SELECTIVE CHEAT (*Bromus secalinus*) CONTROL IN WHEAT (*Triticum aestivum*) WITH ATRAZINE

By

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SELECTIVE CHEAT (*Bromus secalinus*) CONTROL IN

WHEAT (*Triticum aestivum*) WITH ATRAZINE

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SELECTIVE CHEAT (*Bromus secalinus*) CONTROL IN WHEAT (*Triticum aestivum*) WITH ATRAZINE

Selective Cheat (*Bromus secalinus*) Control in Wheat (*Triticum aestivum*) with Atrazine[1]

BRANDY A. PIETZ and THOMAS F. PEEPER[2]

Abstract. Eleven field experiments were conducted to evaluate atrazine for selective cheat control in hard red winter wheat. Cheat control with atrazine at 140 g/ha applied PRE varied from 5 to 83% but was similar to cheat control with the standard treatment, triasulfuron at 29 g/ha. Control with atrazine at 280, 560, and 840 g/ha applied early POST exceeded control with the standard treatment, triasulfuron plus metribuzin at 29 plus 157 g/ha, in one, three, and five experiments, respectively. Metribuzin at 420 g/ha was the standard treatment for cheat control in tillered wheat and controlled cheat 28 to 96%. Cheat control with atrazine at 560 and 840 g/ha applied to tillered wheat was comparable to or exceeded the standard. Of the early POST treatments the standard increased yield in three of five experiments. Triasulfuron plus atrazine applied POST at 29 plus 280 g/ha also increased wheat yield in three of five experiments and yields did not differ from the standard treatment at the other two experiments. In on-farm experiments, cheat control with atrazine at 560 g/ha was similar to control with metribuzin at 420 g/ha

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in two of three experiments. In these experiments five of six treatments of metribuzin at 420 g/ha increased yield and four of six treatments of atrazine at 560 g/ha increased yield. In cultivar tolerance experiments the metribuzin tolerant cultivars 'TAM W-101' and '2180' were much more severely injured by atrazine applied POST at 840 g/ha than 'Karl 92', a cultivar considered less tolerant to metribuzin. **Nomenclature:** Atrazine, 6-chloro-N-ethyl-N'-(1-methylethyl)-1, 3, 5,-triazine-2, 4-diamine; metribuzin, 4-amino-6-(1, 1-dimethylethy)-3-(methylthio)-1, 2, 4-triazin-5(4H)-one; triasulfuron, 2-(2-chloroethoxy)-N-[[(4-methoxy-6-methyl-1, 3, 5-triazin-2-yl)amino]carbonyl]-benzenesulfonamide; cheat, *Bromus secalinus* L. #[3], BROSE; wheat, *Triticum aestivum* L.

Additional index words: Metribuzin, triasulfuron, BROSE,.

INTRODUCTION

The relative high cost of developing new herbicides, differences in wheat cultivar response to some herbicides, and often the lack of adequate selectivity have made it difficult to find a herbicide to effectively control *Bromus* spp in winter wheat (4, 5). Currently there is not a selective herbicide for cheat control in wheat other than metribuzin which has a narrow margin of crop safety, can only be used on a few popular cultivars, and is not recommended on soils with high pH or sandy texture (13). These factors often

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[3] Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 1508 West University Ave., Champaign, IL 61821-3133.

preclude metribuzin use. However, metribuzin applied POST at 420 g/ha has controlled cheat 56 to 98% (12).

Triasulfuron and chlorsulfuron plus metsulfuron are registered for cheat suppression in wheat when applied PRE alone or when applied early POST tank mixed with metribuzin. When applied PRE triasulfuron at 18 and 30 g ai/ha reduced cheat in wheat from 0 to 60% and chlorsulfuron plus metsulfuron (5:1 premix) at 18 and 26 g ai/ha reduced cheat from 0 to 81% (10). In Kansas, triasulfuron at 30 g/ha PRE controlled downy brome (*Bromus tectorum* L.) 59 to 76%, but wheat yields were not increased (15). Chlorsulfuron plus metsulfuron at 21 g/ha tank mixed with metribuzin at 210 g/ha, applied early POST, controlled cheat 36 to 98% in Oklahoma (12). In Kansas , triasulfuron plus metribuzin at 30 plus 140 g/ha applied to three to five leaf wheat controlled downy brome 67 to 70%, but failed to increase wheat yield (15). Attention to soil organic matter content and texture as well as cultivar selection are required for crop safety with this treatment (12). The variation in *Bromus* spp. control with these treatments indicates that a more effective and consistent treatment is needed.

Atrazine was previously used in the central Great Plains in grass pastures for *Bromus* spp. control, but this use is no longer registered (16). Atrazine is currently used in wheat as a preplant or at-planting treatment for downy brome control in the Pacific Northwest at 1.1 to 1.38 kg ai/ha (3). The treated soil is moved away from the drill row during planting and firmed with a press wheel to limit movement of treated soil into the drill row (3). In that region atrazine controls most fall-germinating annual broadleaf weeds and reduces downy brome (8). Atrazine can be applied at a lower cost than other herbicides for the above mentioned weeds (8). However, there are risks of wheat injury from atrazine because it is moderately persistent in the soil and wheat is not highly tolerant of atrazine.

The activity and persistence of atrazine in soil has been related to pH, organic matter, and clay content (7, 17). In general, activity decreases as organic matter or clay content increase, and persistence increases as pH increases. Research in Colorado indicated that the probabilities of carryover injury to wheat from fallow applications of atrazine increased as the clay content decreased and soil pH increased (14).

Crop cultivars differ in tolerance to herbicides. Genotypic responses to atrazine have been reported in corn (*Zea mays*) (2, 11), cotton (*Gossypium hirsutum* L.) (1), oats (*Avena sativa* L.) (9) and wheat (4, 6).

Wheat cultivars grown in a silt loam soil in greenhouse flats were evaluated for seedling tolerance to atrazine (4). Very little damage was observed until the atrazine concentration reached 0.2 mg/kg of soil. At that concentration 23% of the seedlings of a 75 cultivar composite died. Seedling mortality increased to 89% as atrazine concentration increased to 0.3 mg/kg of soil. Survival was low for most of one hundred and twenty cultivars and experimental lines of wheat grown in the silt loam soil with 0.25 mg/kg of atrazine. Seven had a survival rating of 40% or greater, and 73 had a survival rating of less than 20%. Hard red winter wheat cultivars were more tolerant than soft wheat cultivars. Although differences were found in the genotype screening, a level of tolerance considered acceptable for field conditions was not identified. Of eighteen hard red winter wheat varieties evaluated in Texas, 'Scout' and 'Triumph' were more tolerant of atrazine residues than 'TAM 200' and 'TAM 109' (6). 'Chisholm' was considered relatively susceptible also.

In Oregon, 'Stephens', soft white winter wheat was reseeded in November after atrazine was applied at the recommended label rate (0.56 kg/ha) in September, and was not visibly injured (8). The soil pH was 6.4 and organic matter was 1.9%. Injury was minor (less than 20%), even with 2X and 4X rates and no treatments reduced grain yield (8). In Colorado atrazine carryover did not decrease wheat yield unless stand reductions exceeded 25% (14).

'Vona', an as-triazine sensitive cultivar, was not found to be more sensitive to s-triazines (5). Thus, information pertaining to cultivar tolerance to metribuzin would not appear applicable to atrazine.

The objectives of this research were to compare atrazine and atrazine plus triasulfuron to selected standard treatments for selective cheat control in hard red winter wheat, and to evaluate popular hard red winter wheat cultivars for atrazine tolerance.

MATERIALS AND METHODS

Field experiments were conducted in Oklahoma during the 1993-94 and 1994-95 winter wheat growing seasons. All plots were 2.4 by 7.6 m and row spacing was 20 cm. The experimental design for each experiment was a randomized complete block with four replications. Treatments were applied with a CO_2 pressurized backpack sprayer equipped with flat fan nozzle tips spaced 51 cm apart. Wheat and cheat growth stages were determined by examining ten plants of each species at each time of application. Experimental locations, seeding dates, wheat growth stages, for POST treatments, seeding dates, and number of days to 0.64 cm of rainfall are listed on Table 1. Soil properties at each experiment site are listed in Table 2.

Crop injury and cheat control were visually estimated before harvest using a scale of 0 to 100% where 0 = no injury and 100 = complete kill. Visual cheat control and wheat injury data were subjected to arcsin square root transformation before analysis. Original data is reported with means separation according to LSD's from analysis of the transformed data.

Plots were harvested using a small plot combine adjusted to retain as much cheat seed with the harvested grain as possible for dockage determinations. The harvested samples were cleaned with a seed cleaner to remove chaff and straw retaining the wheat and cheat. A second cleaning operation separated the wheat from the cheat. Material removed by the second cleaning was considered dockage and consisted primarily of cheat seed with some small wheat seed. Wheat yield with moisture adjusted to 13.5 % was then determined. Yield for the experiments was subjected to analysis of variance and treatment means were separated with protected least significant differences at the P = 0.05 level.

Application timing experiments. Six field experiments were conducted to evaluate PRE and POST applications of atrazine for selective cheat control in hard red winter wheat. Herbicide treatments included atrazine at various rates plus an appropriate standard treatment for each of the four times of application and an untreated check. The standard treatments and application times included triasulfuron PRE at 29 g/ha, triasulfuron plus metribuzin at 29 plus 157 g/ha on wheat with three leaves to two tillers (POST 1), metribuzin at 420 g/ha on tillered wheat in the fall between mid November and early December (POST 2), and metribuzin at 420 g/ha in February (POST 3). Tank mixes of atrazine with triasulfuron were included in PRE and POST 1 treatments. Locally collected cheat seed was hand-broadcast in each plot at 50 kg/ha and incorporated 3 cm deep after which 'Karl 92' wheat was seeded at 67 kg/ha with a single disc (double disc at Lahoma) grain drill with press wheels. Seeding depth varied with depth to moisture from 1.5 to 4 cm. Soil properties at each site are reported in Table 2. Plots at Perkins were not harvested in the 1994-95 crop year due to disease suspected to be a root rot complex infection that became apparent after the wheat headed and destroyed the crop. Pathologists have not yet identified the causal organism(s).

On-farm experiments. Three experiments were conducted to evaluate atrazine applied POST on farmer-cooperator farms with natural cheat infestations and different soil properties (Tables 1 and 2). At two locations, Okarche and Ponca City, '2180' had been seeded at 84 kg/ha and 'Karl' had been seeded at 78 kg/ha at the other location. Atrazine at 280, 420, and 560 g/ha and a standard treatment, metribuzin at 420 g ai/ha, were applied to tillered wheat in November and December. An untreated check was included at each site.

Cultivar tolerance experiments. Two field experiments were conducted to determine the tolerance of ten popular hard red winter wheat cultivars to atrazine applied POST. Each cultivar was seeded 2 cm deep into moist soil in 15 cm rows at 67 kg/ha using a cone seeder. Herbicide treatments included atrazine at 0.42 and 0.84 kg/ha, applied to tillered wheat and an untreated check (Table 1). Crop injury was estimated visually and the effect of atrazine on interception of photosynthetically active radiation (PAR)[4] was measured with a radiometer with an 80 cm long probe. PAR was measured above the wheat canopy and at ground level parallel with and between the center wheat rows in each

[4] Abbreviations: PAR = photosynthetically active radiation.

plot. The difference between the above and below canopy readings was divided by the above canopy value and multiplied by 100 to obtain the percent of PAR being intercepted by the wheat canopy. Yield data were collected as previously mentioned, except that the harvested seed was cleaned only once because the sites were free of cheat.

RESULTS AND DISCUSSION

Application timing experiments. Treatments varied with years which precluded pooling experiments across years. Interactions with location precluded pooling within years.

Triasulfuron at 29 g/ha, the standard PRE treatment, controlled cheat 0 to 90% in the six experiments (Table 3). The POST 1 standard, triasulfuron plus metribuzin at 29 plus 157 g/ha, controlled cheat 29 to 79%. Metribuzin POST 2 at 420 g/ha controlled cheat 28 to 96% with 90% or more control in three of the six experiments. Cheat control with metribuzin at 420 g/ha applied POST 3 in the six experiments varied from 10 to 95%. The variable control obtained agrees with earlier reports of variable cheat control with the standard treatments (10, 12). Cheat control with metribuzin applied POST 3 was poorer than when applied POST 2 when rainfall was not received within seven days of application.

Cheat control with atrazine at 140 g/ha applied PRE was similar to cheat control with the standard treatment, triasulfuron at 29 g/ha, at all locations (Table 3). However, control was inconsistent varying from 5 to 83%. Control did not appear related to days from treatment to first rainfall (Tables 1, 3). In all three experiments the second year, atrazine at 420 g/ha controlled more cheat than the triasulfuron standard. Atrazine at 560 g/ha controlled more cheat than the triasulfuron standard in four of the six experiments.

In no case did tank mixing triasulfuron at 29 g/ha PRE with atrazine increase cheat control compared to atrazine alone at the same rate.

Control with atrazine at 280, 560, and 840 g/ha applied POST 1 exceeded control with the standard treatment at one, three, and five experiments, respectively. In other cases, control with atrazine was less than control with the standard. Tank mixing triasulfuron with atrazine improved cheat control over atrazine alone only with atrazine at 280 g/ha at one location. Thus, there appeared to be little advantage in the tank mixed treatments, and they did not consistently control cheat.

Cheat control with atrazine at 280 g/ha applied POST 2 was comparable to the standard, metribuzin at 420 g/ha, in only one experiment. Control with atrazine at 560 and 840 g/ha POST 2 was comparable to or exceeded the standard in all experiments.

Applied POST 3, atrazine at 560 g/ha was less effective than metribuzin at 420 g/ha in three of six experiments and controlled cheat 40% or less in the other three experiments. Atrazine at 840 g/ha controlled cheat above 71% in four of the six experiments.

Some wheat stand reductions were expected since wheat does not have high tolerance to atrazine (4, 13) and 'Karl 92' is not considered a metribuzin tolerant cultivar. Wheat injury did not exceed 18% with any standard treatment at Lahoma or Orlando either year (Table 4). However, at Perkins, metribuzin injured wheat 45% when applied to 4 to 7 tiller wheat (POST 2) the first year. Metribuzin is not labeled for application on the soil at Perkins because the organic matter content is less than 1% (Table 2).

Atrazine at 420 g/ha injured wheat 45% at Lahoma and 97% at Perkins when applied PRE. Atrazine at 560 g/ha injured wheat more than 50% in three of six experiments when applied PRE. Thus, depending on soil characteristics, atrazine at rates up to 420 kg/ha could be considered as potential PRE treatments for wheat. Triasulfuron plus atrazine tank mixed at 29 plus 140 g/ha applied PRE did not cause more injury than the triasulfuron standard in any experiment.

Atrazine at 280 g/ha applied POST 1 (2- to 5-leaf wheat) did not injure wheat more than the POST 1 standard in any experiment, but did injure wheat more than the PRE standard at Perkins in 1994-95. At this growth stage, atrazine alone at 560 and 840 g/ha alone and tank mixed with triasulfuron injured the wheat 86 and 98% at Perkins. Adding triasulfuron had little or no effect on wheat stand reduction.

Injury from atrazine at 280 g/ha applied POST 2 was comparable to the standard in four of the six experiments while injury from atrazine at 420 g/ha, applied only in 1994-95, was comparable to the standard in all experiments. Wheat injury did not exceed 50% with any atrazine treatment at Orlando. Injury at Lahoma ranged from 0 to 15% among atrazine treatments, except that injury was 48% the second year with atrazine at 840 g/ha. This difference was attributed to time from application to an activating rainfall which was 76 days the first year and 0 days the second year. Injury from atrazine POST 2 at 840 g/ha was too severe to consider the treatment to be of any potential practical value.

Injury from atrazine at 280, 420, and 560 g/ha applied POST 3 did not differ from the standard at any location, except for atrazine at 420 g/ha at Lahoma the second year. Injury from atrazine at 840 g/ha exceeded injury from the standard in three of the six experiments, but did not exceed 30% at Lahoma or Orlando.

Moisture adjusted grain yield of the untreated checks was 1780, 1170, and 930 kg/ha at Lahoma, Orlando, and Perkins, respectively, for the 1993-94 crop year (Table 5).

Untreated check yields for the 1994-95 crop year were 730 and 650 kg/ha at Lahoma and Orlando.

In contrast to results from Kansas (15), triasulfuron PRE at 29 g/ha, increased wheat yield in two of five experiments (Table 5). Triasulfuron plus metribuzin applied POST 1 at 29 plus 157 g/ha increased yield in three of the five harvested experiments also. The lack of consistent yield response is undesirable.

The PRE atrazine treatments failed to increase yield at more than one of five locations. Wheat yields with triasulfuron plus atrazine at 140 or 280 g/ha applied PRE were not different from wheat yields with the standard.

Atrazine at 280 g/ha applied POST 1 increased yield in two of the same experiments as the standard, and failed to increase yield at Orlando in 1993-94. Triasulfuron plus atrazine tank mixed at 29 plus 280 g/ha applied POST 1 increased wheat yield in three of the five experiments and yield did not differ from the POST 1 standard at the other two experiments. Crop injury with atrazine at 560 or 840 g/ha alone or tank mixed with triasulfuron decreased yields at Perkins in 1993-94 and Orlando in 1994-95. All treatments except atrazine at 840 g/ha applied POST 1 increased yield at Orlando in 1994-95 and were comparable to the standard. At Lahoma in 1994-95 and Orlando in 1993-94 only the standard treatment increased wheat yield. Metribuzin applied POST 2 at 420 g/ha was the only treatment that increased wheat yield in all experiments.

Dockage was determined because it can be a method of detecting differences in cheat control if cheat does not shatter before harvest. Dockage in the untreated check was 33, 60, and 62% at Lahoma, Orlando, and Perkins, respectively, in 1993-94 and 49 and 71% at Lahoma and Orlando in 1994-95 (Table 6). Dockage levels of that magnitude indicate severe cheat infestations. Dockage in harvested grain was reduced by the PRE standard, triasulfuron at 29 g/ha, in two of the five experiments, the same two locations where it increased wheat yield. Atrazine at 280 g/ha PRE reduced dockage at three sites without increasing yield. Thus, that treatment was beneficial even though yields were not increased. Triasulfuron plus atrazine at 29 plus 280 g/ha PRE reduced dockage in three of the five experiments. No PRE treatment reduced dockage at Orlando in 1993-94. With only one exception, adding triasulfuron to atrazine applied PRE did not further reduce dockage.

The standard POST 1 treatment, triasulfuron plus metribuzin applied at 29 plus 157 g/ha, reduced dockage in four of the five experiments. At Orlando in 1994-95 the POST 1 standard and seven of the eight POST 1 atrazine treatments reduced dockage. All treatments reduced dockage at Lahoma both years. Thus, reductions in dockage were again obtained on occasions when yield was not increased.

Metribuzin at 420 g/ha applied POST 2 reduced dockage at all locations. Atrazine at 840 g/ha applied POST 2 reduced dockage at all locations. Atrazine at 420 g/ha was less effective in reducing dockage than metribuzin at that rate. Again, all POST 2 treatments reduced dockage at Lahoma both years.

Atrazine at 840 g/ha applied POST 3 reduced dockage at all locations, while the metribuzin standard reduced dockage at four of five locations. Atrazine at 280 g/ha did not reduce dockage in any experiment. Thus, no atrazine treatments or standard treatments except metribuzin applied POST 2 consistently increased yield and reduced dockage.

On-farm experiments. There was an interaction between herbicide treatment and application timing in the cheat control, wheat grain yield, and dockage data from all three on-farm experiments (Table 7). Therefore, treatment effects were not pooled.

In the on-farm experiments, cheat control with metribuzin at 420 g/ha applied in November was 93 to 98% and better than control with atrazine at 280 or 420 g/ha. Control with atrazine at 560 g/ha was similar to control with metribuzin in two experiments, but not at Ponca City. The lower cheat control at Ponca City was attributed to the higher organic matter content of that soil and wet conditions at the time of application. Both factors would slow herbicide movement into the root zone and the movement of atrazine would be slower because of its lower water solubility. Cheat control with seven of eight treatments applied in December was less than control with the same treatments applied in November at Okarche and Enid. At Okarche, atrazine applied in November at 420 and 560 g/ha controlled cheat 59 and 95%. Delaying application until cheat had 3 to 6 tillers reduced control to 4 and 28%. Atrazine was less effective than metribuzin in this experiment when applied in December.

At Okarche wheat yield was increased by all treatments applied in November. However, among treatments applied in December, only metribuzin at 420 g/ha increased yield. At Enid, atrazine at 560 g/ha and metribuzin at 420 g/ha increased wheat yield when applied either in November or December. Wheat yield was increased at Ponca City in plots treated with atrazine at 280 g/ha and metribuzin at 420 g/ha in November. Of the December treatments, only atrazine at 560 g/ha increased wheat yield. Thus, of the three experiments, each with two times of applications, five of six treatments of metribuzin at 420 g/ha increased yield and four of six treatments of atrazine at 560 g/ha increased yield.

Dockage varied from 44 to 58% in the untreated checks, indicating severe cheat infestations. Dockage in harvested grain was reduced by all herbicide treatments, except atrazine at 280 g/ha at Okarche. However, only atrazine at 560 g/ha applied in November reduced dockage as much as metribuzin

At Enid dockage was reduced with atrazine at 560 g/ha and metribuzin, but atrazine was not as effective as metribuzin applied in November. All treatments applied in December, except atrazine at 280 g/ha, reduced dockage and the atrazine treatments were comparable to the standard.

Only one treatment, metribuzin at 420 g/ha applied in November, reduced dockage at Ponca City.

Cultivar tolerance experiments. Popular wheat cultivars exhibited a wide range of tolerance to atrazine (Table 8). There was an interaction of atrazine rate and wheat cultivar on wheat injury with the two cultivar experiments. At Lahoma, where atrazine at 420 g/ha injured eight cultivars 10% or less, 'TAM W-101' was injured 30% by this treatment. When atrazine was increased to 840 g/ha, wheat injury varied with cultivars from 54 and 97%. At Perkins there were few differences among cultivars in injury from atrazine at 420 g/ha. Injury was between 38 and 75% with atrazine at 840 g/ha. TAM W-101 and '2180' were much more severely injured by atrazine at 840 g/ha at both sites than 'Karl 92'. TAM W-101 and 2180 are considered metribuzin tolerant, and Karl 92 is not. This data is in agreement with the report by Baker and Peeper (5) that wheat tolerance to as-triazine may differ from tolerance to s-triazines.

Pooled across cultivars at Lahoma, atrazine at 420 and 840 g/ha reduced interception of PAR by the canopy to 91 and 24 % of light intercepted by the check. Pooled over atrazine rates at Lahoma atrazine treated TAM W-101 and 2180, intercepted relatively less light than five other cultivars.

Pooled across cultivars at Perkins, atrazine at 420 and 840 g/ha reduced interception of PAR by the canopy to 95 and 45% of the check. Atrazine treated 'Jagger', 'Scout 66', TAM W-101, '2157', and 2180 intercepted less PAR than atrazine treated '2163'.

Yield data from Perkins was discarded because of previously mentioned disease problems. Wheat yield at Lahoma was pooled across treatments and presented as percent of the check for each cultivar. Atrazine reduced the yield of all cultivars, but reduced the yield of TAM W-101 more than five others.

Although exact delineation of cultivar tolerance differences isn't possible with the data available, the data indicate that Karl 92 and 'Tomahawk' are more atrazine tolerant than TAM W-101.

In agreement with the results from Texas, there was some evidence that Scout 66 was more tolerant of atrazine than Chisholm, but the difference between the two was small. Since Karl 92 was seeded in all of the application timing experiments, crop injury from atrazine would have been expected to be as great or greater if another popular cultivar had been selected.

In summary, metribuzin at 420 g/ha applied to tillered wheat in the fall was the most consistent treatment. In several instances crop injury with treatments containing atrazine was severe and the treatments often did not increase wheat yield. Therefore, unless there is a distinct cost advantage to using atrazine, metribuzin appears to have more utility for cheat control in winter wheat than atrazine. However, further research on early POST applications of atrazine is needed. It is feasible that guidelines for using atrazine for cheat control could be devised if care was taken to define rates appropriate for soils with various levels of organic matter and clay.

LITERATURE CITED

1. Abernathy, J. R., J. W. Keeling and L. L. Ray. 1979. Cotton cultivar response to propazine and atrazine. Agron. J. 71:929-931.

2. Anderson, R. N. 1964. Differential response of corn inbreds to simazine and atrazine. Weeds 12:60-61.

3. Anonymous. Undated. Cheat Stop™ Herbicide Label. Platte Chemical Company, Inc. Freemont, Nebraska, 68025.

4. Bacon, R. K., F. C. Collins, and T. L. Lavy. 1986. Evaluation of wheat cultivars for seedling tolerance to atrazine. Field Crops Res. 14:135-139.

5. Baker, T. K. and T. F. Peeper. 1990. Differential tolerance of winter wheat (*Triticum aestivum*) to cyanazine and triazinone herbicides. Weed Technol. 4:569-575.

6. Bean, B. W., C. D. Salisbury, M. D. Lazar, and G. Piccinni. 1995. Wheat variety tolerance to atrazine. Proc., South. Weed Sci. Soc. 48:247.

7. Best, J. A. and J. B. Weber. 1973. Disappearance of s-triazines as affected by soil pH using a balance-sheet approach. Weed Sci. 22:364-373.

8. Bolton, F. E., A. P. Appleby, and S. Case. 1992. Re-seeding wheat (*Triticum aestivum*) following preplant treatments of atrazine. Weed Technol. 6:996-998.

9. Brinkman, M. A., D. K. Langer, R. G. Harvey, and A. R. Hardie. 1980. Response of oats to atrazine. Crop Sci. 20:185-189.

10. Driver, J. E., T. F. Peeper, and J. A. Koscelny. 1993. Cheat (*Bromus secalinus*) control in winter wheat (*Triticum aestivum*) with sulfonylurea herbicides. Weed Technol. 7:851-854.

11. Grogen, C. O., E. F. Eastin, and R.D. Palmer. 1963. Inheritance of susceptibility of a line of maize to simazine and atrazine. Crop Sci. 3:451.

12. Koscelny, J. A. 1995. Evaluation of herbicide options for cheat (*Bromus secalinus*) control in winter wheat (*Triticum aestivum*). PhD Thesis. Oklahoma State University, Stillwater, OK. 73 pp.

13. Peeper, T. F. 1984. Chemical and biological control of downy brome (*Bromus tectorum*) in wheat and alfalfa in North America. Weed Sci. 32 (Supp. 1) :18-25.

14. Smika, D. E. and E. D. Sharman. 1982. Atrazine carryover and its soil factor relationships to no-tillage and minimum tillage fallow-winter wheat cropping systems in the Central Great Plains. Colorado State Univ. Exp. Stn., Fort Collins. Tech. Bull. 144. 4 pp.

15. Stahlman, P. W. and M. A. El-Hamid. 1994. Sulfonylurea herbicides suppress downy brome (*Bromus tectorum*) in winter wheat (*Triticum aestivum*). Weed Technol. 8:812-818.

16. Stritzke, J. F. and T. G. Bidwell. 1991. Weed control on rangeland. OSU Extension Fact Sheet No. 2758. Oklahoma State Univ., 6 p.

17. Weber, J. B. 1970. Adsorption of s-triazines by montmorillonite. Soil Sci. Soc. Amer. 34:401-404.

Table 1. Field experiments and locations, seeding dates, growth stages, and days from herbicide applications to rainfall for treatments in the 1993-94 and 1994-95 crop years.

			Growth stages for POST treatments									
		Seeding date and PRE	Wheat			Cheat			Days to rainfall[b]			
Experiment type	Location	treatments[a]	POST 1	POST 2	POST 3	POST 1	POST 2	POST 3	PRE	POST 1	POST 2	POST 3
Application timing	Lahoma 94	10-14-93	2 tl	3-4 tl[c]	3-5 tl	3 lf	1 tl	3-6tl	29	21	76	6
	Lahoma 95	10-10-94	3 lf[c]	4-5 tl	9-15 tl	1-2 lf	2-4 tl	5-13 tl	7	4	0	33
	Orlando 94	10-12-93	4-5 lf	3-6 tl	5-12 tl	2-3 tl	3-4 tl	10 tl	5	8	4	4
	Orlando 95	09-18-94	3-4 lf	4-6 tl	8-23 tl	1-2 lf	2-4 tl	8-20 tl	15	9	7	24
	Perkins 94	10-01-93	3-5 lf	4-7 tl	7-20 tl	1-2 lf	2-5 tl	11 tl	7	23	9	5
	Perkins 95	10-05-94	3-5 lf	3-4 tl	3-13 tl	2-3 lf	3-4 tl	8-15 tl	3	4	4	4
On-farm evaluation	Okarche	09-20-94	3-6 tl	4-6 tl	-	2-3 tl	3-6 tl	-	-	7	5	-
	Enid	10-19-94	2-5 tl	3-5 tl	-	2-3 tl	3-4 tl	-	-	12	20	-
	Ponca City	09-27-94	3-4 tl	7-9 tl	-	2-4 tl	4 lf-3tl	-	-	5	9	-
Cultivar tolerance	Lahoma	10-11-94	2-5 tl	-	-	-	-	-	-	4	-	-
	Perkins	10-04-94	3-7 tl	-	-	-	-	-	-	9	-	-

Table. 1. Continued.

[a]PRE treatments were included only in the application timing experiments and were applied immediately after seeding.

[b]Number of days from herbicide application to 0.64 cm or more rainfall.

[c]Abbreviations: lf = leaf; tl = tillers.

Table 2. Soil properties at each experiment site.

Experiment	Site	pH	OM	CEC	Texture			Series	Classification
					Sand	Silt	Clay		
		1:1	%	meq/100g	——	(%)	——		
Application timing	Lahoma	6.0	1.2	14.3	33	48	18	Grant loam	Fine silty, mixed, thermic Udic Argiustolls
	Orlando	6.9	1.5	13.6	35	39	26	Port loam	Fine silty, mixed, thermic Cumulic Haplustolls
	Perkins	5.1	0.7	9.2	63	25	12	Teller sandy loam	Fine loamy, mixed thermic Udic Argiustolls
Cultivar tolerance	Lahoma	5.9	1.6	9.9	43	40	17	Grant loam	Fine silty, mixed, thermic Udic Argiustolls
	Perkins	6.2	0.7	7.1	56	31	13	Teller sandy loam	Fine loamy, mixed thermic Udic Argiustolls
On-farm	Okarche	4.9	1.4	9.5	42	43	15	Norge loam	Fine silty, mixed thermic Udic Paleustolls
	Enid	5.1	0.9	9.7	63	23	13	Meno sandy loam	Fine loamy, mixed, thermic Aquic Arenic Haplustalls
	Ponca City	5.0	2.4	15.1	30	46	24	Tabler loam	Fine, mixed, thermic Abruptic Paleustolls

Table 3. Cheat control in wheat with atrazine, triasulfuron plus atrazine, and standard treatments at three locations in the 1993-94 and 1994-95 crop years.

			Lahoma		Orlando		Perkins	
Treatments	Rate	Timing	94[a]	95[a]	94	95	94	95
	g/ha		%					
Triasulfuron	29	PRE	90 a-d[b]	0 j	0 f	35 f-j	13 gh	46 efg
Atrazine	140		83 b-h	9 hij	5 ef	35 g-j	13 gh	60 c-g
Atrazine	280		78 gh	20 f-i	0 f	40 f-j	70 d	93 abc
Atrazine	420		-	48 c-f	-	83 a-e	-	97 a
Atrazine	560		89 a-e	76 abc	0 f	82 a-d	96 abc	98 a
Triasulfuron + atrazine	29+140		86 a-g	5 ij	23 b-e	53 c-i	18 fgh	58 c-g
Triasulfuron + atrazine	29+280		93 ab	28 e-h	8 ef	61 b-h	33 ef	92 abc
Triasulfuron + atrazine	29+420		-	61 b-e	-	60 b-h	-	96 ab
Triasulfuron + atrazine	29+560		85 b-h	75 a-d	13 c-f	68 a-g	89 bcd	78 a-e
Triasulfuron + metribuzin	29+157	POST 1	79 fgh	50 c-f	29 bcd	36 f-j	43 e	79 a-f
Atrazine	280		81 d-h	10 hij	5 ef	23 hij	83 cd	78 a-f
Atrazine	420		-	18 hij	-	85 abc	-	96 ab

Table 3. Continued.

Atrazine	560		83 c-h	88 ab	5 ef	94 ab	99 ab	97 a
Atrazine	840		91 a-d	94 a	43 ab	98 a	100 a	98 a
Triasulfuron + atrazine	29+280		80 e-h	15 hij	5 ef	60 b-i	71 d	70 a-g
Triasulfuron + atrazine	29+420		-	40 d-g	-	92 abc	-	51 d-g
Triasulfuron + atrazine	29+560		88 a-g	63 b-e	15 c-f	76 a-f	99 ab	98 a
Triasulfuron + atrazine	29+840		85 b-h	69 a-d	30 abc	98 a	99 ab	74 a-f
Metribuzin	420	POST 2	90 a-e	50 c-g	28 bcd	90 abc	96 abc	73 a-f
Atrazine	280		75 h	3 ij	5 ef	15 ij	8 gh	58 b-g
Atrazine	420		-	3 ij	-	69 a-g	-	88 a-d
Atrazine	560		89 a-f	15 g-j	10 def	90 abc	93 a-d	88 abc
Atrazine	840		91 abc	85 ab	30 abc	97 a	98 abc	97 a
Metribuzin	420	POST 3	95 a	10 hij	60 a	44 d-j	83 cd	48 d-g
Atrazine	280		75 h	0 j	0 f	8 j	0 h	10 h
Atrazine	420		-	0 j	-	44 e-j	-	43 fgh
Atrazine	560		85 b-h	0 j	10 def	39 g-j	23 efg	35 gh
Atrazine	840		90 a-d	5 ij	30 abc	71 a-g	93 a-d	86 a-d

Table 3. Continued.

Check	-	0 i	0 j	0 f	0 j	0 h	0 h

[a] Abbreviations: 94 = 1993-94 crop year; 95 = 1994-95 crop year.

[b] Numbers followed by the same letter in a column are not significantly different at the 5% level of significance using LSD.

Table 4. Wheat injury from atrazine, triasulfuron plus atrazine, and standard treatments at three locations in the 1993-94 and 1994-95 crop years.

Treatments	Rate	Timing	Lahoma 94[a]	Lahoma 95[a]	Orlando 94	Orlando 95	Perkins 94	Perkins 95
	g/ha		%					
Triasulfuron	29	PRE	0 e[b]	0 i	5 ab	0 g	20 ij	6 i
Atrazine	140		0 e	8 e-h	0 b	5 fg	23 ij	30 f-i
Atrazine	280		0 e	18 de	5 ab	3 fg	56 fg	89 abc
Atrazine	420		-	45 bc	-	8 def	-	97 a
Atrazine	560		18 abc	55 ab	0 b	21 cd	81 cde	98 a
Triasulfuron + atrazine	29+140		4 de	3 hi	3 b	3 fg	20 ij	18 ghi
Triasulfuron + atrazine	29+280		0 e	10 e-h	3 b	5 fg	45 gh	43 e-h
Triasulfuron + atrazine	29+420		-	38 bc	-	6 efg	-	95 a
Triasulfuron + atrazine	29+560		25 a	68 a	5 ab	10 def	91 abc	75 a-d
Triasulfuron + metribuzin	29+157	POST 1	0 e	3 hi	13 a	0 g	20 ij	41 e-h
Atrazine	280		0 e	3 hi	5 ab	3 fg	30 hi	44 d-h

Table 4. Continued.

Atrazine	420		-	0 i	-	16 cd	-	78 a-e
Atrazine	560		3 de	10 e-h	3 b	30 c	86 bcd	86 ab
Atrazine	840		9 bcd	50 ab	0 b	91 a	98 ab	98 a
Triasulfuron + atrazine	29+280		0 e	5 ghi	5 ab	3 fg	13 ij	31 f-i
Triasulfuron + atrazine	29+420		-	0 i	-	18 cd	-	50 d-g
Triasulfuron + atrazine	29+560		3 de	0 i	3 b	15 cde	84 cde	98 a
Triasulfuron + atrazine	29+840		8 cde	46 bc	5 ab	86 a	99 a	74 a-e
Metribuzin	420	POST 2	18 ab	8 e-h	5 ab	3 fg	45 gh	16 hi
Atrazine	280		0 e	8 e-h	3 b	0 g	28 hi	55 b-f
Atrazine	420		-	8 f-i	-	5 fg	-	45 d-h
Atrazine	560		5 de	15 efg	0 b	19 cd	68 d-g	54 c-f
Atrazine	840		10 bcd	48 abc	0 b	50 b	78 c-f	88 ab
Metribuzin	420	POST 3	10 bcd	5 ghi	3 b	3 fg	18 ij	30 f-i
Atrazine	280		0 e	8 e-h	0 b	0 g	12 j	23 f-i
Atrazine	420		-	15 def	-	6 efg	-	38 fgh
Atrazine	560		8 bcd	10 efg	0 b	9 def	28 hi	50 d-g

Table 4. Continued.

Atrazine	840	10 bcd	30 cd	3 b	28 c	64 efg	76 a-e
Check	-	0 e	0 i	0 b	0 g	0 j	0 i

[a]Abbreviations: 94 = 1993-94 crop year; 95 = 1994-95 crop year.

[b]Numbers followed by the same letter in a column are not significantly different at the 5% level of significance using LSD.

Table 5. Effect of atrazine, triasulfuron plus atrazine, and standard treatments on wheat yield at three locations in the 1993-94 and 1994-95 crop years.

			Lahoma		Orlando		Perkins
Treatments	Rate	Timing	94[a]	95[a]	94	95	94
	g/ha		% of check				
Triasulfuron	29	PRE	122	142	114	168	117
Atrazine	140		112	126	93	101	144
Atrazine	280		113	124	95	140	110
Atrazine	420		-	68	-	212	-
Atrazine	560		103	50	116	153	48
Triasulfuron + atrazine	29+140		123	161	107	149	139
Triasulfuron + atrazine	29+280		118	120	112	174	138
Triasulfuron + atrazine	29+420		-	77	-	175	-
Triasulfuron + atrazine	29+560		86	47	113	166	48
Triasulfuron + metribuzin	29+157	POST 1	114	207	140	143	202
Atrazine	280		112	188	97	128	217
Atrazine	420		-	186	-	137	-
Atrazine	560		125	182	122	111	63
Atrazine	840		102	97	146	10	0
Triasulfuron + atrazine	29+280		105	186	119	188	219
Triasulfuron + atrazine	29+420		-	162	-	185	-
Triasulfuron + atrazine	29+560		110	186	121	162	61
Triasulfuron + atrazine	29+840		112	126	149	36	0
Metribuzin	420	POST 2	125	225	166	194	192
Atrazine	280		111	117	97	149	151
Atrazine	420		-	130	-	146	-

Table 5. Continued.

Atrazine	560		111	126	120	166	124
Atrazine	840		91	61	126	106	31
Metribuzin	420	POST 3	123	187	176	116	115
Atrazine	280		114	117	98	84	89
Atrazine	420		-	120	-	104	-
Atrazine	560		108	118	111	83	55
Atrazine	840		94	71	141	50	24
LSD 0.05			19.1	33.4	23.3	78.0	29.4

[a]Abbreviations: 94 = 1993-94 crop year; 95 = 1994-95 crop year.

Table 6. Reductions in dockage in wheat obtained from atrazine, triasulfuron plus atrazine, and standard treatments at three locations in the 1993-94 and 1994-95 crop years[a].

			Lahoma		Orlando		Perkins
Treatments	Rate	Timing	94[b]	95[b]	94	95	94
	g/ha		%				
Triasulfuron	29	PRE	44	26	8	19	15
Atrazine	140		12	14	-7	9	28
Atrazine	280		40	34	-4	14	30
Atrazine	420		-	13	-	56	-
Atrazine	560		65	5	8	57	59
Triasulfuron + atrazine	29+140		40	39	1	24	23
Triasulfuron + atrazine	29+280		53	34	7	35	34
Triasulfuron + atrazine	29+420		-	15	-	38	-
Triasulfuron + atrazine	29+560		61	-18	6	48	47
Triasulfuron + metribuzin	29+157	POST 1	27	68	20	16	57
Atrazine	280		26	48	-6	14	75
Atrazine	420		-	55	-	54	-
Atrazine	560		52	73	11	61	88
Atrazine	840		65	68	24	57	-[c]
Triasulfuron + atrazine	29+280		35	43	7	40	67
Triasulfuron + atrazine	29+420		-	54	-	66	-
Triasulfuron + atrazine	29+560		52	70	11	49	88
Triasulfuron + atrazine	29+840		64	68	24	77	-[c]
Metribuzin	420	POST 2	77	77	26	64	89
Atrazine	280		28	19	-3	30	35
Atrazine	420		-	40	-	26	-

Table 6. Continued.

Atrazine	560		67	41	6	56	81
Atrazine	840		76	54	19	82	77
Metribuzin	420	POST 3	76	55	35	14	48
Atrazine	280		13	14	-2	-7	5
Atrazine	420		-	20	-	7	-
Atrazine	560		64	33	6	4	10
Atrazine	840		76	22	29	-1	49
LSD 0.05			17.0	20.9	11.6	33.1	18.2

[a]Reductions in dockage were calculated using the formula: Reduction (%) = (((\[dockage in check] minus [% dockage])/[dockage in check]) ∗100).

[b]Abbreviations: 94 = 1993-94 crop year; 95 = 1994-95 crop year.

[c]Yield was to low to determine dockage.

Table 7. Interaction of herbicide treatment and application timing on cheat control, wheat grain yield, and dockage in wheat grain in three on-farm experiments.

			Cheat control[a]		Wheat yield		Dockage	
			Time of application					
Location	Treatment	Rate	November	December	November	December	November	December
		g/ha	%		kg/ha		%	
Okarche	Atrazine	280	10 c	5 c	1110	770	43	53
	Atrazine	420	43 b	15 c	1450	970	28	38
	Atrazine	560	85 a	38 b	1190	930	17	41
	Metribuzin	420	95 a	8 c	1560	1780	7	22
	Check	-	0		630		58	
	LSD 0.05				396		15	
Enid	Atrazine	280	15 d	0 e	670	650	47	47
	Atrazine	420	59 b	4 de	710	790	40	30
	Atrazine	560	95 a	30 c	1030	980	28	27
	Metribuzin	420	98 a	75 b	1300	1220	12	18

Table 7. Continued.

	Check	-	0		610		48	
	LSD 0.05				282		14	
Ponca City	Atrazine	280	15 c	30 c	1450	880	31	43
	Atrazine	420	23 c	25 c	1050	1080	34	39
	Atrazine	560	43 bc	68 ab	910	1380	38	26
	Metribuzin	420	93 a	89 a	1370	1050	21	45
	Check	-	0		820		44	
	LSD 0.05				540		22	

[a] Numbers within a location followed by the same letter are not significantly different at the 5% level of significance using LSD.

Table 8. Interaction of atrazine rate and wheat cultivar on visual wheat injury and effect of atrazine, pooled over rates, on interception of PAR by the canopy and on wheat yield at Lahoma.

	Wheat injury						
	Lahoma		Perkins				
	Atrazine (g/ha)				PAR[a]		
Cultivar	420	840	420	840	Lahoma	Perkins	Wheat yield
	%				% of check		
AGSECO 7853	5 hij[b]	92 abc	15 de	60 ab	50	74	61
Chisholm	10 gh	93 ab	8 def	63 ab	56	74	48
Jagger	0 j	83 bcd	4 ef	61 ab	64	61	55
Karl 92	0 j	55 e	5 ef	46 bc	70	73	71
Scout 66	16 fg	80 cd	5 def	44 bc	59	68	41
TAM 101	30 f	97 a	8 def	71 a	37	59	29
Tomahawk	0 j	54 e	6 def	44 bc	74	77	69
2157	3 ij	90 abc	1 f	38 c	61	62	50
2163	4 hij	73 de	8 def	71 a	64	91	50
2180	11 gh	91 abc	16 d	75 a	42	57	54

Table 8. Continued.

LSD 0.05	17.5	18.4	24

[a]Abbreviations: PAR = interception of photosynthetically active radiation.

[b]Numbers followed by the same letter in a column are not significantly different at the 5% level of significance using LSD.

VITA

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