HERBICIDE-GRAZING INTERACTIONS

IN CHEAT INFESTED WHEAT

By

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INTRODUCTION

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HERBICIDE-GRAZING INTERACTIONS

IN CHEAT INFESTED WHEAT

Herbicide-Grazing Interactions in Cheat Infested Wheat[1]

JEFFREY A. KOSCELNY and THOMAS F. PEEPER[2]

Abstract. Three field experiments were conducted to determine the interaction of grazing winter wheat during tillering and herbicide treatments on cheat control, wheat and cheat biomass, wheat grain yield and wheat yield components. Ethyl-metribuzin at 560 and 1120 g/ha and metribuzin at 280 and 420 g/ha controlled cheat 32 to 98 and 87 to 98%, respectively. Grazing had no effect on the efficacy of the herbicide treatments for cheat control. Grazing increased cheat biomass in the check at one location by 24%, but had no effect at the other two locations. Total wheat plus cheat biomass was unaffected by grazing and was increased by only one herbicide treatment at one location, indicating that the controlled cheat was typically replaced by wheat on a 1:1 biomass basis. All herbicide treatments increased grain yield, but yield was not influenced by grazing at any location. Harvest index was not affected by either grazing or herbicide treatments. At two locations, increased heads/m^2 and spikelets/head accounted for the majority of the grain yield increases. At one location seeds/spikelet and weight/seed were increased. The sums of these yield component

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increases were comparable to yield increases measured by combine harvesting. Nomenclature: Ethyl-metribuzin (BAY SMY 1500), 4-amino-6-(1,1-dimethylethyl)-3-(ethylthio)-1,2,4-triazin-5(4H)-one; metribuzin, 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one; cheat, *Bromus secalinus* L. #[3] BROSE; wheat, *Triticum aestivum* L. *Additional index words:* Winter wheat, grazing, harvest index, yield components.

INTRODUCTION

Hard red winter wheat is grown continuously on most of the cropland in the Southern Great Plains region of the United States. Returns from grazing winter wheat during tillering can equal the value of the harvested grain (5, 7, 12). Approximately one-third of the wheat planted annually in Oklahoma is grazed by cattle (*Bos taurus* L.) from November to early March and then harvested for grain. In order to obtain substantial wheat forage production, earlier planting dates are used. Phillips (17) reported that the optimum wheat seeding date for forage production in Oklahoma is August 22, with every two week delay reducing forage yields from 860 to 1030 kg/ha. Krenzer and Doye (15) reported that Oklahoma wheat producers can obtain 385 kg/ha of beef from winter wheat grazing and still obtain a normal grain crop. In Texas, wheat grazed until February 1 had reduced biomass and seed weight but grain yield, head density, and harvest index were not reduced (24). In

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[3]Letters following this symbol are a WSSA approved computer code from Composite List of Weeds, Weed Sci. 32, Suppl. 2. Available from WSSA, 309 W. Clark St., Champaign, IL 61820.

Oregon, grazing did not affect head density but increased yield by increasing spikelets/head (21). Weed control was not a variable in any of the above reports.

Little is known about the effects of wheat defoliation by grazing on the growth, competitiveness, and control of serious problem weeds such as cheat. Cheat and other annual Bromus spp. infest over 1.2 million ha of wheat land in Oklahoma (11). As few as 54 downy brome (Bromus tectorum L. # BROTE) plants/m^2 can reduce yields by 28% (20), and infestations commonly exceed this level (6). Early seeding of wheat for pasturing purposes increases cheat infestations because cheat seedlings do not typically emerge in Oklahoma wheat fields earlier than mid-September (19).

Grazing can alter the competitive relationships of pasture species (13). Juvenile cheat seedlings develop slower than juvenile wheat seedlings, and the wheat leaves tend to canopy over the cheat (3). However, grazing removes the wheat canopy allowing greater light penetration and thus may give the cheat a competitive advantage. Bromus spp. control is more difficult in continuous wheat than in cropping systems with a fallow season or crop rotation (23). Other than moldboard plowing, delayed seeding or stubble burning followed by plowing, no cultural practices have been identified that control Bromus spp. in continuous winter wheat (9, 23). In the past, Bromus spp. populations were suppressed by delaying seeding to allow late fall tillage to destroy seedlings (16) but delayed seeding reduces the amount of forage produced during the winter months (17). Thus, selective herbicides are needed for cheat control.

The discovery of differential tolerance of wheat cultivars to metribuzin in 1979 led to the first label for a selective cheat control herbicide for wheat grown in the southern region (19). These researchers reported that metribuzin applied either in the fall or spring to tillered ungrazed wheat provided excellent cheat control with no yield reductions of tolerant wheat cultivars. However, metribuzin has edaphic and cultivar restrictions and a relatively narrow margin of crop safety that has restricted its widespread acceptance. Ethyl-metribuzin selectively controls cheat with a wider margin of safety on wheat than metribuzin (10, 18, 22).

The objectives of our research were to determine the interaction of grazing winter wheat during tillering and herbicide treatments on cheat control, wheat and cheat biomass, wheat grain yield and wheat yield components.

MATERIALS AND METHODS

Field experiments were conducted during the 1986-87 and 1987-88 growing seasons near Perkins and during 1987-88 near Stillwater, OK. The design for each experiment was a split-plot with grazed or ungrazed as the main plot and herbicide treatments as subplots, with four replications. Main plots were 9 by 10m and subplots were 1.8 by 10m. To ensure uniform cheat infestations, the experimental areas at Perkins were overseeded with approximately 60 and 90 kg/ha of locally harvested cheat seed in 1986 and 1987, respectively, prior to seeding. The site at Stillwater had a natural infestation and was not overseeded. At each site, 'TAM 105' hard red winter wheat was seeded at 80 kg/ha in 20 cm rows the first week of September. The soil was a Teller sandy loam (thermic, Udic Argiustoll) and a Zaneis sandy clay loam (thermic, Udic Haplustoll) at Perkins and Stillwater, respectively. The pH varied from 6.2 to 6.4 and organic matter contents from 0.8 to 1.4%. Ammonium nitrate was applied prior to seeding at 76 and 112 kg N/ha at Stillwater and Perkins, respectively. These application increased surface soil nitrogen to approximately 125 kg/ha at all locations which, with subsoil reserves, was considered sufficient for anticipated forage and wheat grain yields. Residual P_2O_5 and K_2O levels were adequate at all locations.

Herbicide treatments included ethyl-metribuzin at 560 and 1120 g ai/ha spray-applied to 3 leaf to 1 tiller wheat (2 to 4 leaf cheat), metribuzin at 280 and 420 g/ha spray-applied to 3 to 4 tiller wheat (2 to 3 tiller cheat) and an untreated control. Herbicide application dates were Sept. 29 and Oct. 9 for ethyl-metribuzin and Oct. 7 and Oct. 29 for metribuzin for the 1987-88 experiments at Perkins and Stillwater and 1986-87 experiment at Perkins, respectively. All herbicide treatments were applied with a compressed air bicycle sprayer in a carrier volume of 282 L/ha.

Wire panels were used to exclude the cattle from the ungrazed plots. Cattle were allowed to graze the appropriate main plots beginning on December 3, December 2 and November 11, at the Perkins-87, Stillwater and Perkins-88 locations, respectively, when the wheat had 6 to 8 tillers and was 18 to 20 cm tall. Grazing was terminated February 16 at Perkins-87 and March 3 at Stillwater and Perkins-88. Grazing was continuous except for short periods when the soil was too wet to support the cattle. The grazing intensity was adequate to uniformly remove most wheat leaf blades and expose the area between rows to full sunlight.

Cheat control and wheat stand reduction were evaluated visually in April. At wheat maturity, four single row samples of wheat, one m long, and the cheat in these wheat rows plus the area to one adjoining row were hand harvested from each plot to determine wheat head density and wheat and cheat biomass. Wheat yield components were determined using 20 heads randomly selected from each plot the day before harvest. Plots were then harvested with a small plot combine adjusted to retain cheat seed with the grain. The combine harvested samples were cleaned with a small commercial type seed cleaner to remove the cheat seed. Wheat grain yield, adjusted to 13.5% moisture, was determined after cleaning. Data were subjected to analysis of variance and means separated using protected least significant differences.

RESULTS AND DISCUSSION

In combined data analyses, locations were significant. Thus, the data was not pooled across locations. The location effect was not unexpected since cheat densities were different at each location (Table 1). Since grazing alters competitive relationships (13), it was anticipated that foliage removal by grazing might reduce the ability of the crop to suppress partially controlled cheat populations. However, grazing had no effect on herbicide efficacy at any location. Ethyl-metribuzin at 560 and 1120 g/ha controlled cheat 32 to 89 and 95 to 98%, respectively (Table 2). The substantially lower (32%) cheat control with the lower rate at Perkins-88 may be attributed to lack of an activating rainfall for 32 days after treatment and the much higher cheat density. Ratliff and Peeper (18) also reported variable control with ethyl-metribuzin at 560 g/ha. Metribuzin at 280 and 420 g/ha controlled cheat 87 to 90 and 96 to 98%, respectively. However, metribuzin at 280 g/ha reduced the wheat stand 6% at Perkins-88 and 420 g/ha reduced wheat stands 4 and 30% at Perkins-87 and Perkins-88, respectively. No other herbicide treatments injured wheat. Cheat control with the higher rates of the two herbicides was very similar at all three locations.

Grazing did not influence wheat grain yield at any location which agrees with the findings of Winter and Thompson in Texas (24), and there were no grazing by herbicide treatment interactions in grain yield. All herbicide treatments increased wheat grain yield at all locations, but the magnitude of the yield increases varied. At Perkins-87, the cheat panicle density in the control at harvest was $120/m^2$, and the ethyl-metribuzin treatments increased yield approximately 35%. In contrast, at Perkins-88, the cheat panicle density averaged $695/m^2$ in June, and ethyl-metribuzin at 1120 g/ha increased yield 167%. Wheat yields in both years at Perkins were higher with the higher rate of ethyl-metribuzin than the higher rate of metribuzin. These differences could be attributed to reduced wheat stands from the metribuzin treatment rather than a benefit of earlier weed control, because such a difference was not observed at Stillwater, where no wheat stand reduction occurred.

In the wheat yield components of the 1988 experiments, there were no grazing effects or grazing by herbicide treatment interactions. Examination of the yield components explains why grazing did not influence yield. At Stillwater, averaged over herbicide treatments, grazing reduced wheat head density by 9%, increased seeds/spikelet by 9% and did not affect spikelets/head or weight/seed (Table 3). At Perkins-88, grazing decreased spikelets/head 6%, increased seeds/spikelet by 7%

and did not affect other yield components. Clearly, grazing influenced wheat growth, but the wheat was able to compensate for grazing effects to avoid yield loss. Differences in yield component response between the two locations were not unexpected, since environmental conditions may favor one yield component over another (2).

Examination of the wheat yield components from each herbicide treatment, averaged over grazing treatments, revealed that the biggest effect of cheat control was an increase in wheat heads/m^2 (Table 4). However, spikelets/head were also increased by all herbicide treatments except the low rate of ethyl-metribuzin at Stillwater. At Perkins-88, increases in seeds/spikelet occurred with all herbicide treatments and seed weight was increased by all treatments but the low rate of ethyl-metribuzin. Faris and DePauw (8) reported that increasing wheat seeding rates from 75 to 1350 seeds/m^2 decreased kernel size, kernels/head, and heads/plant. Their reported effects of intraspecific interference on wheat yield components, which became apparent at high seeding rates, were similar to the response we observed from cheat interference.

Summing the significant increases obtained from the individual yield components provided estimates of yield increases similar to yield increases detected by harvesting with a plot combine. These comparisons were closer than reported elsewhere and indicate the adequacy of the sampling techniques employed (14). These data also indicate that cheat competes with wheat from tillering through the last yield component to develop, grain size.

Harvest index, the ratio of grain yield to total wheat biomass, was not influenced by grazing or herbicide treatment. Averaged over grazing and herbicide treatments, harvest index values were 0.33, 0.26, and 0.28

at Perkins-87, Stillwater, and Perkins-88, respectively. Winter and Thompson (24) also reported that grazing did not reduce harvest index unless grazing continued past first internode elongation. The lack of herbicide treatment effects on harvest index indicates that cheat interference reduced wheat vegetative growth proportionately to yield. Also, cheat interference did not affect the physiological capacity of the wheat to mobilize photosynthate and translocate it to the grain (1).

At Perkins-87 grazing increased the cheat biomass in the control at harvest, but not in the herbicide treated plots (Table 5). At the other locations, grazing did not influence cheat biomass and there were no grazing by herbicide treatment interactions. All herbicide treatments reduced cheat biomass. In accordance with the visual ratings, cheat biomass was only reduced 33% by ethyl-metribuzin at 560 g/ha at Perkins-88.

All herbicide treatments increased wheat biomass except ethyl-metribuzin at 560 g/ha at Stillwater. At Stillwater, grazing reduced mean wheat biomass from 5710 to 4960 kg/ha ($P>0.05$) but did not influence wheat biomass production at the other two locations.

Total wheat plus cheat biomass was increased by ethyl-metribuzin at 1120 g/ha at Stillwater and decreased by both rates of metribuzin at Perkins-88. Total biomass values from all other herbicide treatments were not significantly ($P>0.05$) different from the control indicating that controlled cheat was replaced by wheat on a 1:1 biomass basis when wheat was not injured by the herbicide treatment. Cudney et al. (4) also reported similar total shoot dry weights for wheat growing with 0 to 268 wild oats (Avena fatua L. # AVEFA) per m^2.

Thus, ethyl-metribuzin and metribuzin can effectively control cheat in both grazed and ungrazed wheat. Controlling cheat increases wheat yield primarily by increasing wheat head density, but all other yield components were increased by some treatments.

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Table 1. Weed population and days from treatment until first rainfall (greater than 0.5 cm) at the three locations.

	Weed	Treatment	
Location	population	ethyl-metribuzin	metribuzin
	(panicles/m^2)	—— (days until rainfall) ——	
Perkins-87	120	1	9
Stillwater	73	25	16
Perkins-88	695	32	24

Table 2. Cheat control and effect of herbicide treatments on wheat grain yield.[a]

Treatment	Rate	Perkins-87		Stillwater		Perkins-88	
		Cheat control	Wheat yield	Cheat control	Wheat yield	Cheat control	Wheat yield
	(g/ha)	(%)	(kg/ha)	(%)	(kg/ha)	(%)	(kg/ha)
Ethyl-metribuzin	560	89	2260	82	1270	32	1050
Ethyl-metribuzin	1120	98	2250	95	1540	97	1790
Metribuzin	280	87	1910	90	1370	89	1410
Metribuzin	420	97	2040	96	1470	98	1320
Control	0	0	1670	0	1090	0	670
LSD (0.05)		4	240	3	180	9	190

[a]Grazing did not influence the cheat control or wheat grain yield responses.

Table 3. Effect of grazing, averaged over herbicide treatment on wheat grain yield components and plot yield obtained by combine harvesting.[a]

	Stillwater					Perkins-88				
Treatment	Heads /m^2	Spikelets /head	Seeds /spikelet	Weight /seed	Plot yield	Heads /m^2	Spikelet /head	Seeds /spikelet	Weight /seed	Plot yield
				(mg)	(kg/ha)				(mg)	(kg/ha)
Grazed	472	13.5	1.99	20.9	1200	428	15	2.21	23.3	1260
Ungrazed	512	13.6	1.81	22.8	1490	384	16	2.07	23.0	1240
LSD 0.05	NS	NS	0.07	NS	NS	NS	NS	0.12	NS	NS
LSD 0.10	34	NS	-	NS	NS	NS	0.5	-	NS	NS

Table 4. Yield components increased by herbicide treatment and plot grain yield obtained by combine harvesting.[a]

		Stillwater[b]				Perkins-88					
Treatment	Rate	Heads /m^2	Spikelets /head	Sum[c]	Plot yield	Heads /m^2	Spikelets /head	Seeds /spikelet	Weight /seed	Sum[c]	Plot yield
	(g/ha)	(% above control)									
Ethyl-metribuzin	560	21	NS	21	16	43	6	5	NS	54	57
Ethyl-metribuzin	1120	37	7	44	42	135	13	10	6	158	168
Metribuzin	280	22	7	29	26	90	12	10	4	116	111
Metribuzin	420	31	11	42	34	76	19	15	4	114	96

[a]Numerical values indicate significant (P = 0.05) increases. NS indicates no significant increase.

[b]Seeds/spikelet and weight/seed were not significantly affected at this location.

[c]Sum = sum of the significantly different yield components.

Table 5. Effects of grazing by cattle and herbicide treatments on cheat, wheat, and total biomass at maturity, at three locations.

		Perkins-87				Stillwater			Perkins-88		
		Cheat[a]									
Treatment	Rate	graz	ungr	Wheat	Total	Cheat	Wheat	Total	Cheat	Wheat	Total
	(g/ha)	(kg/ha)									
Ethyl-metribuzin	560	80	20	8360	8410	290	4750	5040	3980	4220	8200
Ethyl-metribuzin	1120	10	20	9010	9020	40	6340	6380	530	7030	7570
Metribuzin	280	400	400	7870	8270	130	5420	5550	940	5510	6450
Metribuzin	420	90	50	8060	8130	40	6120	6160	110	5050	5160
Control	0	3240	2470	5960	8820	1160	4040	5200	5910	2790	8700
LSD (0.05)		---540[b]---		1650	NS	250	1050	1040	780	1320	1200

[a]graz = grazed, ungr = ungrazed

[b]Interaction LSD

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