Chapter III

Efficacy of DPX-R6447 for the Control of Italian Ryegrass (*Lolium multiflorum*) in Small Grains[1]

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Abstract: In Virginia, Italian ryegrass (*Lolium multiflorum*) has become one of the most troublesome and difficult to control weeds in small grains. Italian ryegrass control has declined due to the development of resistance to diclofop-methyl, which has been the only treatment available for postemergence (POST) control of this species in wheat and barley. Experiments were initiated in Virginia in 2000 and 2001 to evaluate the efficacy of DPX-R6447 for the control of Italian ryegrass in wheat and barley. Field experiments were arranged in a randomized complete block design and replicated at two sites in Virginia in both years. Treatments included four PRE and four early postemergence (EP)

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

rates of DPX-R6447, one PRE and one EP rate of flufenacet plus metribuzin, one PRE and one EP rate of chlorsulfuron plus metsulfuron-methyl, and a non-treated control. Two PRE and two EP rates of flufenacet plus metribuzin and chlorsulfuron plus metsulfuron-methyl were also applied in combination. Equivalent barley and wheat injury and barley and wheat yield occurred with treatments of DPX-R6447 at rates below 176 g ai/ha and treatments of flufenacet plus metribuzin applied alone in both years. Consistent Italian ryegrass control with DPX-R6447 occurred only with rates of 176 g ai/ha or greater in both years. Treatments of DPX-R6447 at rates of 176 g ai/ha, however, resulted in variable injury in both wheat and barley between years. Rates higher than 176 g ai/ha of DPX-R6447 exhibited unacceptable barley and wheat injury. The lack of consistency with regard to barley and wheat injury could limit the utility of this compound in these crops.

Nomenclature: Azafenidin; chlorsulfuron; diclofop-methyl; flufenacet; metribuzin; metsulfuron-methyl; Italian ryegrass, *Lolium multiflorum* (Lam.) #[3] LOLMU; barley, *Hordeum vulgare* (L.) # HORVX 'Nomini'; wheat, *Triticum aestivum* (L.) 'Jackson'.

Additional index words: Diclofop-methyl resistance; crop tolerance.

Abbreviations: EP, early postemergence; Chlor/met, chlorsulfuron/metsulfuron-methyl; Flu/metr, flufenacet/metribuzin LSD, least significant difference; MAT, months after treatment; POST, postemergence; PRE, preemergence; WAT, weeks after treatment.

INTRODUCTION

Italian ryegrass [*Lolium multiflorum* (Lam.)] is recognized throughout the southeastern United States as one of the ten most common and troublesome weeds in small grains (Webster 2000). Excellent Italian ryegrass control and increased wheat [*Triticum aestivum* (L.)] yields have been reported to result from the application of diclofop-methyl (Griffen 1986; Khodayari et al. 1983; Shaw and Wesley 1991) Diclofop-methyl is an aryloxyphenoxypropanoate herbicide that inhibits the activity of acetyl-Coenzyme A carboxylase (ACCase) in susceptible plants (Devine and Shimabukuro 1994). ACCase is an essential enzyme that facilitates fatty acid biosynthesis (Devine and Shimabukuro 1994).

In recent years, Italian ryegrass control has declined due to the proliferation of resistance to diclofop-methyl, which has been the only treatment available for control in wheat and barley [*Hordeum vulgare* (L.)]. The first occurrence of diclofop-resistance in Italian ryegrass was documented in 1987 (Stanger and Appleby 1989), and resistance was confirmed in Virginia in 1993 in Brunswick County (Heap 2002). Resistance in biotypes of normally sensitive grass weeds, including Italian ryegrass, has been associated with an insensitive site of action (ACCase), which is not inhibited by aryloxyphenoxypropanoate herbicides (Ahrens 1994). In 1999, collections of Italian ryegrass biotypes from Virginia were screened for diclofop-methyl resistance. Resistance was determined to be widespread and results indicated that certain biotypes exhibited up to 16-fold resistance to the normal use rate of diclofop (Morozov et al. 1999). Lack of control of Italian ryegrass has been shown to reduce small grain yield by as much as 75 percent through

competition for resources coupled with harvest impairment[3]. Inability to control Italian ryegrass and low small grain prices have led to a reduction is small grains hectarage planted in Virginia. During the period of 1996-2000, harvested wheat hectares decreased from 111,291 to 82,962 (VDACS 2000).

In 2000 and 2001, Virginia was granted a specific exemption in accordance with Section 18 of FIFRA to use flufenacet plus metribuzin to control Italian ryegrass in wheat. Flufenacet is an oxyacetamide, which acts as a seedling growth inhibitor (Hatzios 98). Metribuzin is an inhibitor of photosynthesis in the asymetrical triazine chemical family (Ahrens 94). Because they are applied preemergence (PRE), the efficacy of these compounds is dependent upon rainfall. Previous research demonstrated that flufenacet plus metribuzin applied either PRE or one leaf (SPIKE) controlled Italian ryegrass at least 97% four months after treatment (MAT) when rainfall was received shortly after application (Bailey 2002). When rainfall was not received, however, reduced control of Italian ryegrass was observed (Bailey 2000). Ritter and Menbere (2002) determined that rates of flufenacet plus metribuzin of 0.29 and 0.07 kg ai/ha, respectively, or higher resulted in Italian ryegrass control of at least 87% in June when treatments were applied PRE in late October of the previous year.

Phytotoxicity is a major concern with the application of flufenacet plus metribuzin. Wheat injury due to application of flufenacet plus metribuzin averaged 17 % with rates of 0.48 plus 0.12 kg ai/ha, respectively, however wheat yields were significantly greater than the non-treated control (Ritter and Menbere 2002). Significantly reduced wheat

[3] Hagood, E. S. and H. P. Wilson. 2000. Application for specific exemption in accordance with Section 18 of FIFRA to use Axiom herbicide to control Italian ryegrass in wheat. pp. 12

injury and higher yields were attained with lower rates of flufenacet plus metribuzin (Ritter and Menbere 2002). These results indicate that flufenacet plus metribuzin could provide an alternative control method for Italian ryegrass in areas where diclofop-methyl resistance is prevalent. Bailey (2002), however, observed wheat yield reductions of 20 to 49 % when flufenacet plus metribuzin was applied PRE compared to diclofop PRE, and 8 to 63% when flufenacet plus metribuzin was applied SPIKE compared to diclofop-methyl SPIKE in fields containing diclofop-methyl-sensitive Italian ryegrass. Variations in wheat injury are often a reflection of soil type, where application to fine-textured soils with higher organic matter content results in less injury than application to coarse-textured soils with low organic matter (E. S. Hagood, personal communication).[4]

The experimental herbicide DPX-R6447 contains the active ingredient azafenidin, produced by E. I. DuPont de Nemours and Company[5]. This herbicide inhibits the enzyme protoporphyrinogen oxidase, resulting in excessive formation of singlet oxygen radicals causing destruction of plant cell membranes (Hatzios 1998). Azafenidin, used primarily as a PRE herbicide, controls a wide range of grass and broadleaf weeds, and is registered in citrus and other specialty crops (Chandran and Singh 2000). Currently, no published reports of the efficacy of azafenidin for the control of Italian ryegrass in small grains crops are available. Other researchers have evaluated azafenidin for the control of annual grass species in other crops. Monks et al. (1999) observed excellent control of fall panicum [*Panicum dichotomiflorum* (Michx.)] and over 95% control of large crabgrass [*Digitaria sanguinalis* (L.) Scop.] 12 weeks after treatment (WAT) with azafenidin.

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[5] E. I. DuPont de Nemours and Co., Walker's Mill, Banley Mill Plaza, Wilmington, DE. 19898

Chlorsulfuron plus metsulfuron-methyl is also labeled for Italian ryegrass control in wheat and barley (CPR 2002). Chlorsulfuron and metsulfuron-methyl are both sulfonylurea herbicides, which inhibit the enzyme acetolactate synthase (ALS), and are applied both PRE and POST in wheat and barley (Ahrens 1994). Weed control is also dependent upon rainfall and Italian ryegrass can be suppressed or controlled.[6]

As a result of the need to control diclofop-methyl resistant Italian ryegrass in wheat and barley and the lack of consistent control with flufenacet plus metribuzin and chlorsulfuron plus metsulfuron-methyl, evaluation of additional compounds could be useful. Therefore, the objective of this research was to investigate DPX-R6447 in comparison to flufenacet plus metribuzin, and chlorsulfuron plus metsulfuron-methyl for Italian ryegrass control in wheat and barley.

Materials and Methods

Field experiments were established in 2000 and 2001 in Amelia and Montgomery Counties, Virginia. Soil types were an Appling sandy loam (*Typic Hapludults*) with 1.7 % organic matter and pH 6.4 and a Ross silt loam (fine-loamy, mixed, mesic *Cumulic Hapludolls*) with 2.6 % organic matter and pH 6.1, respectively. The Amelia county location was chosen because of a heavy natural infestation of Italian ryegrass, which was previously characterized as highly resistant to diclofop-methyl (Morozov et al. 1999). The Montgomery county location was overseeded prior to planting with diclofop-methyl

[6] Finesse label. E. I. DuPont de Nemours and Co., Walker's Mill, Banley Mill Plaza, Wilmington, DE. 19898

susceptible Italian ryegrass purchased from a commercial seed supplier[7]. In both years, 'Nomini' barley[8] was planted in Amelia County and 'Jackson' wheat was planted in Montgomery County. Wheat and barley were planted at a rate of 112 kg of seed per hectare in 19 cm rows with a no-till grain drill[9] in soil that was conventionally prepared by off-set discing twice. Wheat and barley were fertilized in accordance to Virginia Polytechnic Institute and State University Extension recommendations (Brann et al. 2000).

Experiments were conducted in a randomized complete block design. Treatments applied at all locations included four PRE and four early postemergence (EP) rates of DPX-R6447, one PRE and one EP rate of flufenacet plus metribuzin, one PRE and one EP rate of chlorsulfuron plus metsulfuron-methyl, and a non-treated control. Two PRE and two EP rates of flufenacet plus metribuzin and chlorsulfuron plus metsulfuron-methyl were also applied in combination.

Individual plots were 3.1 m wide and 9.1 m long where the center 1.8 m of each plot was treated. Herbicide treatments were applied using a CO_2 backpack sprayer at a volume of 210 L/ha with flat-fan spray tips[10]. EP chlorsulfuron plus metsulfuron-methyl treatments contained 0.5% V/V nonionic surfactant[11]. PRE treatments were applied one day after planting in late October or early November, and prior to small grain and

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[7] Landscape supply, Inc. P. O. box 12706, Roanoke, VA. 24027

[8] Nomini barley and Jackson wheat marketed by Southern States, crops division, P. O. box 26234, Richmond, Va. 23260

[9] 1205 NT, Great Plains, A division of Great Plain Mfg., Inc. P. O. box 5060, Salina, KS 67402-5060

[10] Teejet 8003 flat fan spray nozzles, Spraying Systems Co., North Ave. Wheaton, IL. 60188

[11] X-77, non-ionic surfactant, Valent USA Corp. 1333 N. California Blvd., Walnut Creek, CA. 94596

ryegrass emergence. EP treatments were applied in late November or early December to one to two leaf wheat and barley plants and Italian ryegrass plants ranging in size from SPIKE to two leaves. Herbicide efficacy and crop phytotoxicity ratings were made throughout the growing season. A 0-100 rating scale was used to evaluate herbicide efficacy, where 0 was equal to the weed population observed in the control plots and 100 was equal to complete Italian ryegrass control. Crop phytotoxicity was visually rated as a combination of stand reduction, plant size reduction, chlorosis and necrosis in comparison to the crop plants in non-treated plots. The center 1.5 m of each plot was harvested with a small plot combine[12] at maturity, and grain moisture and yields were determined for each plot. Barley from the 2001 Amelia County experiment was not harvested due to crop predation.

Due to extremely dry autumns at the Amelia county location in 2000 and 2001, Italian ryegrass did not germinate in levels sufficient to allow rating of Italian ryegrass control. Therefore, the Amelia county location in 2000 and 2001 was used only to evaluate barley phytotoxicity and grain yields. Weed control ratings, phytotoxicity ratings, and grain yields were subjected to analysis of variance and means were separated using the least significant difference (LSD) test at the 5% level of probability. To determine significance of main effects and interactions for herbicide treatment and year, factorial analyses were also performed.

[12] Nurserymaster, manufactured by Wintersteiger, Inc., 217 Wright Brothers Drive, Salt Lake City, UT. 84116

Results and Discussion

Homogeneity of variance evaluation indicated significant interactions of year with respect to wheat and barley injury, Italian ryegrass control, and wheat and barley yield. Therefore, results will be presented individually by years. Homogeneity of variance analysis with respect to location was not conducted because of different climatic and edafic conditions between locations as well as different crops. Significance of main effects and interactions were determined for each dependant variable. Where no significant interaction was observed, means will be presented.

Amelia County 2001 and 2002. In 2001 and 2002, there was a non-significant effect of application timing for barley injury at both rating times and for barley yield in 2002. In both years, barley injury was significantly greater with treatments of DPX-R6447 with rates greater than 176 g ai/ha than all other treatments for the initial rating, where injury was greater than 40 percent (Tables 1 and 2). In both years, a general decrease in barley injury occurred between the initial rating and the final rating prior to harvest with treatments of DPX-R6447 at rates of 176 g ai/ha or lower. The highest rate of DPX-R6447 or any treatment containing chlorsulfuron plus metsulfuron-methyl increased barley injury prior to harvest in June compared to the initial rating in January (Tables 1 and 2). In 2002, differences in barley yield were directly associated with barley injury, where the high rate of DPX-R6447 caused 63% barley injury and significantly lower yield compared to treatments which resulted in less injury (Table 2). Treatments of DPX-R6447 at rates less than 88 g ai/ha resulted in equivalent barley injury in both years and yield in 2002 to treatments of flufenacet plus metribuzin.

Montgomery County 2001. Wheat injury from PRE or EP applications of DPX-R6447 was significantly greater than injury from any other treatment when rates of DPX-R6447 exceeded 44 g ai/ha (Table 3). Wheat injury increased from 24 to 69% and 69 to 86% as the rate of PRE DPX-R6447 increased from 88 to 176, and 176 to 352 g ai/ha, respectively, for the initial rating (Table 3). Similar results also occurred for the initial rating when DPX-R6447 was applied EP. Wheat injury prior to harvest was unacceptable with applications of DPX-R6447 at rates greater than 88 g ai/ha (Table 3). Equivalent injury occurred prior to harvest when treatments of chlorsulfuron plus metsulfuron-methyl alone, flufenacet plus metribuzin alone and chlorsulfuron plus metsulfuron-methyl combined with either rate of flufenacet plus metribuzin were compared to the treatment of DPX-R6447 applied at 44 g ai/ha. Injury also increased from 43 to 69% and 75 to 86% when PRE applications were compared to EP applications of DPX-R6447 with rates of 176 and 352 g ai/ha, respectively.

Greater than 94% Italian ryegrass control occurred with applications of DPX-R6447 applied at either timing with rates of 176 g ai/ha or greater or any treatment containing 336 and 84 g ai/ha of flufenacet plus metribuzin, respectively (Table 3). DPX-R6447 applied at 44 g ai/ha or chlorsulfuron plus metsulfuron-methyl applied alone controlled Italian ryegrass less than 75% at either rating. In 2001, Italian ryegrass control of 90% prior to wheat harvest and the greatest wheat yield occurred with application of 88 g ai/ha of DPX-R6447. Equivalent wheat yield to that provided by 88 g ai/ha was observed with all other treatments except the high rate of DPX-R6447. This result occurred because of the high injury level associated with the high rate of DPX-R6447. Non-significant differences in wheat yield between herbicide treatments with significantly different injury

and Italian ryegrass control levels resulted from a combination of factors. Where Italian ryegrass control of only 52% and wheat injury of 1% was observed with DPX-R6447 applied at 44 g ai/ha, yield was equivalent to that provided by DPX-R6447 applied at 176 g ai/ha, which provided Italian ryegrass control of 98% and wheat injury of 39 percent. In this case, Italian ryegrass control and injury were offsetting factors, and increased injury reduced yield in the absence of Italian ryegrass competition.

Montgomery County, 2002. In 2002, significantly greater wheat injury occurred with both PRE and EP treatments of DPX-R6447 at 352 g ai/ha than with any other treatment (Table 4). Wheat injury increased from 10 to 28% and 28% to 85% between PRE and EP treatments of DPX-R6447 applied at 176 and 352 g ai/ha, respectively, at the initial rating. Similar results occurred prior to harvest between application timings with the two highest rates of DPX-R6447. Minimal wheat injury occurred with all other treatments, where injury was typically below 10% at both ratings.

Due to a dense infestation of Italian ryegrass and lack of rainfall for both treatment timings, Italian ryegrass control was less than 68% with all treatments except for the two high rates of DPX-R6447 at the initial rating. Italian ryegrass control was below 55% with either application timing for treatments of chlorsulfuron plus metsulfuron-methyl applied alone or in combination with flufenacet plus metribuzin, or flufenacet plus metribuzin applied alone (Table 4). Significantly greater Italian ryegrass control occurred with all EP applications of DPX-R6447 compared to PRE applications except for the highest rate of DPX-R6447. Italian ryegrass control with treatments of

chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin applied alone or in combination typically increased between the initial and final rating.

Wheat yield was equivalent with treatments of DPX-R6447 at 352 g ai/ha compared to chlorsulfuron plus metsulfuron-methyl in combination with either rate of flufenacet plus metribuzin (Table 4). This result occurred even though the DPX-R6447 treatments resulted in greater wheat injury compared to treatments of chlorsulfuron plus metsulfuron-methyl combined with flufenacet plus metribuzin. Significantly lower wheat yield was observed with applications of DPX-R6447 at rates below 176 g ai/ha compared to any other treatments.

Equivalent barley injury and yields occurred between treatments of DPX-R6447 at rates below 176 g ai/ha and treatments of chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin applied alone or in combination in both years in Amelia County. Rates of DPX-R6447 above 176 g ai/ha and all treatments that contained chlorsulfuron plus metsulfuron-methyl resulted in unacceptable injury to barley and significantly greater injury compared to the lower rates of DPX-R6447 or flufenacet plus metribuzin applied alone in Amelia County in 2002. Lack of an Italian ryegrass population in Amelia County did not allow for comparison of yields as affected by Italian ryegrass control. Therefore, additional research needs to be conducted to evaluate rates below 352 g ai/ha for the control of Italian ryegrass in barley.

Similar results also occurred in wheat due to the application of DPX-R6447, where wheat injury was greater than 40% in both years with rates exceeding 176 g ai/ha. Italian ryegrass control was effective with DPX-R6447 applied at rates of 176 and 352 g ai/ha in both years. Equivalent yields between treatments of DPX-R6447 at rates of 176 g ai/ha

and flufenacet plus metribuzin indicated some potential for use of this compound in wheat. Additional research should focus on rates of DPX-R6447 between 176 and 88 g ai/ha for Italian ryegrass control in wheat as well as barley. The lack of consistency with regard to barley and wheat injury could limit the utility of this compound in these crops.

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Table 1. Barley injury with DPX-R6447, chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin in Amelia County, 2001. [a]

Treatment	Rate	Barley injury	Barley injury
	g ai/ha	1-25-01[b]	6-5-01[c]
		Mean	Mean
		%	
DPX-R6447	44	13	5
DPX-R6447	88	22	12
DPX-R6447	176	34	32
DPX-R6447	352	42	42
Chlor + met[d]	29 + 6	4	33

Chlor + met / flu + metr	29 + 6 / 224 + 56	5	31
Chlor + met / flu + metr	29 + 6 / 336 + 84	5	15
Flu + metr	336 + 84	8	1

[a] LSD (á = 0.05) for barley injury on 1-25-01 for comparison of treatments averaged over application timings = 19

LSD (á = 0.05) for barley injury on 6-5-01 for comparison of treatments averaged over application timings = 29

[b] PRE and EP treatments applied 13 and 11 weeks before 1-25-01, respectively

[c] PRE and EP treatments applied 32 and 30 weeks before 6-5-01, respectively

[d] Abbreviations: Chlor + met, chlorsulfuron plus metsulfuron-methyl; flu / metr, flufenacet plus metribuzin

Table 2. Barley injury and barley yield with DPX-R6447, chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin in Amelia County, 2002.[a]

Treatment	Rate	Barley injury	Barley injury	Barley Yield[b]
	g ai/ha	1-20-02[c]	5-31-02[d]	6-5-02[e]
		Mean	Mean	Mean
		%	%	kg / ha
DPX-R6447	44	0	0	5490
DPX-R6447	88	3	0	5502
DPX-R6447	176	11	4	5173
DPX-R6447	352	40	63	3089
Chlor + met[f]	29 + 6	0	13	4199

Chlor + met / flu + metr	29 + 6 / 224 + 56	0	11	4409
Chlor + met / flu + metr	29 + 6 / 336 + 84	0	15	3927
Flu + metr	336 + 84	0	0	5408

[a] LSD (á = 0.05) for barley injury on 1-20-02 for comparison of treatments averaged over application timings = 12

LSD (á = 0.05) for barley injury on 5-31-02 for comparison of treatments averaged over application timings = 16

LSD (á = 0.05) for barley yield on 5-31-02 for comparison of treatments averaged over application timings = 1635

[b] Yield calculated at 14% moisture

[c] PRE and EP treatments applied 12.5 and 8 weeks before 1-20-02, respectively

[d] PRE and EP treatments applied 31 and 26.5 weeks before 5-31-02, respectively

[e] PRE and EP treatments applied 32 and 27.5 weeks before 6-5-02, respectively

[f] Abbreviations: Chlor + met, chlorsulfuron plus metsulfuron-methyl; flu / metr, flufenacet plus metribuzin

Table 3. Wheat injury, Italian ryegrass control, and wheat yield with DPX-R6447, chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin in Montgomery County, 2001.[a]

Treatment	Rate	Wheat injury		A. ryegrass control		Wheat injury	A. ryegrass control	Wheat Yield[b]
	g ai/ha	1-27-01[c]				7-9-01[d]		7-9-01
		PRE	EP	PRE	EP	Mean	Mean	Mean
		%						kg / ha
DPX-R6447	44	18	14	60	58	1	52	3882
DPX-R6447	88	24	21	80	79	5	90	5033
DPX-R6447	176	69	43	95	86	39	98	4048
DPX-R6447	352	86	75	100	98	83	100	2592
Chlor + met[e]	29 + 6	0	1	58	55	5	71	4675

Chlor + met / flu + metr	29 + 6 / 224 + 56	4	5	93	84	5	95	4872
Chlor + met / flu + metr	29 + 6 / 336 + 84	7	11	97	94	7	98	4711
Flu + metr	336 + 84	11	8	97	95	3	96	4604

[a] LSD (á = 0.05) for wheat injury on 1-27-01 for comparison of application timings within an individual treatment = 5

LSD (á = 0.05) for wheat injury on 1-27-01 for comparison of treatments within an application timing = 9

LSD (á = 0.05) for Italian ryegrass control on 1-27-01 for comparison of application timings within an individual treatment = 3

LSD (á = 0.05) for Italian ryegrass control on 1-27-01 for comparison of treatments within an application timing = 6

LSD (á = 0.05) for wheat injury on 7-9-01 for comparison of treatments averaged over application timings = 26

LSD (á = 0.05) for wheat yield on 7-9-01 for comparison of treatments averaged over application timings = 1852

[b] Yield calculated at 14% moisture

[c] PRE and EP treatments applied 12.5 and 8.5 weeks before 1-27-01, respectively

[d] PRE and EP treatments applied 35.5 and 31.5 weeks before 7-9-01, respectively

[e] Abbreviations: Chlor + met, chlorsulfuron plus metsulfuron-methyl; flu / metr, flufenacet plus metribuzin

Table 4. Wheat injury, Italian ryegrass control, and wheat yield with DPX-R6447, chlorsulfuron plus metsulfuron-methyl and flufenacet plus metribuzin in Montgomery County, 2002.[a]

Treatment	Rate	Wheat injury		A. ryegrass control		Wheat injury		A. ryegrass control		Wheat Yield[b]
	g ai/ha	1-17-02[c]				7-1-02[d]				7-1-02
		PRE	EP	PRE	EP	PRE	EP	PRE	EP	Mean
		%								kg / ha
DPX-R6447	44	0	0	15	30	0	0	0	8	600
DPX-R6447	88	3	10	29	68	0	0	6	41	1331
DPX-R6447	176	10	28	65	83	9	14	77	91	3075
DPX-R6447	352	28	85	94	99	40	78	97	100	2809
Chlor + met[e]	29 + 6	1	8	19	41	0	3	38	48	2821

Chlor + met / flu + metr	29 + 6 / 224 + 56	3	10	35	55	3	0	51	83	2840
Chlor + met / flu + metr	29 + 6 / 336 + 84	6	11	50	53	1	5	69	79	3446
Flu + metr	336 + 84	5	6	45	36	4	5	59	73	2692

[a] LSD (á = 0.05) for wheat injury on 1-17-02 for comparison of application timings within an individual treatment = 7

LSD (á = 0.05) for wheat injury on 1-17-02 for comparison of treatments within an application timing = 5.5

LSD (á = 0.05) for Italian ryegrass control on 1-17-02 for comparison of application timings within an individual treatment = 13

LSD (á = 0.05) for Italian ryegrass control on 1-17-02 for comparison of treatments within an application timing = 9

LSD (á = 0.05) for wheat injury on 7-1.02 for comparison of application timings within an individual treatment = 5

LSD (á = 0.05) for wheat injury on 7-1-02 for comparison of treatments within an application timing = 4

LSD (á = 0.05) for Italian ryegrass control on 7-1-02 for comparis on of application timings within an individual treatment = 4

LSD (á = 0.05) for Italian ryegrass control on 7-1-02 for comparison of treatments within an application timing = 13

LSD (á = 0.05) for wheat yield on 7-9-01 for comparison of treatments averaged over application timings = 1091

[b] Yield calculated at 14% moisture

[c] PRE and EP treatments applied 12 and 7 weeks before 1-17-02, respectively

[d] PRE and EP treatments applied 35.5 and 30.5 weeks before 1-17-02, respectively

[e] Abbreviations: Chlor + met, chlorsulfuron plus metsulfuron-methyl; flu / metr, flufenacet plus metribuzin