Warm-season Grass Establishment with Atrazine

A. R. Martin, R. S. Moomaw, and K. P. Vogel

ABSTRACT

Weed competition is a limiting factor in warm-season grass establishment, often delaying the first forage harvest 2 or 3 years. Weed control with herbicides could reduce this competition resulting in more rapid grass establishment. Field experiments were conducted to evaluate the effect of atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] on weed control, warm-season grass establishment, and forage yield during the seeding and following year.

Several warm-season grass species were spring seeded at locations having distinctly different soils. The soils involved were a Butler silty clay loam (Abruptic Argiaquoll) containing 3.8% organic matter and a pH of 5.2, a Croton silty clay loam (Typic Ustorthent) containing 2.1% organic matter with a pH of 7.2 and a Nora silty clay loam (Udic Haplustoll) containing 2.8% organic matter and pH 5.8. Atrazine at various rates was applied preemergence shortly after grass seeding and at one site it was also applied the preceding fall. Weed control, grass establishment, and forage yield were measured the year of seeding and the following year.

Uncontrolled weeds during the year of seeding reduced stands and 1st year forage yields of big bluestem (Andropogon gerardi Vitman), indiangrass [Sorghastrum nutans (L.) Nash], sand lovegrass [Eragrostis trichodes (Nutt.) Wood], sideoats grama [Bouteloua curtipendula (Michx.) Torr.], and switchgrass [Panicum virgatum L.]. Big bluestem and switchgrass tolerated preemergence atrazine applications of 3.4 kg/ha on the Butler soil. Big bluestem was less tolerant of atrazine than switchgrass on the Croton soil. Some atrazine tolerance was present in indiangrass but not in sand lovegrass and sideoats grama. Seedling year forage yields of big bluestem and switchgrass were significantly increased by atrazine. Weed control during the seedling year sometimes resulted in higher forage yields the following year. Big bluestem and switchgrass can be readily established and produce substantial forage yields the year of seeding by using atrazine for weed control. This would make these grasses more attractive to farmers and ranchers.


W eed competition is a serious limiting factor in the establishment of forage grasses from seed. Poor stands or complete stand failures may occur as a result of weed competition (4, 12). When weeds are controlled during the establishment phase of a new seeding, excellent stands can be obtained (3, 12).

Warm-season perennial forage grasses are particularly slow to become established from seed, often requiring 2 to 4 years from seeding before they can be grazed or harvested for hay (18). This slowness and uncertainty of stand establishment deters many farmers and ranchers from seeding warm-season grasses. One of the major reasons for the slow establishment is weed competition (2, 16, 17, 18). Cool-season weed species are especially competitive (16).

Weed competition has reduced both forage and seed yield of grasses (2, 6, 13). Uncontrolled weeds reduced 2nd year forage yields of big bluestem (Andropogon gerardi Vitman) and indiangrass [Sorghastrum nutans (L.) Nash] 50 and 33%, respectively (2). Sideoats grama [Bouteloua curtipendula (Michx.) Torr.] seed yields were increased 10-fold with adequate weed control (13). Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] has been used successfully for weed control in established warm-season grass seed production fields (5). Ethofumesate [(±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate] has been used successfully to control annual bluegrass (Poa annua L.) in Italian ryegrass (Lolium multiflorum Lam.) seed fields (11). Post-emergence herbicides have been used effectively for weed control just prior to seeding and in new seedings of cool-season grasses (8, 10). The use of soil-applied herbicides for weed control in new grass seedings is a relatively new practice.


Research and commercial use on seed fields has demonstrated the safety of atrazine on established warm-season grasses. There has been evidence that s-triazine herbicides especially atrazine would be useful in establishing certain warm-season grasses from seed. With weed competition controlled, the time required for warm-season grasses to become established and productive would be reduced. This would make

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the increased use of warm-season grasses more economical to the farmer and rancher.

Field studies were conducted at Concord and Mead, Nebr. from 1977 through 1979 to evaluate the use of atrazine on new seedings of several warm-season grasses. Experiments were designed to evaluate weed control, grass establishment and forage yield as influenced by atrazine during the seeding and following year.

### MATERIALS AND METHODS

Concord Experiments. An experiment was initiated in 1977 on a Crofton silty clay loam (Typic Udorthent) containing 33% clay, 2.1% organic matter, and having a pH of 7.2. After disking and harrowing for seedbed preparation, grass was seeded 28 April in 18 cm rows with a plot drill which was used for all experiments (15). Individual plots consisted of seven drilled rows 5.5 m long spaced 18 cm apart and were arranged in a randomized complete block design with four replications. Seed of ‘Pathfinder’ switchgrass, Holt indiangrass, Trailway sideoats, Pawnee big bluestem were seeded as described earlier. Atrazine at 0.9 kg/ha was applied 4 Apr. 1979 to the entire experimental area. This treatment provided partial weed control. Weed growth was hand separated and excluded from the forage yields, which were determined on 29 and 30 Aug. 1979.

Mead Experiment. An experiment was initiated in 1978 on a Butler silty clay loam (Aubric Argiaquoll) containing 3.8% organic matter and a pH of 5.5. The experimental design was a randomized complete block with a split-split plot treatment arrangement and four replications. Grass species were main plots, atrazine rates were subplots and handweeding vs. no weeding were sub-subplots. After disking and harrowing for seedbed preparation, grasses were seeded on 17 May 1978. Individual plots were seven 18 cm rows wide and 4.6 m long. Seed of Pathfinder switchgrass, Hold indiangrass, Trailway sideoats, Pawnee big bluestem, and ‘Nebr 27’ sand lovegrass was seeded at 400 PLS/m². Grass stand was determined in late June by taking four line transects per plot and counting the number of points out of 100 points at 5 cm intervals along the transect contacting a clump of grass. Visual weed control evaluations were made on 30 June. On 2 July plots were clipped above grass height with a mower and weeds were harvested and expressed as kg/ha of oven-dry material. Grass growth was excellent where weeds were controlled; however, yields were not taken until 1978. In early spring 1978, grass growth from the previous year was removed and 0.9 kg/ha atrazine was applied to the experimental area on 4 April. Forage yield was determined 16 Aug. 1978 by clipping a 0.6 m swath from the center of each plot with the yield expressed as kg/ha of oven-dry forage. Weed growth was removed and excluded from the forage yield. Forage yields were taken again on 29 Aug. 1979 and expressed as kg/ha of oven-dry material.

Another experiment was initiated in 1977 on a Nora silty clay loam (Udic Hapludoll) containing 34% clay, 2.8% organic matter, and having a pH of 5.8. The experimental design was a split block with time of atrazine applications as the main plots and four replications. Treatments consisted of atrazine applied either in the fall of 1977 or the spring of 1978 with and without handweeding. Fall atrazine application was made on 26 Sept. 1977 at 0, 1.1, and 2.2 kg/ha; handweeded plots were hoed as needed. Stand establishment was determined in late June by taking four line transects per plot and counting the number of points out of 100 points at 5 cm intervals along the transect contacting a clump of grass. Visual weed control evaluations were made on 30 June. On 2 July plots were clipped above grass height with a mower and weeds were harvested and expressed as kg/ha of oven-dry material. Grass growth was excellent where weeds were controlled; however, yields were not taken until 1978. In early spring 1978, grass growth from the previous year was removed and 0.9 kg/ha atrazine was applied to the experimental area on 4 April. Forage yield was determined 16 Aug. 1978 by clipping a 0.6 m swath from the center of each plot with the yield expressed as kg/ha of oven-dry forage. Weed growth was removed and excluded from the forage yield. Forage yields were taken again on 29 Aug. 1979 and expressed as kg/ha of oven-dry material.

### Table 1. Mean grass stand, forage and weed yields for four warm-season grasses seeded on a Crofton silty clay loam with a pH of 7.2 in 1977 as influenced by weed control at Concord, Nebr. from 1977 through 1979.

<table>
<thead>
<tr>
<th>Grass Atrazine Rate</th>
<th>Grass Stand (4)</th>
<th>Forage (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1977 1978 1979</td>
<td></td>
</tr>
<tr>
<td>Big bluestem 0</td>
<td>930 a 920 a 910 a</td>
<td>6,600 a 6,500 a 6,400 a</td>
</tr>
<tr>
<td>0 + handweed 1.1</td>
<td>750 a 740 a 730 a</td>
<td>6,300 a 6,200 a 6,100 a</td>
</tr>
<tr>
<td>1.1 + handweed</td>
<td>630 b 620 b 610 b</td>
<td>5,900 b 5,800 b 5,700 b</td>
</tr>
<tr>
<td>2.2 + handweed</td>
<td>450 c 440 c 430 c</td>
<td>4,600 c 4,500 c 4,400 c</td>
</tr>
<tr>
<td>Indiangrass 0</td>
<td>720 a 710 a 700 a</td>
<td>6,900 a 6,800 a 6,700 a</td>
</tr>
<tr>
<td>0 + handweed 1.1</td>
<td>560 b 550 b 540 b</td>
<td>5,700 b 5,600 b 5,500 b</td>
</tr>
<tr>
<td>1.1 + handweed</td>
<td>380 d 370 d 360 d</td>
<td>4,900 d 4,800 d 4,700 d</td>
</tr>
<tr>
<td>2.2 + handweed</td>
<td>140 e 130 e 120 e</td>
<td>3,100 e 3,000 e 2,900 e</td>
</tr>
<tr>
<td>Sideoats grama</td>
<td>420 a 410 a 400 a</td>
<td>6,700 a 6,600 a 6,500 a</td>
</tr>
<tr>
<td>0 + handweed 1.1</td>
<td>1,480 a 1,470 a 1,460 a</td>
<td>8,000 a 8,000 a 8,000 a</td>
</tr>
<tr>
<td>1.1 + handweed</td>
<td>850 b 840 b 830 b</td>
<td>6,400 b 6,300 b 6,200 b</td>
</tr>
<tr>
<td>2.2 + handweed</td>
<td>550 c 540 c 530 c</td>
<td>4,900 c 4,800 c 4,700 c</td>
</tr>
<tr>
<td>Switchgrass 0</td>
<td>1,980 a 1,970 a 1,960 a</td>
<td>8,400 a 8,300 a 8,200 a</td>
</tr>
<tr>
<td>0 + handweed 1.1</td>
<td>290 b 280 b 270 b</td>
<td>7,200 b 7,100 b 7,000 b</td>
</tr>
<tr>
<td>1.1 + handweed</td>
<td>270 c 260 c 250 c</td>
<td>6,000 c 5,900 c 5,800 c</td>
</tr>
<tr>
<td>2.2 + handweed</td>
<td>120 d 110 d 100 d</td>
<td>4,700 d 4,600 d 4,500 d</td>
</tr>
<tr>
<td>2.2 + handweed</td>
<td>100 a 90 a 80 a</td>
<td>10,200 ab 10,100 ab 10,000 ab</td>
</tr>
</tbody>
</table>

* Based on a grass stand of a plant every 5 cm of row.

† Numbers within columns for individual grass species followed by the same letter are not different at the 5% level of probability using Duncan’s Multiple Range Test. In the combined analysis the species and atrazine rate effects on grass stand and forage yield were significant at the 0.05 level.
was fertilized on 14 May 1979 with 112 kg/ha N as NH₄N0₃. The experimental area was handweeded prior to harvest. Grasses were harvested on 20 Aug. 1979 by mowing at a 5 cm height and yields expressed as kg/ha of oven-dry matter. Stand counts in 1979 were determined by placing a metal grid containing 25 squares each 15 by 15 cm over the center five rows of each plot. The number of squares containing a grass plant or portion of a plant were counted and the numbers multiplied by 4 to obtain percent stand.

Results were analyzed using standard statistical procedures. Weed yields from sand lovegrass plots at Mead in 1978 were excluded from the analysis of variance because weed yields from only one replication were available. Weed yields in the other replication were not determined since there was no harvestable forage in any of these plots treated with atrazine.

**RESULTS AND DISCUSSION**

Weed Control. Green foxtail (Setaria viridis (L.) Beauv.) and redroot pigweed (Amaranthus retroflexus L.), were the principal weed species at both Concord and Mead. Weed growth tended to be greater at Mead than at Concord in atrazine treated as well as the untreated plots (Tables 1, 2, and 3). Greater rainfall, soil organic matter and soil weed seed numbers at Mead all contributed to the greater weed growth.
Atrazine provided less complete weed control at Mead than at Concord.

Soil pH and organic matter both have a strong influence on atrazine activity (7). Atrazine activity and persistence is increased at higher pH levels (1). Soil organic matter adsorbs atrazine reducing its activity (7). This effect of carbon and organic matter on atrazine activity has been utilized by applying bands of activated carbon over the crop row to protect crops from atrazine injury (9). The effect of soil pH and organic matter on atrazine activity has an influence on suggested use patterns (Ciba-Geigy Corp., 1982. Agricultural Division Sample Labels. p. 1–17).

Soil organic matter and pH differences would contribute to lesser atrazine activity and reduced weed control at the Mead location than either of the Concord sites. The 2.2 kg/ha atrazine application in the 1977 Concord experiment provided better weed control than in the 1978 experiment. Greater soil pH (7.2 vs. 5.8) and lower soil organic matter (2.1% vs. 2.8%) probably contributed to greater atrazine activity on the 1977 site and therefore better weed control. Weed control with the 3.4 kg/ha atrazine rate in the fall at Concord was comparable to the 2.2 kg/ha rate applied in the spring (Table 2). The 2.2 kg/ha atrazine application provided almost complete weed control at Concord in 1977 but in the other experiments some weed growth and therefore competition with the grass occurred even at the highest rates of atrazine used.

Grass Stand. There was a significant grass by atrazine rate interaction on grass stand in these studies (Tables 1, 2, and 3). Poor stands of switchgrass were obtained at Concord in 1977 because the seed was old and had poor seedling vigor. Examination of the species response to atrazine showed that switchgrass was tolerant of atrazine at the rates used at Concord in 1977 and Mead in 1978 as indicated by the stands in the handweeded plots (Tables 1 and 3). There was a
switchgrass stand reduction at Concord with the 2.2 kg/ha atrazine application in the spring of 1978 (Table 2). Spring atrazine applications at 2.2 kg/ha caused a big bluestem stand reduction in both Concord experiments, but not at Mead where the soil pH was lower and organic matter content higher. This suggests big bluestem is somewhat less tolerant of atrazine than switchgrass. Indiangrass showed some tolerance to atrazine, but stand reductions were substantial even at low atrazine rates at all three sites. Sideoats grama was more sensitive to atrazine than indiangrass, and sand lovegrass was the most sensitive of the five species.

Weed competition was a significant factor in grass establishment. Handweeding in the absence of atrazine resulted in improved stands the year of seeding especially with indiangrass and sideoats grama (Tables 1 and 2). Big bluestem and switchgrass stands the year of seeding suffered less from weed competition than the other grasses. Stands improved markedly between 1978 and 1979 at Mead with all of the grasses (Table 3). Stands of indiangrass, sand lovegrass, and sideoats grama the 2nd year continued to reflect poor weed control during the seeding year as indicated by the 1979 stand of weeded compared with non-weeded plots (Table 3). Big bluestem and switchgrass stands were quite good the 2nd year even without weed control, indicating that these species are better weed competitors than the other grasses.

Forage Yield. Handweeding without atrazine during the year of seeding caused a dramatic increase in yield of all the grasses at all locations illustrating the detrimental effect of weed competition on grass production (Tables 1, 2, and 3). None of the grasses produced a harvestable yield during the year of seeding without weed control. With weed control, big bluestem and switchgrass produced forage yields of 3,830 and 5,350 kg/ha, respectively at Concord in 1978 and 4,440 and 8,650 kg/ha, respectively at Mead the year of seeding (Tables 2 and 3). Forage yields of big bluestem and switchgrass treated with atrazine were equal and usually significantly greater than the plots not treated with atrazine the year of seeding. Even though the low rates of atrazine reduced indiangrass stands, forage yields the year of seeding were equal to the no weed control treatments. Thus, the benefit of weed control offset the effect of stand loss due to low rates of atrazine. Sideoats grama and sand lovegrass were more sensitive to atrazine and 1st year yields tended to be reduced even at low rates of atrazine.

Second and third year forage yields tended to be higher, though not in all cases, where weed control as handweeding was utilized the year of seeding. Weed control with atrazine the year of seeding gave this same response during the 2nd and 3rd year with big bluestem and switchgrass.

Atrazine was applied preemergence at 2.2 kg/ha to 23 different switchgrass cultivars and 10 big and sand bluestem cultivars in a yield test at Mead, Nebr. in 1980 without adverse visual affects. This indicates the atrazine tolerance of these grasses is acceptable among the cultivars currently available.

LITERATURE CITED