ECONOMIC RETURNS FROM CHEAT CONTROL
IN WINTER WHEAT

By

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ECONOMIC RETURNS FROM CHEAT CONTROL

IN WINTER WHEAT

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INTRODUCTION

This thesis is a manuscript to be submitted for publication in Weed Technology, a Weed Science Society of America publication.

ECONOMIC RETURNS FROM CHEAT CONTROL IN WINTER WHEAT

Economic Returns from Cheat Control in Winter Wheat[1]

KENNETH L. FERREIRA, THOMAS F. PEEPER, and FRANCIS M. EPPLIN[2]

Abstract. Field experiments were conducted to determine the influence of winter wheat seeding date and forage removal on the efficacy of cheat control herbicides, forage and grain yields, and net returns to land, overhead, risk, and management for the various cheat control strategies. Economic analysis revealed that net returns were higher when wheat was seeded during the traditional seeding period than when seeded early for increased forage production or delayed for cultural cheat control. Some herbicide applications provided an economic benefit at two of three locations where the initial cheat population exceeded 170 plants/m^2. Nomenclature: Cyanazine, 2-[[4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino]-2-methylpropanenitrile; ethyl-metribuzin (BAY SMY 1500), 4-amino-6-(1,1-dimethylethyl)-3-(ethylthio)-1,2,4-triazin-5(4*H*)-one; metribuzin, 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one; cheat, *Bromus secalinus* L.#[3] BROSE; wheat, *Triticum aestivum* L.

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[2]Grad. Res. Asst. and Prof. respectively, Dep. Agron. and Prof. Dep. Agric. Econ., Oklahoma State Univ., Stillwater, OK 74078.

[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 Street, Champaign, IL 61820.

Additional index words: Enterprise budget, cyanazine, ethyl-metribuzin, metribuzin, BROSE.

INTRODUCTION

The discovery of differential tolerance of wheat cultivars to metribuzin led to the first label for a selective cheat control herbicide for wheat grown in the southern region in 1979 (22). However, the relatively high cost of metribuzin coupled with edaphic and variety restrictions and a relatively narrow margin of crop safety have restricted widespread acceptance. A number of other herbicides have been investigated for cheat control in wheat, but only cyanazine has been registered and marketed for that purpose (2,19). Cyanazine has no cultivar restrictions, is less than one-third the cost of metribuzin, and typically suppresses cheat populations, but seldom controls over 90% (3). Ethyl-metribuzin controls most *Bromus* spp. effectively with minimal wheat injury and is expected to be registered soon for use on wheat (11,20,26). However, the cost of ethyl-metribuzin is not currently known, and it may have cultivar restrictions on its label.

Epplin et al. (9) developed cost estimates of alternative wheat production systems in central Oklahoma, however, they did not consider the frequent need for *Bromus* spp. control. Recently, Krenzer and Doye (16) developed budgets for a winter wheat enterprise useful in calculating returns from both wheat grain and forage production. Their budgets were based on the typical practice of purchasing 180 kg steers to graze available forage from November to March, and harvesting grain in June. However, they did not consider cheat control or returns from federal commodity programs in their budgets.

Prior to introduction of herbicides, Bromus spp. populations were suppressed by annual moldboard plowing which buried seed below its emergence capability and by delaying seeding to permit late fall tillage to destroy seedlings (12,17,23). However, annual moldboard plowing is often unacceptable on erosive soils and delaying seeding reduces forage production dramatically. When forage for pasture is important, seeding may be advanced several weeks from traditional dates to promote vegetative growth (18). Returns from grazing winter wheat during tillering can reportedly equal the value of harvested grain, but lack of livestock watering or control facilities can make forage utilization impractical (7,8,13). Thus, benefit analyses must include situations wherein forage is or is not grazed.

The objectives of this research were to define the interaction between wheat seeding date and cheat control herbicide treatment on wheat forage production, grain yields and quality, and to use existing enterprise budgets to estimate the net returns associated with each combination.

MATERIALS AND METHODS

Field experiments were conducted during the 1988-89 growing season near Lahoma, Orlando, and Perkins in central Oklahoma to determine the interaction between seeding dates and herbicide treatments on cheat populations and wheat forage, grain yields, and quality. The soil at Lahoma, Orlando, and Perkins was a Pond Creek loam (thermic, Udic Argiustoll), a Pulaski loam (thermic, Typic Ustifluvent), and a Konawa sandy loam (thermic, Ultic Haplustalf), respectively. The pH varied from 6.2 to 6.5 and organic matter content from 1.4 to 1.9%. The experimental design used at each site was a split-plot with a factorial arrangement of subplots and four replications. The main plots were three seeding dates and the two subplot factors were herbicide treatment and forage removal, i.e., forage was or was not removed. The plot size was 2.1 by 6.7 m. Prior to initiation of the experiments, 60 kg/ha of cheat seed (approximately 1300 seeds/m^2) and fertilizer adequate for 3300 kg/ha grain yield were broadcast and incorporated into the soil. At each location, 'Pioneer 2157' wheat, a metribuzin tolerant, hard red winter cultivar was seeded at 74 kg/ha in 20 cm rows on three dates: September 2 or 3 (early), September 30 to October 11 (traditional seeding period), and November 1 to 3 (delayed seeding). These dates also correspond to dates considered optimum for forage and grain production, grain production only, and delayed seeding for cheat control, respectively. In April, wheat and cheat densities were determined in two 0.09 m^2 quadrats in each replication of the check plots for each seeding date.

The herbicide treatments included ethyl-metribuzin at 0.84 and 1.26 kg ai/ha and cyanazine at 0.45 and 0.67 kg/ha applied when the wheat had three leaves, metribuzin at 0.28 and 0.42 kg/ha applied when the wheat had 3 to 4 tillers, and a check. Thus, the herbicide application dates differed for each seeding date. All herbicide treatments were applied with a CO_2 backpack sprayer in a total carrier volume of 280 L/ha. Wheat injury was visually estimated as the wheat matured. Forage dry matter production was determined from appropriate plots by harvesting that forage over 5 cm tall with a mower and bagging attachment. Forage moisture content was obtained by weighing all samples in the field and after drying in a forced air drying cabinet. Forage from the early seeded wheat was harvested on November 18 and March 1 to 7. Wheat seeded on the traditional date was clipped only in March. The late seeded wheat did not reach a forageable stage (3 tillers) during the grazing period (November to March 1) therefore no forage was harvested. Thus, all data were analyzed as a complete factorial but data from the first two seeding dates was considered separately to permit unbiased determination of forage removal effects in the first two seeding dates. Since no forage was harvested from the delayed seeded wheat the designated foraged and unforaged plots were averaged and considered unforaged. Using the Kjeldahl method, crude protein was determined on the forage harvested in November to determine whether the herbicide treatments affected the nutritional value. The early seeded, foraged plots were top dressed with ammonium nitrate in late winter to replace the nitrogen removed in the forage harvested in November.

Grain yield was determined by harvesting 10 m^2/plot in June with a small plot combine. The cheat at all locations matured later than the wheat and all plots were harvested before the cheat began to shatter. Dockage due to cheat was determined by separating cheat seed and wheat grain from each sample with a Carter Dockage Tester[4] set according to United States Department of Agriculture (USDA) regulations for samples with high cheat seed content (1). Dockage does not influence grain grade but the cheat content of the wheat was used as a measure of cheat control.

The grain was graded according to USDA standards to determine market value (1). Established grades include 1 to 5 and sample, where grade 1

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[4]Carter-Day Company, 500 73rd Ave. N.E., Minneapolis, MN 55432.

is the highest quality, and sample grade wheat has lower quality than grade 5. For statistical analysis, a 6 was assigned to sample grade plot samples. The regional average price penalties used for determining the value of inferior quality grain were 0.02, 0.11, 0.18, and 0.26 ¢/kg for grades 2 through 5, respectively[5]. A penalty of 0.26 ¢/kg was estimated for sample grade grain. The yields reported are based on clean grain adjusted to 13.5% moisture content.

Using the appropriate variables for each plot, the net return to land, overhead, risk, and management was determined for each seeding date by herbicide treatment by forage removal treatment combination at all locations with enterprise budgets. Total revenues from forage production, grain, and the federal wheat commodity programs were included.

The value of harvested forage was estimated using a stocker steer enterprise budget (16) and seasonal stocker steer prices for the region (4,5). Each steer was expected to weigh 180 kg when purchased and to gain 82 kg during the November to early March grazing season, thus 820 kg/animal of forage was required for the entire grazing period. The dry matter to weight gain conversion ratio used was 10:1 (16). For budgeting purposes the stocking rate was calculated based on quantities of forage actually harvested from each treatment combination. Returns from the forage were then calculated as the number of steers/ha for which the forage produced would have been sufficient.

The revenue from farm programs was estimated for a representative

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[5]Anderson, K. 1989. Personal communication. Agric. Econ. Dept., Okla. State Univ., Stillwater, OK 74078.

farm with a typical acreage base (24). The appropriate weighted county average wheat yields used by the Agricultural Stabilization and Conservation Service, United States Department of Agriculture (ASCS) to determine commodity program benefits were used in calculating government payments[6]. Production costs and net returns to land, overhead, risk, and management were computed for each treatment combination at all locations by using an appropriate enterprise budget (Table 1).

The prices used for cyanazine and metribuzin, \$10.98/kg ai and \$65.71/kg, respectively, are current average retail prices in Oklahoma[7]. The price of ethyl-metribuzin was estimated at \$22/kg.

RESULTS AND DISCUSSION

Seeding date did not affect wheat plant density at any location (Table 2). However, cheat densities were higher in early seeded wheat than in wheat seeded during the traditional period at Lahoma and Perkins. At Orlando, where the cheat population was greatest, delayed seeding reduced the cheat population from the traditional seeding date.

The protein content of the wheat forage harvested from the early seeded wheat at Lahoma, Orlando, and Perkins averaged 26.8, 21.3, and 20.3%, respectively. The herbicide treatments did not affect forage protein except at Perkins, where the low and high rates of cyanazine reduced ($P = 0.05$) the protein content to 18.2 and 18.8%, respectively.

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[6]Chesney, B. 1989. Personal communication. Chief, Production Adjustment Section, USDA-ASCS State Office, Stillwater, OK 74078.

[7]Criswell, J. T. 1989. Personal communication. Coop. Ext. Ser., Okla. State Univ., Stillwater, OK 74078.

The reduction in protein was attributed to slight leaf tip necrosis caused by cyanazine treatments. However, 10% crude protein is adequate for normal growth of 180 kg steers, and thus no economic penalty was assigned to the decrease in forage protein (14).

All of the early seeded, foraged wheat at Lahoma suffered some stand loss during a hard freeze (-17 to -20° C lows for 4 days) in early February that followed a month of unusually mild temperatures (data not shown). Both early and late seeding can decrease winter survival of wheat (25), but in this case in the check plots, only the early seeded wheat with protective forage removed was injured. 'Pioneer 2157' is a metribuzin tolerant variety; therefore, wheat injury was not expected from metribuzin or ethyl-metribuzin. However, after the hard freeze, considerable wheat injury was visible in the metribuzin treated, early seeded, foraged wheat at Lahoma (Table 3). The lack of freeze damage on the unforaged wheat was attributed to the insulating effect of the unharvested forage. There was no injury in any treatment on early seeded wheat at Orlando or Perkins or on wheat at any location seeded during the traditional period (data not shown). When seeding was delayed until November 1-3, metribuzin severely injured the wheat at Lahoma, and the high rate injured wheat 15% at Orlando (Table 3). At Lahoma 4.4 cm of rainfall occurred within 24 hrs of treatment, which undoubtedly increased injury.

Both seeding date and herbicide treatments significantly affected dockage due to cheat at all locations (Table 4). Also, seeding date by herbicide treatment by forage treatment interactions occurred at Lahoma and Orlando.

At Lahoma, when no herbicide was applied, forage removal increased dockage in the early seeded wheat, but not in the wheat seeded a month later (Table 4). Dockage was low in all ethyl-metribuzin and most metribuzin treatments.

The higher cheat population at Orlando caused higher dockage due to cheat. As at Lahoma, when no herbicides were applied, dockage in the early and traditionally seeded unforaged wheat was similar. In contrast dockage in the early seeded, foraged wheat was 7.9% higher than dockage in the traditionally seeded, foraged wheat. At Orlando, metribuzin at 0.28 kg/ha did not reduce dockage in the early seeded, foraged wheat as much as it did in the early seeded, unforaged wheat. These results indicate that forage removal may not affect cheat reproduction in traditionally seeded wheat, but increases the cheat seed content of early seeded wheat.

At Perkins, with no herbicides, dockage was higher in the wheat seeded early. All of the ethyl-metribuzin and metribuzin treatments reduced dockage to 1.8% or less in the traditionally seeded wheat. In contrast no treatment reduced dockage of the early seeded wheat below 8.5%.

In the grain yield data, there were seeding date by herbicide treatment interactions at Lahoma and Orlando (Table 5). Also, at Lahoma there was an interaction between foraging treatment and seeding date. A herbicide treatment by seeding date by foraging treatment interaction was found at Perkins (Table 6). In the check plots, grain yields at Lahoma and Perkins were highest in the traditionally seeded wheat and lowest in the early seeded wheat. At Orlando, grain yield of the early seeded wheat was less than half of the yield of wheat seeded later.

In the early seeded wheat at Lahoma, averaged across herbicide treatments the foraged wheat yielded 16.5% less grain than the unforaged wheat. This reduction in yield was attributed to the freeze damage in the early seeded foraged wheat. Since the cheat population was relatively low, only cyanazine at 0.67 kg/ha and ethyl-metribuzin at 0.84 kg/ha increased grain yield of the early seeded wheat, and none of the treatments increased forage yield (Table 5). Only ethyl-metribuzin at 1.26 kg/ha increase the grain yield of traditionally seeded wheat. All herbicide treatments reduced the yield of wheat with delayed seeding, but metribuzin treatments reduced the yield more than other treatments because it caused severe stand reduction.

At Orlando, cheat pressure was heavy in wheat seeded early or during the traditional period. All ethyl-metribuzin and metribuzin treatments applied to that wheat increased grain yields considerably and ethyl-metribuzin at 0.84 kg/ha increased forage yields. Cyanazine at 0.67 kg/ha increased the yield of early seeded wheat and decreased the yield of the delayed seeded wheat. Metribuzin at 0.42 kg/ha reduced the stand and decreased the grain yield of delayed seeded wheat.

At Perkins, a significant three-way interaction revealed that cyanazine at 0.67 kg/ha, increased the grain yield of traditionally seeded unforaged wheat by 14% compared to the unforaged check, and did not increase the yield of the foraged wheat (Table 6). Similarly, ethyl-metribuzin at 1.26 kg/ha increased the yield of only the unforaged, early seeded wheat. Also, the low and high rates of ethyl-metribuzin increased the yield of unforaged, traditionally seeded wheat by 22 and 10%, respectively.

Wheat grain grades were affected by herbicide treatment and forage harvesting, but the greatest effect was from seeding date. At all locations averaged over herbicide treatment, wheat seeded early graded lower than wheat seeded at the traditional time (Table 7). Also, at Lahoma, harvesting forage from the early seeded wheat caused a further reduction in grain grade. Harvesting forage from wheat seeded during the traditional seeding period did not reduce grain grade at any location. Delaying seeding reduced grade at two locations compared to traditionally seeded wheat but increased quality at Orlando. In all cases the grading factors that reduced grade were low test weight (weight/volume), and shriveled grain (data not shown).

The early seeded wheat was shriveled, perhaps because soil moisture was depleted in sustaining early fall forage growth, and less than 0.6 cm of rain was received at any site during April, which subjected the early seeded wheat to substantial stress. Greater early wheat growth has previously been found to cause more stress for limited resources with fewer available for the last yield component that develops, i.e. grain size (10). Delaying seeding did not delay wheat maturity nor increase foliar disease incidence. However, averaged over herbicide treatments, compared to traditional seeding, delaying seeding reduced ($P = 0.0001$) test weights at Lahoma and Perkins from 720 to 670 kg/m^3 and 740 to 660 kg/m^3, respectively.

Averaged over other factors, application of ethyl-metribuzin at 1.26 kg/ha increased grain grade at Lahoma (Table 8). At Perkins, only cyanazine at 0.45 kg/ha did not improve grain quality. At Orlando, none of the herbicide treatments improved the grade of the early seeded wheat. Metribuzin at 0.42 kg/ha improved grain quality of traditionally seeded wheat, and cyanazine at 0.67 kg/ha reduced the grade of delayed seeded wheat. Thus, the herbicide treatments had much less influence on grain grade than they did on grain yield.

Economic benefits. Averaged over other factors, mean grain yields of wheat seeded during the traditional period at Lahoma, Orlando, and Perkins averaged 112, 98, and 86%, respectively, of the weighted county average yields[6]. Thus, grain yield results should be typical for the representative areas.

Also, the early seeded wheat had ample opportunity to produce forage, and did produce substantial quantities. However, at all locations, early seeding resulted in negative returns (Table 9). At Lahoma, averaged over herbicide treatments, forage removal did not affect net returns to land, overhead, risk, and management from the early seeded wheat, but increased returns from the traditionally seeded wheat from \$43/ha to \$60/ha.

At Orlando and Perkins, there were several herbicide treatment by seeding date by foraging treatment interactions in wheat seeded early or traditionally. In the respective checks and several herbicide treatments, forage harvesting did not significantly affect net returns. Thus, in these treatments the returns from forage production were similar to costs associated with forage utilization plus the additional nitrogen fertilizer applied.

At Perkins, in the traditionally seeded wheat, none of the herbicide treatments increased net returns in either foraged or unforaged wheat, and metribuzin at both rates applied to the foraged wheat reduced net returns. Several herbicide treatments decreased the net losses in the early seeded wheat.

At Orlando, which had the heaviest cheat population, both ethyl-metribuzin treatments applied to early seeded, foraged wheat, decreased net losses from \$154/ha to \$25/ha or less. In traditionally seeded wheat, all ethyl-metribuzin and metribuzin treatments, except metribuzin at 0.28 kg/ha on foraged wheat, substantially increased net returns.

Although delaying seeding reduced cheat populations at all sites, the economic penalties for delaying seeding were severe. In the unforaged untreated checks at Lahoma and Perkins, where cheat populations in traditionally seeded wheat were 38 and 73 plants/m^2, delaying seeding decreased net returns \$69 (data not shown) and \$104/ha, respectively. Even at Orlando, with higher cheat populations, when no herbicides were applied, delaying seeding did not increase net returns above those from traditionally seeded wheat. At all locations net returns were much higher when the wheat was seeded during the traditional period and either ethyl-metribuzin or metribuzin was applied to control cheat than when seeding was delayed to control cheat and no herbicides were applied, except when metribuzin was applied at 0.42 kg/ha and 0.28 kg/ha at Lahoma and Orlando, respectively. Thus, regardless of the cheat density, delayed seeding for cheat control was economically unfeasible and should not be recommended in Oklahoma.

Early seeding for high forage production has gained popularity in very recent years. However, rainfall has been above normal during those years. In these experiments, with a relatively wet fall and dry spring, early seeding increased forage production substantially but was economically disastrous. However, the conditions encountered are probably not unusual since the climate in the hard red winter wheat production area is characterized as continental, subhumid to semiarid, with wide fluctuation in precipitation from year to year. In this region, a wheat crop usually exhausts most stored moisture by maturity and in most years the wheat plant races to finish its production of grain before moisture is depleted (21). Kolp et al. (15) noted that early seeded winter wheat in Wyoming depleted 3.4 cm more water in the fall than later planted wheat. They suggested that conservation of moisture by avoiding early planting could be important during years of low spring precipitation. Thus, seeding during the traditional seeding period may be the most economically sound practice over a period of years.

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Table 1. Wheat grain and pasture budget.

Receipt source	Unit of measure	Price[a]	Quantity	Value[b]
		($/unit)	(units/ha)	($/ha)
Wheat grain	kg	0.145		
Winter forage	animals	31.52		
USDA wheat program	kg	0.006	(c)	
Total receipts				
Operation inputs				
Wheat seed	kg	0.165	73.92	$12.20
Custom harvest	ha	39.52	1.0	39.52
Labor charges	hr	3.22	7.222	23.26
Machinery fuel + repairs	ha			38.61
18-46-0 fertilizer	kg	0.216		
Ammonium nitrate	kg	0.21		
Amm. Nit. application	ha	4.94		
Herbicide	kg			
Herbicide application	ha	7.41		
Annual operating capital[d]	dol	0.09		
Custom hauling	kg	0.005		
Total operating cost				

Table 1. Wheat grain and pasture budget, con't.

Fixed costs for machinery		
Interest at 9.0%	dol	$27.07
Depreciation, taxes, insurance	dol	41.87
Total fixed costs		68.94
Returns above all costs except land, overhead, risk, and management		(e)

[a]Local harvest date price ($/kg) for USDA #1 hard red winter wheat (6) adjusted for price penalties[5].

[b]Obtain values by multiplying price by quantity.

[c]County average wheat yield, ie., 2009 kg/ha for Lahoma and 2211 kg/ha for the other locations.

[d]Operating capital equals wheat seed, machinery fuel, fertilizer, and herbicide costs times by 0.75, the part of the year wheat is grown.

[e]Net returns are tabulated in Table 9.

Table 2. Effect of seeding date on wheat and cheat populations in check plots in April.

Species	Seeding date	Location		
		Lahoma	Orlando	Perkins
		----------(plants/m^2)-----------		
Wheat	Early	126	110	102
	Traditional	136	97	123
	Delayed	110	118	115
LSD (0.05)		NS	NS	NS
Cheat	Early	113	509	171
	Traditional	38	394	73
	Delayed	8	21	8
LSD (0.05)		48	145	90

Table 3. Effect of seeding date, forage harvesting, and herbicide treatment on wheat injury at three locations.[a]

		Lahoma, early		Delayed		
Treatment	Rate	Foraged	Unforaged	Lahoma	Orlando	Perkins
	(kg/ha)	(%)				
Cyanazine	0.45	24	0	14	0	1
	0.67	15	3	20	1	13
Ethyl-metribuzin	0.84	18	0	11	0	1
	1.26	18	0	14	0	13
Metribuzin	0.28	40	5	71	6	0
	0.42	51	3	88	15	0
Check	-	15	3	4	0	0
LSD (0.05)[b]		11		8	2	3

[a]There was no visual injury in the traditional seeding date at any location or in the early seeded wheat at Orlando and Perkins.

[b]LSDs for comparing means within one location and seeding date.

Table 4. Effect of seeding date, herbicide treatment, and forage harvesting on dockage due to cheat at three locations.

			Early			Traditional			Delayed
Location	Treatment	Rate	Foraged	Unforaged	Mean	Foraged	Unforaged	Mean	Unforaged
		(kg/ha)	(%)						
Lahoma	Cyanazine	0.45	6.2	6.2	-	4.6	6.4	-	4.0
		0.67	5.0	2.2	-	4.8	4.0	-	4.0
	Ethyl-metribuzin	0.84	3.0	1.0	-	1.3	1.1	-	1.8
		1.26	1.1	0.7	-	0.8	0.4	-	0.4
	Metribuzin	0.28	4.8	2.5	-	1.1	1.8	-	4.1
		0.42	2.0	1.2	-	0.7	0.9	-	0.9
	Check	-	12.0	5.5	-	3.3	5.1	-	1.7
LSD (0.1)[a]			2.3			2.3			1.7
LSD(00.1)[b]			2.7						
LSD (0.1)[c]			2.3						
Orlando	Cyanazine	0.45	22.0	24.1	-	27.6	23.1	-	1.0
		0.67	32.4	17.5	-	21.7	20.5	-	0.7
	Ethyl-metribuzin	0.84	14.0	9.4	-	8.1	6.4	-	0.2
		1.26	5.7	12.1	-	3.0	4.0	-	0.1
	Metribuzin	0.28	20.9	13.1	-	7.8	6.4	-	0.7
		0.42	9.1	8.5	-	1.9	1.9	-	0.1

Table 4. Effect of seeding date, herbicide treatment, and forage harvesting on dockage due to cheat at three locations. (cont'd)

	Check	-	30.5	24.6	-	22.6	24.0	-	4.6
LSD(0.05)[a]			-----6.5-------			------6.5------			4.6
LSD(0.05)[b]			--------------------7.7---------------------						
LSD(0.05)[c]			------------------------------6.6------------------------------						
Perkins	Cyanazine	0.45	-	-	14.1	-	-	3.6	10.1
		0.67	-	-	11.5	-	-	3.1	9.6
	Ethyl-metribuzin	0.84	-	-	10.2	-	-	1.8	2.3
		1.26	-	-	8.7	-	-	1.1	2.7
	Metribuzin	0.28	-	-	14.4	-	-	1.1	6.0
		0.42	-	-	8.5	-	-	0.9	4.9
	Check	-	-	-	22.5	-	-	5.0	9.1
LSD(0.05)[a]					3.8			3.8	3.8
LSD(0.05)[d]					-------------------4.1-----------------------				

[a]LSDs for comparing means within one location and seeding date.

[b]LSDs for comparing means between the early and traditional seeding dates.

[c]LSDs for comparing the delayed seeding date means with the early and traditional seeding date means.

[d]LSD for comparing means in different seeding dates.

Table 5. Effect of seeding date and herbicide treatment on forage and grain yields at Lahoma and Orlando.

Location	Herbicide Treatment	Rate	Forage yield Early[a]	Forage yield Traditional	Grain yield Early	Grain yield Traditional	Grain yield Delayed
			(kg/ha)				
Lahoma	Cyanazine	0.45	2410	280	1100	2050	1450
		0.67	2190	230	1200	2070	1140
	Ethyl-metribuzin	0.84	2580	260	1200	2390	1380
		1.26	2560	200	1040	2570	1450
	Metribuzin	0.28	1930	140	960	2330	510
		0.42	2040	130	840	2100	160
	Check	0.0	2200	220	900	2280	1740
LSD (0.05)[b]			410	NS	230	230	230
LSD (0.05)[c]						310	
Orlando	Cyanazine	0.45	1480	230	930	1490	1490
		0.67	1390	190	1040	1530	1210
	Ethyl-metribuzin	0.84	2130	490	1430	2560	1840
		1.26	1870	310	1390	2880	1620
	Metribuzin	0.28	1490	220	1220	2350	1370
		0.42	1440	370	1470	2690	980
	Check	0.0	1620	230	740	1690	1650
LSD (0.05)[b]			385	153	280	280	280
LSD (0.05)[c]						320	

[a]Total forage yield from fall and spring forage harvests.

[b]LSDs for comparisons within a seeding date and location.

[c]LSDs for comparing means in different seeding dates at a location.

Table 6. Effect of seeding date, herbicide treatment, and forage harvesting on forage and grain yields at Perkins.

Herbicide		Forage yield		Grain yield				
				Early		Traditional		Delayed
Treatment	Rate	Early	Traditional	Foraged	Unforaged	Foraged	Unforaged	Unforaged
	(kg/ha)							
Cyanazine	0.45	3170	1040	590	640	1880	1890	880
	0.67	3060	1090	720	630	1820	2040	900
Ethyl-metribuzin	0.84	3480	1260	610	670	1850	2170	980
	1.26	3260	1100	520	840	1980	1980	920
Metribuzin	0.28	2260	1130	600	720	1820	1820	950
	0.42	2020	1260	730	730	1810	1900	1010
Check	-	1830	1250	530	580	1840	1780	1030
LSD(0.05)[a]		510	NS	-----192------		------192------		136
LSD(0.05)[b]				-----------------198-----------------				
LSD(0.05)[c]				------------------------166------------------------				

[a]LSDs for comparing means within one seeding date.

[b]LSD for comparing means between the early and traditional seeding date.

[c]LSD for comparing the delayed seeding date means with the early or traditional seeding date means.

Table 7. Effect of seeding date and forage harvesting on grain grade at three locations.

Forage Harvested	Lahoma			Orlando			Perkins		
	Early	Traditional	Delayed	Early	Traditional	Delayed	Early	Traditional	Delayed
Yes	5.9	3.3	-	5.7	3.6	-	6.0	3.0	-
No	4.8	3.4	5.4	5.9	3.6	2.9	5.8	3.5	5.5
LSD(0.05)		0.4			0.4			0.4	

Table 8. Effect of herbicide treatment and seeding date on official grade of wheat grain at three locations.

Treatment	Rate	Lahoma[a]	Orlando Early	Orlando Traditional	Orlando Delayed	Perkins[a]
	(kg/ha)					
Cyanazine	0.45	4.7	5.6	3.5	3.1	5.0
	0.67	4.8	5.6	3.6	3.6	4.8
Ethyl-metribuzin	0.84	4.5	5.8	4.4	2.3	4.7
	1.26	4.3	5.8	3.4	2.9	4.6
Metribuzin	0.28	4.8	6.0	3.4	3.1	4.9
	0.42	5.1	5.8	2.9	3.1	4.7
Check	0.0	4.8	6.0	4.1	2.5	5.4
LSD (0.05)[b]		0.4	------------0.9------------			0.4

[a]There were no herbicide treatment by seeding date interactions at Lahoma or Perkins.

[b]LSDs are for comparison of means within one location.

Table 9. Effect of seeding date, herbicide treatment, and forage harvesting on returns above all costs except land, overhead, risk, and management.

			Early			Traditional			Delayed
Location	Treatment	Rate	Foraged	Unforaged	Mean	Foraged	Unforaged	Mean	Unforaged
		(kg/ha)	($/ha)						
Lahoma	Cyanazine	0.45	-	-	-83	-	-	44	-44
		0.67	-	-	-76	-	-	45	-89
	Ethyl-metribuzin	0.84	-	-	-80	-	-	78	-68
		1.26	-	-	-114	-	-	93	-69
	Metribuzin	0.28	-	-	-127	-	-	67	-188
		0.42	-	-	-151	-	-	25	-245
	Check	-	-	-	-101	-	-	89	10
LSD(0.05)[a]					32			32	32
LSD(0.05)[b]			44						
Orlando	Cyanazine	0.45	-122	-132	-	-28	-30	-	-32
		0.67	-117	-73	-	-14	-38	-	-74
	Ethyl-metribuzin	0.84	-25	-99	-	114	105	-	2
		1.26	-11	-153	-	155	126	-	-38
	Metribuzin	0.28	-145	-107	-	80	72	-	-64
		0.42	-103	-74	-	123	107	-	-127

Table 9. Effect of seeding date, herbicide treatment, and forage harvesting on returns above all costs except land, overhead, risk, and management, cont'd.

	Check	-	-154	-134	-	30	-6	-	3
LSD(0.05)[a]			-------67-------			------67-----			47
LSD(0.05)[c]			---------------------81--------------------						
LSD(0.05)[d]			-------------------------------70--------------------------------						
Perkins	Cyanazine	0.45	-119	-172	-	62	22	-	-118
		0.67	-116	-177	-	53	41	-	-117
	Ethyl-metribuzin	0.84	-120	-212	-	52	47	-	-119
		1.26	-150	-180	-	54	10	-	-136
	Metribuzin	0.28	-164	-183	-	43	-3	-	-123
		0.42	-177	-193	-	36	0	-	-124
	Check	-	-163	-169	-	77	20	-	-84
LSD(0.05)[a]			-------31-------			------31-----			22
LSD(0.05)[c]			---------------------61--------------------						
LSD(0.05)[d]			-------------------------------53--------------------------------						

[a]LSDs for comparing means within one location and seeding date.

[b]LSDs for comparing means in different seeding dates.

[c]LSDs for comparing means between the early and traditional seeding dates.

[d]LSDs for comparing the delayed seeding date means with the early and traditional seeding date means.

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