moving-nozzle research spray cabinet[6] containing a single flat-fan nozzle tip[7] that delivered 237 L/ha of spray solution at 269 kPa. Average plant height/pot and visual observations of percent mortality were recorded 3 wk after treatment (WAT). At 5 WAT, plant material from each pot was harvested at soil level, dried for 72 h, and weighed. The greenhouse experiment included six replications of treatments and was conducted four times.

Field Experiments

Field experiments were also conducted at the Eastern Shore Agricultural Research and Extension Center in 2000 and 2001. The soil type was a Bojac sandy loam (coarse-loamy, mixed, thermic Typic hapludult) with pH 6.3 and <1.0 % organic matter in both years. A conventional seedbed was prepared in each year by moldboard plowing and tandem disking two to three times. Final seedbeds were prepared shortly before planting using a field cultivator with double rolling baskets and S-tine harrows set at a 6-cm depth.

Seed of all wheat cultivars were planted at 72 seed/m row and 3.2 cm deep on October 20, 2000 and October 23, 2001 using a cone-type grain drill equipped with disk openers and press wheels on 18-cm row spacing. Each plot consisted

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[7]Spraying Systems Co. P. O. Box 7900, Wheaton, IL 60189.

of seven rows that were 6.1 m long. The experimental design was a randomized complete block with three replications of treatments and a two (herbicide treatment) by 10 (wheat cultivar) factorial arrangement of treatments. Each cultivar either received AE F130060 03 at 15 g/ha plus AE F107892 at 30 g/ha or remained nontreated. Wheat cultivars used were the same as those used in greenhouse experiments.

AE F130060 03 applications were made POST to one-tiller wheat on November 20, 2000 and November 27, 2001. For additional weed control, a prepackaged mixture[8] of thifensulfuron-methyl plus tribenuron-methyl (2:1 by wt.) was applied at 47 g ai/ha to all plots on January 22, 2000 and December 14, 2001. Wheat was visually evaluated for injury at 3 WAT with AE F130060 03 and again late-season 2 wk prior to wheat harvest. Wheat injury was rated using a 0 to 100% scale where 0 = no visible wheat injury and 100 = complete wheat death (Frans et al. 1986).

To further quantify wheat response to AE F130060 03, tillers were counted and heights were measured from six wheat plants in each plot at 3 and 9 WAT. Mean tiller number and height for the six plants evaluated in each plot were used for analysis. Wheat grain from all plots was harvested at maturity on June 21, 2000 and June 11, 2001 using a small plot combine and all yields were adjusted to 13.5% moisture. In 2001, one grain sample of approximately 100 g was collected from each plot during harvest, weighed, dried for two wk, and weighed again to determine percent moisture in harvested grain. Weight per 1000 kernels was also measured for each plot in 2001. Sub-economic thresholds of powdery mildew (*Erysiphe graminis* DC. f. sp. *tritici* Em. Marchal) were prevalent in 2000 and an evaluation of powdery mildew incidence was made in order to identify any possible correlation between AE F130060 03 application

[8]Harmony Extra herbicide. E. I. DuPont de Nemours and Company. Agricultural Enterprise. Walker’s Mill, Banley Mill Plaza. Wilmington, DE 19898-0038.

and increased incidence of powdery mildew. Powdery mildew incidence was evaluated on the basis of presence or absence and severity was evaluated on a 1 to 10 scale where 10 = most severe. Following powdery mildew evaluation, propiconazole[32] at 670 g ai/ha was applied to all plots for control of powdery mildew.

All data were subjected to factorial analyses of variance in SAS[33] with sums of squares partitioned to reflect the factorial treatment design. Factors subjected to analysis in all experiments were wheat cultivar, herbicide treatment, and the interactions thereof. Separation of appropriate means is based on Fisher's protected LSD at P=0.05. Sufficient homogeneity of data was found between all data from greenhouse experiments; therefore, greenhouse data were averaged over experiments. Tillering and height data from field experiments were averaged over years. Year by cultivar by treatment interaction occurred for wheat injury and yield data, however, so these data are presented by year. Analysis of data residual plots indicated heterogeneity of variance among wheat injury data, so these data were arcsine transformed prior to analysis. Mean separation for wheat injury is based on transformed data, although nontransformed means are presented for clarity.

RESULTS AND DISCUSSION

Greenhouse Experiments

AE F130060 03 injured all wheat cultivars 7 to 12% 3 WAT. Injury levels were similar among all cultivars (data not presented). Similarly, wheat height was reduced 11 to 14% 3 WAT but did not differ between cultivars (data not

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[9]Tilt fungicide. Syngenta Crop Protection. 410 Swing Road. Greensboro, NC 27409.

[10]Statistical Analysis Systems (SAS) software, Version 7.0, SAS Institute, Inc., Box 8000, SAS Circle, Cary, NC 27513.

presented). Wheat biomass production was influenced only by wheat cultivar. Wheat biomass production ranged from 1.34 to 1.65 g across all cultivars regardless of AE F130060 03 application (Table 7.1).

Field Experiments

Wheat injury. AE F130060 03 application to wheat cultivars resulted in 18% to 32% injury 3 WAT in 2000. Injury symptoms were similar across all cultivars in both years, and were displayed as a general stunting with some foliar discoloration (purpling), particularly when colder temperatures occurred at the time of and just after application in 2000. Air temperature at the time of application was 2 C in 2000 and 15 C in 2001. In 2000, greatest injury generally occurred in USG 3209 (32%) while the least injury was seen in AgriPro Patton (18%) (Table 7.2). In 2001, injury ranged from 11% in Roane to 24% in AgriPro Patton at 3 WAT.

Wheat tillering, height, and powdery mildew incidence. Stunting injury seen from AE F130060 03 applications was also reflected in delayed tillering in most wheat cultivars 3 WAT. Wheat tiller number at 3 WAT was influenced by wheat cultivar and AE F130060 03. In wheat treated with AE F130060 03, tillers per plant ranged from 1.0 to 1.7 while nontreated wheat had 1.7 to 2.4 tillers per plant (Table 2). Significant reductions in tillering due to AE F130060 03 application occurred in all cultivars except Roane, Coker 9663, and VA98W-593. By 9 WAT, however, tillering of treated wheat was similar to tillering of nontreated wheat in all cultivars (data not presented).

Wheat height at 3 WAT was also influenced by wheat cultivar and AE F130060 03 application. AE F130060 03 injury resulted in significant decreases in plant height at 3 WAT in all cultivars except USG 3209 and VA98W-593. Mean height of all cultivars treated with AE F130060 03 ranged from 9.8 to 14.8 cm while height of nontreated wheat ranged from 16.9 to 23.9 cm (Table 7.2). As observed with regard wheat tillering patterns, height of wheat treated with AE F130060 03 was similar to height of nontreated wheat by 9 WAT.

Where powdery mildew occurred in 2000, powdery mildew incidence and severity was only influenced by wheat cultivar. Powdery mildew incidence was seen in all cultivars. Powdery mildew severity was lowest in Roane, AgriPro Patton, Pioneer 2643, and USG 3209 (data not presented). Roane, Pioneer 2643, and USG 3209 have relatively high resistance to powdery mildew while AgriPro Patton has moderate powdery mildew resistance (Brann et al. 2000).

Wheat yield. Wheat yield was influenced by wheat cultivar and AE F130060 03 application in 2000. Yield of nontreated wheat ranged from 6500 to 8120 kg/ha (Table 7.3). In most cultivars, yields of wheat treated with AE F130060 03 were comparable to nontreated wheat. All cultivars except Roane and Coker 9663 produced yields that exceeded 7100 kg/ha. In general, highest yields of nontreated wheat occurred in Sisson (VA96W-250) and VA98W-593. However, significant reductions in yield due to AE F130060 03 treatment occurred in FFR 518 and Coker 9663. Although significant reductions in yield occurred in these cultivars, yields of AE F130060 03-treated cultivars were at least 81% of their respective nontreated controls in 2000.

Due to lower rainfall following planting in 2001 as compared to 2000, yields of all cultivars were lower in 2001 than in 2000. Wheat yields in 2001 were also influenced by wheat cultivar and AE F130060 03 application. In 2001, nontreated wheat produced grain yields of 4040 to 7140 kg/ha (Table 7.4). All cultivars except Roane, FFR 518 and Coker 9663 produced at least 5000 kg/ha. Similar to yields in 2000, Roane and Coker 9663 were two of the lower yielding cultivars regardless of AE F130060 03 treatment. Yields of two wheat cultivars (AgriPro Patton and VA98W-593) were also reduced by AE F130060 03 treatment in 2001. Regardless of AE F130060 03 treatment, however, any wheat cultivar treated with AE F130060 03 produced yields that were at least 88% of their respective nontreated controls. Although yields were not significantly reduced in FFR 518 treated with AE F130060 in 2001, yields of treated FFR 518 were 88% of the yields of nontreated FFR 518. Unlike yield reductions seen in 2000, yield of treated Coker 9663 was 101% of nontreated Coker 9663.

Percent moisture and kernel weight. Although relatively minor yield reductions due to AE F130060 03 treatment occurred in FFR 518 and Coker 9663 in 2000 and AgriPro Patton and VA96W-250 in 2001, differences in percent moisture due to delays in maturity did not occur due to application of AE F130060 03 to any cultivar in 2001. Moisture content of wheat cultivars ranged from 8.4 to 10.1% regardless of AE F130060 03 application (Table 7.4). Lowest moisture content of nontreated wheat occurred in FFR 518 and Pioneer 2643 while highest moisture content was in VA96W-593.

Also, kernel weight of any wheat cultivar was not influenced by AE F130060 03 treatment. Weight of 1000 kernels ranged from 31.5 to 44.7 g across all cultivars (Table 7.4).

Biomass production was not reduced due to AE F130060 03 application in greenhouse experiments but yield reductions were present in certain cultivars in field experiments. Although yields of wheat treated with AE F130060 03 were reduced in FFR 518 and Coker 9663 in 2000 and AgriPro Patton and VA98W-593 in 2001, yields of wheat treated with AE F130060 03 were at least 81% of nontreated wheat yields in any cultivar in either year. In research conducted under weedy conditions with high infestations of Italian ryegrass, yield of wheat treated with AE F130060 03 was increased 116% above yield of nontreated wheat (Bailey et al. 2002). Although yield reductions occurred on certain wheat cultivars under weed-free conditions, the benefits derived from AE F130060 03 application under conditions of Italian ryegrass infestation could more than compensate for any potential reduction in wheat yield associated with AE F130060 03 application.

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Table 7.1. Influence of AE F130060 03 application on biomass production of winter wheat cultivars in the greenhouse.

Winter wheat cultivar	Wheat biomass production[ab]
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Roane	1.50 cd
Sisson (VA96W-250)	1.42 def
FFR 518	1.52 bc
USG 3209	1.34 f
AgriPro Patton	1.61 ab
AGS 2000	1.65 a
Coker 9663	1.43 de
Pioneer 2643	1.34 ef
Pioneer 26R24	1.55 bc
VA98W-593	1.40 ef

[a]Data are the means of four repetitions with six treatment replications per experiment. Data are pooled over experiments and herbicide treatments (AE F130060 03 vs. no AE F130060 03).

[b]Means followed by the same letter are not significantly different according to Fisher's protected LSD at P=0.05.

Table 7.2. Influence of AE F130060 03 treatment and winter wheat cultivar on wheat injury, tillering, and plant height in field experiments.

Winter wheat cultivar	Wheat					
	Injury[a]		Tillering[ab]		Height[ab]	
	2000	2001	Treated	Nontreated	Treated	Nontreated
	%		tillers/plant		cm	
Roane	21 de	11 c	1.0 cA	1.7 cA	12.9 abcB	18.8 bcdA
Sisson (VA96W-250)	21 de	23 a	1.3 abcB	2.1 abcA	12.3 abcB	22.3 abA
FFR 518	28 ab	15 bc	1.5 abB	2.3 aA	14.5 aB	23.9 aA
USG 3209	32 a	18 ab	1.0 cB	2.0 abcA	12.4 abcA	18.3 cdA
AgriPro Patton	18 e	24 a	1.3 abcB	2.4 aA	9.8 cB	19.3 bcdA
AGS 2000	24 bcd	20 ab	1.3 abcB	2.2 abA	14.3 abB	20.1 bcA
Coker 9663	21 de	13 bc	1.3 abcA	1.8 bcA	11.2 bcB	16.2 dA
Pioneer 2643	23 cd	17 abc	1.2 bcB	2.2 abA	12.9 abcB	19.7 bcdA
Pioneer 26R24	19 e	17 abc	1.1 bcB	2.0 abcA	11.9 abcB	20.5 abcA
VA98W-593	28 abc	17 abc	1.7 aA	2.1 abcA	14.8 aA	16.9 cdA

[a]Means within a column followed by the same lowercase letter do not significantly differ according to Fisher's protected LSD at P=0.05. Comparison of means within a wheat cultivar and data parameter followed by the same letter do no significantly differ according to Fisher's protected LSD at P=0.05.

[b]Wheat tillering and height data collected 3 wk after treatment and are the means of six subsamples/plot averaged over years.

Table 7.3. Influence of AE F130060 03 treatment and winter wheat cultivar on wheat grain yield in 2000.

Winter wheat cultivar	Wheat yield[a] Nontreated	Wheat yield[a] Treated	Percent of nontreated yield[b]
	kg/ha	kg/ha	%
Roane	6640 cdA	6310 cA	95 bcd
Sisson (VA96W-250)	8120 aA	7910 aA	97 abc
FFR 518	7600 abA	6700 bcB	88 cde
USG 3209	7820 abA	7740 aA	99 ab
AgriPro Patton	7490 abcA	7860 aA	105 a
AGS 2000	7800 abA	7580 aA	97 abc
Coker 9663	6500 dA	5230 dB	81 e
Pioneer 2643	7130 bcdA	6210 cA	87 de
Pioneer 26R24	7490 abcA	7420 abA	99 ab
VA98W-593	8020 abA	7470 aA	93 bcd

[a]Means followed by the same lowercase letter within a column do not differ according to Fisher's protected LSD at P=0.05. Means of nontreated vs. treated yield followed by the same uppercase letter within a cultivar do not differ according to Fisher's protected LSD test at P=0.05.

[b]Treated wheat yield expressed as a percentage of nontreated wheat yield.

Table 7.4. Influence of AE F130060 03 treatment and winter wheat cultivar on wheat grain yield, moisture, and kernel weight in 2001.

Winter wheat cultivar	Wheat yield[a] Nontreated	Wheat yield[a] Treated	Percent of nontreated yield[b]	Moisture[c]	Kernel weight[c]
	kg/ha	kg/ha	%	%	g/1000 kernels
Roane	4850 deA	4490 dA	92 ab	9.6 b	31.5 f
Sisson (VA96W-250)	6400 abA	6260 aA	98 ab	9.2 c	39.0 bc
FFR 518	4040 fA	3560 eA	88 b	8.4 f	37.0 cde
USG 3209	6170 bcA	5780 abA	94 ab	9.2 c	40.5 b
AgriPro Patton	5230 deA	4600 cdB	88 b	9.3 bc	38.0 cd
AGS 2000	5060 deA	5200 bcA	103 a	9.2 c	44.7 a
Coker 9663	4540 efA	4570 cdA	101 ab	9.3 bc	35.4 de
Pioneer 2643	5520 cdA	4930 cdA	89 ab	8.7 e	35.4 de
Pioneer 26R24	6150 bcA	5730 abA	93 ab	9.0 d	37.1 cde
VA98W-593	7140 aA	6340 aB	89 ab	10.1 a	36.0 de

[a]Means within a column followed by the same lowercase letter are not significantly different according to Fisher's protected LSD at P=0.05. Comparison of means within a wheat cultivar and data parameter followed by the same uppercase letter are not significantly different according to Fisher's protected LSD at P=0.05.

[b]Treated wheat yield expressed as a percentage of nontreated wheat yield.

[c]Data for percent moisture and kernel weight of grain averaged over treatment (AE F130060 03 vs. no AE F130060 03).