Control of Downy Brome on Nebraska Rangeland

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Highlight: Experiments to study the control of downy brome were conducted at three locations on Nebraska rangeland. Soils ranged from a silty clay loam to a loamy sand. Herbicide treatments included atrazine, cyanazine, metribuzin, and simazine at 0.5 and 1.0 lb/acre; glyphosate and terbacil at 0.25 and 0.5 lb/acre; secbumeton at 1.0 and 2.0 lb/acre; and paraquat at 0.25 lb/acre applied in the spring. All treatments, with the exceptions of glyphosate and paraquat, were also applied in the fall. Metribuzin at 0.33 lb/acre was also applied in the fall. Atrazine, metribuzin, and simazine effectively controlled downy brome. Downy brome control and forage production were greater when these herbicides were applied in the spring. Forage production was not significantly increased when herbicides were applied in the fall, but the trend was toward increased production. Injury to perennial cool-season forage grasses was greater from spring-applied herbicides than from fall applications. Control of downy brome was greater on fine-textured soils than on coarse-textured soils.

Downy brome (*Bromus tectorum* L.) was introduced to the arid and semiarid western United States about 1900 and has become a major portion of the cover on grazing lands in that area (Stewart and Hull 1949). It has forage value in its immature stages, but production fluctuates greatly with moisture conditions. Downy brome is a prolific seed producer and spreads rapidly. Seeds will germinate and plants emerge when conditions are favorable, whether in the fall, during the winter, or in the early spring (Hull and Hansen 1974). Large numbers of viable seeds are carried over from one year to the next in litter and soil (Young et al. 1969; Hull and Hansen 1974), but germination of downy brome seeds after that period of time is very low (Hulbert 1955). Downy brome seed production is density-dependent and seed can be environmentally conditioned to continuous germination (Young et al. 1969); however, complete germination in a single season under natural conditions is rare (Hull and Hansen 1974). Competition from downy brome can be reduced if seed production can be prevented.

Weed growth and establishment of replacement vegetation are directly related to soil moisture and temperatures in the immediate environment of the growing plants (Evans et al. 1970). More soil moisture is available to perennial grass seedlings where weeds such as downy brome are controlled.

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Rydrych (1974) in Oregon found that downy brome emerging with winter wheat was most competitive during March. On a silt loam soil receiving 42 cm (16.5 inches) of precipitation annually, downy brome densities of 108 to 160 plants per m^2 (10 to 15 plants per ft^2) lowered wheat (*Triticum aestivum* L. 'Gaines') yields by only 6% when controlled by March. A reduction of 40% resulted when the competition from downy brome was not removed until wheat harvest.

Several herbicides are presently available that will control annual weeds such as downy brome. Kapusta and Strieker (1975) in Illinois found that cyanazine [2-[[4-chloro-6-(ethylamino)-*s*-triazin-2-yl]amino]-2-methlpropionitrile] at 3.4 kg/ha (3 lb/acre), paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) at 0.56 kg/ha (0.5 lb/acre), pronamide [3,5-dichloro(*N*-1,1-dimethyl-2-propynyl)benzamide] at 0.84 and 1.4 kg/ha (0.75 and 1.25 lb/acre), simazine [2-chloro-r,6-bis(ethylamino)-*s*-triazine] at 1.12 kg/ha (1.0 lb/acre), and terbacil (3-*tert*-butyl-5-chloro-6-methyluracil) at 0.84 kg/ha (0.75 lb/acre) resulted in excellent control of downy brome in alfalfa (*Medicago sativa* L.) when applied when the alfalfa and downy brome were dormant. There was no injury to the alfalfa and yield increases were associated with downy brome control.

Eckert et al. (1974), in an evaluation of the atrazine-fallow technique, fund that 0.6 to 1.2 lb/acre of atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine] applied in the fall effectively controlled annual weeds. Only the 1.2 lb/acre rate of atrazine damaged perennial grass seedlings. More research is needed in determining the effect of atrazine on established perennial grasses.

The objectives of this study were to evaluate several herbicides for the control of downy brome and to determine the effect of downy brome on perennial forage grass production.

Materials and Methods

Experiments were established for the control of downy brome at three locations in Nebraska: northwestern Nebraska on a silty clay loam soil receiving 13 inches annual precipitation; north central Nebraska on a loamy sand soil receiving 21 inches annual precipitation; and western Nebraska on a silt loam soil receiving 15 inches annual precipitation. Spring and fall herbicide treatments were applied at the north central and northwestern locations; spring treatments were applied at the western location.

Spring treatments were applied in early March and fall treatments were applied in November. Treatments were applied one time in each experiment. Herbicide treatments included atrazine, cyanazine, and simazine at 0.5 and 1.0 lb/acre; secbumeton [N-ethyl-6-methoxy-N'(1-methylpropyl) 1,3,5-triazine-2, 4-diamine] at 1 and 2 lb/acre, metribuzin [4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazine-5(4*H*-one] at 0.33, 0.5, and 1.0 lb/acre and terbacil at 0.25 and 0.5 lb/acre. Paraquat at 0.25 and glyphosate [*N*-(phosphonomethyl)glycine] at 0.25 and 0.50 lb/acre were also included in spring treatments at the north central and northwestern locations.

The experimental design was a randomized complete block with four replications. Plot size was 10 by 35 ft. Herbicides were applied with a tractor-mounted constant-pressure sprayer in a total volume of 20 gal/acre at 32 psi. Percentage of downy brome control was visually estimated the year of application and 1 and 2 years following application. The fall-applied treatments were not evaluated the year of application. Forage yields were determined by clipping at a 2-inch height the year of application and the year following application of spring-applied treatments, and the year following fall application of herbicides. An area 3 by 28 ft was harvested in each plot. The harvested forage was oven-dried at 140°F for 48 hours. No forage yields were determined from the loamy sand soil location because of the lack of moisture and control over grazing livestock. Primary forage species were western wheatgrass (*Agropyron smithii* Rydb.) and blue grama [*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.]. Other forage species include sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.], prairie sandreed [*Calamovilfa longifolia* (Hook.) Scribn.], needleandthread (*Stipa comata* Trin. and Rupr.), prairie Junegrass [*Koeleria cristata* (L.) Pers.], and sand dropseed [*Sporobolus cryptandrus* (Torr.) A. Gray]. The primary weedy grass was downy brome. Sixweeks fescue (*Festuca octoflora* Walt.) was also present. Broadleaf plants were of minor consequence in the study area.

Results and Discussion

Herbicides applied on the silty clay loam soil in the spring resulted in excellent control of downy brome at 2 months after application (Table 1). All treatments except cyanazine at 0.5 lb/acre and paraquat at 0.25 lb/acre resulted in 95% or more control at this time. Five months after application, glyphosate and paraquat had lost their effectiveness, and the effect of cyanazine at 0.5 lb/acre had decreased to 40%. The effect of simazine at 0.5 lb/acre decreased from 98% to 78% 5 months after application, but all other treatments effectively controlled downy brome. Glyphosate and paraquat had effectively controlled emerged downy brome at the time of application, but did not affect later emerging plants or plants arising from seed sources out of the plot area.

Herbicide applications in the spring on the loamy sand soil were not as effective as those applied to the fine-textured soil. Three months after application, atrazine at 0.5 and 1.0 lb/acre controlled 55 and 78%, respectively, of the downy brome. Only metribuzin at 0.5 and 1.0 lb/acre and terbacil at 0.25 and 0.5 lb/acre resulted in more than an 85% stand reduction of downy brome. Metribuzin at 0.5 lb/acre resulted in a stand reduction of 88%, while the 1.0 lb/acre rate controlled 98% of the downy brome. Terbacil at 0.25 and 0.5 lb/acre resulted in 85 and 95% downy brome control, when evaluated 3 months after application. The differences in effectiveness between herbicides applied to the silty clay loam soil and the loamy sand soil are apparently related to the soil texture, organic matter content and amount of annual precipitation. Precipitation was below normal during the years these experiments were conducted.

Of the herbicides applied in the spring on the silt loam soil, only atrazine at 1 lb/acre, metribuzin at all rates, and terbacil at 0.5 lb/acre reduced the stand of downy brome by more than 80%. All other treatments were less than 70% effective when evaluated 5 months after application. Terbacil at 0.5 lb/acre and metribuzin at 1.0 lb/acre gave nearly complete control the year of application. Metribuzin at 0.33 and 0.5 lb/acre resulted in 88 and 83% control, respectively, of the stand of downy brome during the year of application.

Fall application of herbicides on the silty clay loam soil was generally not as effective for the control of downy brome as

Table 2. Downy brome control (%) following fall application of several herbicides on two soil types of Nebraska rangeland.[1]

Treatment		Silty clay loam		Loamy sand
Herbicide	Rate (lb/acre)	8 mo. after application	20 mo. after application	7 mo. after application
Check	—	0 a	0 a	0 a
Atrazine	0.5	75 de	80 cd	68 d
Atrazine	1.0	100 f	85 cd	89 ef
Cyanazine	0.5	40 b	12 ab	2 a
Cyanazine	1.0	50 bc	42 bc	18 abc
Secbumeton	1.0	42 b	22 ab	5 ab
Secbumeton	2.0	98 f	82 cd	28 c
Metribuzin	0.33	68 cd	45 bc	35 c
Metribuzin	0.5	90 ef	78 cd	78 de
Metribuzin	1.0	95 f	95 d	100 f
Simazine	0.5	68 cd	52 bc	22 bc
Simazine	1.0	98 f	75 cd	68 d
Terbacil	0.25	58 bcd	80 cd	75 de
Terbacil	0.5	98 f	72 cd	99 f

[1] Means in the same column followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

Table 1. Downy brome control (%) following spring application of several herbicides on three soil types of Nebraska rangeland.[1]

Treatment		Silty clay loam		Loamy sand	Silt loam
Herbicide	Rate (lb/acre)	2 mo. after application	5 mo. after application	3 mo. after application	5 mo. after application
Check	—	0 a	0 a	0 a	0 a
Atrazine	0.5	100 d	98 d	55 d	55 cd
Atrazine	1.0	98 d	92 cd	78 e	88 f
Cyanazine	0.5	72 b	40 b	12 abc	43 bc
Cyanazine	1.0	95 cd	95 cd	45 cd	68 de
Glyphosate	0.25	98 d	8 a	15 abc	
Glyphosate	0.5	98 d	0 a	20 abc	
Secbumeton	1.0	95 cd	88 cd	0 a	58 cd
Secbumeton	2.0	100 d	100 d	28 bc	68 de
Metribuzin	0.33				88 f
Metribuzin	0.5	100 d	100 d	88 e	83 ef
Metribuzin	1.0	100 d	95 cd	98 e	100 f
Paraquat	0.25	85 c	0 a	5 ab	
Simazine	0.5	98 d	78 c	28 bc	10 a
Simazine	1.0	100 d	98 d	30 cd	43 bc
Terbacil	0.25	98 d	95 cd	85 c	30 b
Terbacil	0.5	98 d	100 d	95 e	98 f

[1] Means in the same column followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

spring application (Table 2). Eight months after application, atrazine, metribuzin and simazine at 1.0 lb/acre, secbumeton at 2.0 lb/acre, and terbacil at 0.5 lb/acre resulted in more than 95% stand reduction of downy brome, while metribuzin at 0.5 lb/acre resulted in 90% downy brome control. Atrazine at 0.5 lb/acre gave 75% control. Twenty months after application, most herbicides had decreased in effectiveness, as would be expected. There was no difference between rates of atrazine 20 months after application, each rate resulting in about 80% control of downy brome. The 2.0 lb/acre rate of secbumeton still achieved 82% control, while 0.5 lb/acre of metribuzin controlled 78% of the stand of downy brome. Metribuzin at 1.0 lb/acre reduced the stand of downy brome by 95%, 20 months after application. There was no difference between rates of terbacil: 0.25 and 0.5 lb/acre rates resulted in 80 to 72%, respectively. Atrazine or simazine at 1.0 lb/acre applied in the fall to a silty clay loam soil receiving about 13 inches annual precipitation appears to be an effective treatment for the control of downy brome.

Fall applications of herbicides on a loamy sand soil responded slightly differently than those applied to the fine-textured soil. Seven months after application, all treatments, except both rates of cyanazine and secbumeton at 1.0 lb/acre, resulted in a statistically significant stand reduction of downy brome. However, only atrazine and metribuzin at 0.5 and 1.0 lb/acre, simazine at 1.0 lb/acre, and terbacil at both rates resulted in downy brome control of more than 65% when compared to the untreated plots. Atrazine at 0.5 lb/acre and simazine at 1.0 lb/acre resulted in 68% control of downy brome, while 1.0 lb/acre of atrazine reduced the stand of downy brome by 89%. Metribuzin at 0.5 lb/acre gave 78% control, while 1.0 lb/acre resulted in complete control of downy brome. Terbacil at 0.25 lb/acre gave 75% control and 0.5 lb/acre resulted in 99% downy brome control. These data indicate that the most promising herbicide for the control of downy brome growing on a loamy sand soil receiving about 21 inches precipitation would appear to be atrazine at a rate of 1.0 lb/acre applied in the fall. The other effective herbicides are too high in cost to be considered at this point.

Herbicides applied to a silt loam soil in the spring decreased in effectiveness the year following application, with the exception of secbumeton at 2.0 lb/acre (Table 3). Downy brome control for this treatment was 86%, but all other treatments were less than 60% effective the year after application.

Table 3. Downy brome control (%), downy brome and forage production (lb/acre, oven-dry) 17 months after application of herbicides in the spring on a silt loam soil of Nebraska rangeland.[1]

Treatment		Downy brome control	Forage production	Downy brome production
Herbicide	Rate (lb/acre)			
Check	—	0 a	540 a	410 d
Atrazine	0.5	31 bcdef	885 ab	255 bcd
Atrazine	1.0	49 fg	745 ab	65 ab
Cyanazine	0.5	41 defg	915 ab	190 abc
Cyanazine	1.0	22 bcd	750 ab	310 cd
Secbumeton	1.0	58 g	730 ab	20 a
Secbumeton	2.0	86 h	545 a	30 a
Metribuzin	0.33	20 bc	970 ab	115 ab
Metribuzin	0.5	28 bcde	845 ab	190 abc
Metribuzin	1.0	40 cdefg	965 ab	70 ab
Simazine	0.5	20 bc	680 ab	385 d
Simazine	1.0	31 bcdef	1230 b	115 ab
Terbacil	0.25	15 ab	635 a	250 bcd
Terbacil	0.5	42 efg	1065 ab	70 ab

[1] Means in the same column followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

Forage grass production was significantly increased only by the 1 lb/acre rate of simazine when compared to the untreated plots. This treatment resulted in a forage grass yield increase of 686 lb/acre or about 126%. However, atrazine, cyanazine, metribuzin and terbacil at 0.5 lb/acre, and metribuzin at 0.33 lb/acre increased forage grass yields more than 300 lb/acre when applied in the spring on a silt loam soil and evaluated the year after herbicide application. There were no significant forage grass yield increases from any treatment applied to a silt loam soil in the spring during the year of herbicide application. The year following herbicide application, downy brome production was reduced by atrazine at 1.0 lb/acre, secbumeton at both rates, metribuzin at all rates, simazine at 1.0 lb/acre, and cyanazine and terbacil at 0.5 lb/acre. It appears that the most promising herbicide treatments in relation to control of downy brome and forage grass production to be applied to a silt loam soil in the spring would be atrazine at 0.5 lb/acre or simazine at 1.0 lb/acre.

When herbicide treatments were applied in the spring on a silty clay soil, forage grass production was increased the yer of herbicide application by atrazine and terbacil at 0.5 lb/acre and cyanazine and metribuzin at 1.0 lb/acre (Table 4).

Table 4. Forage production (lb/acre, oven-dry) 5 months after spring application of herbicides on a silty clay loam soil of Nebraska rangeland.[1]

Herbicide	Rate (lb/acre)	Forage production
Check	—	410 a
Atrazine	0.5	1305 d
Atrazine	1.0	930 abcd
Cyanazine	0.5	905 abcd
Cyanazine	1.0	1010 cd
Glyphosate	0.25	465 ab
Glyphosate	0.5	495 abc
Secbumeton	1.0	880 abcd
Secbumenton	2.0	860 abcd
Metribuzin	0.5	870 abcd
Metribuzin	1.0	1120 d
Paraquat	0.25	540 abc
Simazine	0.5	920 abcd
Simazine	1.0	850 abcd
Terbacil	0.25	930 abcd
Terbacil	0.5	980 bcd

[1] Means followed by the same letter do not differ significantly at the 5% level by Duncan's multiple range test.

Forage yield increases when atrazine at 0.5 lb/acre was applied in the spring and evaluated the same year was about 900 lb/acre. Cyanazine and metribuzin at 1.0 lb/acre each increased forage production by about 600 lb/acre, while the resulting increase from the application of terbacil at 0.5 lb/acre was more than 550 lb/acre.

Atrazine at 0.5 or 1.0 lb/acre applied in the spring or fall to a variety of soils in areas of variable precipitation appears to be effective for the control of cool-season grassy weeds, such as downy brome, in grazing lands. Although no data are shown regarding injury to forage grasses, injury to forage grasses does appear to be greater from spring-applied herbicide treatments than from treatments applied in the fall. However, these forage grasses apparently are able to recover from this injury rapidly and with the reduced competition from the annual weeds, production will be increased. Proper grazing management must accompany weed control techniques for maximum benefits to be attained on a sustained basis.

Literature Cited

Eckert, Richard E., Jr., Jerry E. Asher, M. Dale Christensen, and Raymond A. Evans. 1974. Evaluation of the atrazine-fallow technique for weed control and seedling establishment. J. Range Manage. 27:288-292.

Evans, R. A., H. R. Holbo, R. E. Eckert, Jr., and J. A. Young. 1970. Functional environment of downy brome communities in relation to weed control and revegetation. Weed Sci. 18:154-162.

Hulbert, Lloyd C. 1955. Ecological studies of *Bromus tectorum* and other annual bromegrasses. Ecol. Monogr. 25:181-213.

Hull, A. C., Jr., and W. Theron Hansen, Jr. 1974. Delayed germination of cheatgrass seed. J. Range Manage. 27:366-368.

Kapusta, George, and C. F. Strieker. 1975. Selective control of downy brome in alfalfa. Weed Sci. 23:202-206.

Rydrych, D. J. 1974. Competition between winter wheat and downy brome. Weed Sci. 22:211-214.

Stewart, George, and A. C. Hull. 1949. Cheatgrass (*Bromus tectorum* L.)—An ecologic intruder in southern Idaho. Ecology 30:58-74.

Young, J. A., R. A. Evans, and R. E. Eckert, Jr. 1969. Population dynamics of downy brome. Weed Sci. 17:20-26.