THE EFFECTS OF ALFALFA SEEDING RATE AND DATE OF FIRST CUTTING ON CHEAT-ALFALFA COMPETITION

By

DAVID R. PIKE

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Brigham Young University

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Thesis Approved:

Jimmy F. Stritzke
Thesis Adviser

John L. Caddel

Billy B. Tucker

Richard Berberet

Norman N. Durham
Dean of the Graduate College

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I. INTRODUCTION

Alfalfa is a hardy and drought tolerant forage crop well adapted to the environmental conditions of Oklahoma. It is grown and used throughout the state as a high protein hay and supplement for the horse and cattle industries. In efforts to improve the quality of hay much recent research has been directed at the elimination of weeds from alfalfa stands. Cheat, a winter annual grass, has been a troublesome weed in fields of winter wheat and recently has become a problem in alfalfa. The cheat kernels mature and shatter before wheat harvest and then are dormant until fall. Subsequent germination of cheat in areas fall seeded to alfalfa results in a very competitive association.

Control of cheat in new seedings of alfalfa is possible with herbicides but currently that is not a common practice. Some reasons for not controlling cheat include: 1) preference of the producer to graze mixed plantings, 2) the producer may feel that the competition severity does not warrant the cost of herbicide application, 3) failure to recognize problem severity. Little information on the extent of losses due to cheat competition is available to the alfalfa producer. To answer this need research was initiated; 1) to determine the competitiveness of various alfalfa densities on cheat, 2) to evaluate the extent of quality and yield losses due to cheat, and 3) to determine if time of first harvest could be used to minimize losses caused by cheat.

II. LITERATURE REVIEW

The deleterious effects of cheat infestations in alfalfa can be manifested in several ways. Some of these ways include reduced palatability and digestability, reduced protein and dry matter yield, and loss of alfalfa stand. Platt and Jackman (14) indicated that sharp points on mature cheat kernels may injure cattle feeding on infested hay. In both this study and in a report by Cords (4) the high fiber content of cheat hay also caused digestability to be low. Because of this cheat usually makes a very poor quality hay. In addition, Cords and others (10, 24) have reported reductions in total protein yield. These losses in yield were a result of the large low protein biomasses of cheat crowding out the high protein alfalfa growth. Reductions in alfalfa dry matter caused by cheat were also noted in these same studies.

The use of harvest management in alfalfa weed control has not been extensively studied, although alfalfa cutting dates and cutting frequencies have been studied for many years from the standpoint of maximizing yield and/or stand longevity (2,7,9,11,25). Of those studies using harvest management in weed control there are few that deal with cheat or other winter annuals. Peters and Peters (13) in a review of alfalfa weed control practices did not mention control of winter annuals nor does Smith (17) in his extensive review of management practices. Finnerty and Klingman (8), in a report on winter annual grasses, examined mowing dates as a seed production control method. They concluded that mowing annual Bromus species one week after heads appear prevents the production of viable seed. Their work, however, does not examine the competitiveness of the plants cut at the different times.

One of the most important aspects of grass-legume competition is light. Donald (6) in a review of several works reports that grass dominance is favored by leaf shape, leaf area index, and leaf angle of the grass. He noted, where developmental conditions do not vary to the extreme, (drought, cold, etc.) light is consistently the limiting factor in mixed swards. This idea is based on the concept that light is not stored and is often limited in quantity. Stern and Donald (21) found that clover (Trifolium subterraneum L.) in mixed stands with ryegrass (Lolium rigidum Gaud.) received from 20 to 80% of normal radiation with yield reductions of clover being as great as 95%. Yields of clover in this study actually decreased over time since respiration exceeded photosynthesis. Even moderate expression of grass inflorescences above the clover canopy has been found to reduce light intensity by 15 to 20% (20).

Several studies have been conducted to determine the exact nature of the losses caused by shading. Pritchett and Nelson (15) found that an 85% reduction in light intensity caused a 55% decrease in top growth and a 70% decrease in root growth of alfalfa under conditions where no nitrogen fertilizer was used. Shading also caused a short term increase in stem elongation but overall leaf area index was significantly reduced. In this study, competing, dense stands resulted in reduced photosynthesis and reduced cortex development under the basal cambium layer of the stem. Cooper (3) found plant height and root weight to be reduced by shading with a corresponding reduction in mean leaf area and dry matter yield. These changes in morphology translated into a 40% loss of dry matter yield from 50% shade. These studies all indicate that more vigorous and higher yielding plants resulted as light availability increased.

A phenomena associated with light, but not widely studied, is that of temperature. Cowett and Sprague (5) report that in dense alfalfa stands both soil and air temperatures were depressed and less variable than with thinner stands. These same researchers report lower stem numbers on a per plant basis in denser stands although alfalfa dry matter yields were not closely correlated with these numbers. According to Smith (17) cooler temperatures in denser stands can be responsible for delayed flowering and consequently an increase in the root and top growth results with the delayed harvest time. These effects were expected to be most noticeable in early spring when there are large diurnal temperature variations. In another experiment Robison and Massengale (16) theorized that early harvest allows for quicker temperature buildup in the rooting zone which could theoretically speed up physiological processes.

Soil moisture can also greatly influence herbage production in grass-legume mixtures. Wilkinson and Cross (23) in greenhouse studies with Ladino clover (Trifolium repens L) and orchardgrass (Dactylis gomerata L) mixtures found that the growth of clover was restricted to half that of clover growing alone. Both light and fertility levels were carefully controlled so the stress was attributed to root competition for moisture. Chamblee (1) in field studies, found fall established stands of alfalfa and orchardgrass seeded in separate plots to have nearly identical rates of water removal at the 8 and 30 cm depths the first season. However, as early as April of that first year alfalfa was able to withdraw significantly more water from depths to 90 cm. When the two species were grown in close association in alternate rows the water use was similar to orchardgrass alone indicating that competition of the grass had reduced root growth of the alfalfa. Van Riper (22) in similar studies reported water removal by bromegrasses to be greater at 30 and 60 cm but less at 120 and 150 cm than alfalfa. He observed that water removal by grass-legume mixtures was greater than that of either species grown alone.

III. METHODS AND MATERIALS

During the fall of 1980 two similar field studies were initiated. Location I was located at the Agronomy Research Station, Perkins, Oklahoma and Location II was located at the South Central Research Station at Chickasha, Oklahoma. Both studies consisted of four replications in a split-plot design with three dates of first harvest as main plots. Dates of first harvest were as follows: 1) 'early', cheat in late boot stage; 2) 'normal', cheat at soft dough, alfalfa in 1/10th bloom; and 3) 'late', cheat mature and yellowing. The subplots consisted of four alfalfa seeding rates (4.5, 9.0, 13.5, 22.5 kg/ha) in a factorial arrangement with and without a cheat overseeding. Subplot dimensions were 1.8 by 6 m with 3 m borders between main plots.

Prior to planting, the soil at both locations was tested for available phosphorus and potassium and fertilized according to soil recommendations. Incorporation of fertilizer was via a tandem disk. No nitrogen fertilizer was applied. Alfalfa (var. Riley) was seeded with a 1.6 m Brillion seeder at both locations after making perpendicular passes with the seeder empty to firm the soil.

Alfalfa and cheat plant counts were taken in October at both locations from four (15.2 by 91.4 cm) quadrats randomly placed in each subplot. All first harvest samples were taken from two (0.5 by 1.0 m) quadrats randomly placed in each subplot and cut at a height of approximately 6 cm. Cheat and alfalfa components were hand separated and oven dried at 50 C to obtain dry matter weights. Each main plot was uniformly trimmed with a Carter flail-type forage harvester immediately after sampling. All subsequent harvests were taken with the Carter harvester with subplot forage weights taken in the field and subsamples oven dried for the determination of moisture percentage. The various yields were adjusted to oven dry basis and converted to kg/ha yield. All data were subjected to analysis of variance and LSD calculated on means found to be significantly different. Reference to significance indicates differences occurring at the P=0.05 level of confidence. In the tables differences between treatment means are identified by the use of an LSD figure at the 5% level of confidence. The LSD to compare main plot levels (cutting dates) at the same subplot level (cheat or no cheat) was computed as follows (18):

$$LSD=(\sqrt{(2((b-1)MS_b+MS_a)/b)/\#\ obsns\ in\ mean})\ x\ t$$

$$df=((b-1)MS_b+MS_a)^2/(b-1)^2MS_b{}^2/df_b+MS_a{}^2/df_a$$

Where: b = # of observations at one level of main effect

MS_a = mean square of error a

MS_b = mean square of error b

Low rainfall and abnormally hot weather during the summer of 1980 resulted in depleted moisture reserves in deep rooting zones at both locations. Although rainfall was considered normal for the spring of 1981 the previous year's deficit translated into stressed moisture conditions as plant water requirement exceeded available moisture.

Location I was seeded on Sep 3, 1980 on a Farnum silt loam (fine-loamy, mixed, thermic Pachic Argiustolls) which is classified as well drained but having moderately slow permeability. Soil moisture at the time of planting was considered fair to poor and rainfall for September was below normal. On Sep 14, 1980 approximately 8 cm of irrigation water was applied to aid in germination. Plant emergence counts were taken Oct 22, 1980 when plants were from 4 to 9 cm tall. The study was sprayed with 0.84 kg/ha carbofuran for alfalfa weevil (Hypera postica Gyllenhal) control on Mar 27, 1981. Cheat plants were wilting in early April from moisture stress so another 8 cm of water was applied on Apr 10, 1981. Dates of cutting main plots at first harvest were Apr 22, May 1, and May 12, 1981. Cheat and alfalfa dry matter yield and percent protein was determined from samples from all first harvest plots at this location. Protein concentration of these samples was determined by the Oklahoma State University Agronomic Services laboratory.

At second harvest an attempt was made to bring harvest dates closer together so the third harvest could be taken at the same date. Dates of second harvest were Jun 5, 10, and 17, 1981 for 'early', 'normal', and 'late' main plot treatments respectively. Third harvest of all plots was on Jul 13, 1981. The study was again irrigated on Jul 20, 1981. Fourth and fifth harvest were on Aug 18 and Sep 29, 1981. Stem counts were taken in each subplot after the second cutting from three randomly placed (15.2 by 91.4 cm) quadrats.

Location II was seeded Sep 10, 1980 on a Dale silt loam (fine silty, mixed, thermic Pachic Haplustolls) which is classified as moderately permeable with a high capacity for holding available water. Seedbed condition was only fair at seeding but soil moisture was good. Plant emergence counts were taken Oct 29, 1980 when plants were from 4 to 9 cm tall. The study was sprayed on Apr 8, 1981 with 0.84 kg/ha carbofuran for control of alfalfa weevils. Dates of cutting main plots at first harvest were Apr 21, May 7, and May 20, 1981. Dates for second harvest were Jun 8, 11, and 12 for the 'early', 'normal', and 'late' cutting dates respectively. A third harvest was taken on Jul 20, 1981. Stem counts in all subplots were taken Jul 21, 1981 from three randomly placed (15.2 by 91.4 cm) quadrats. No additional harvests were taken since part of the study was subjected to standing water from an attempted irrigation followed by an intensive rain which ruined the stand for experimental purposes.

IV. RESULTS AND DISCUSSION

Moisture conditions due to rainfall, irrigation, and water holding capacity of the soil varied greatly between locations throughout the duration of the experiment. This resulted in some treatment by location interactions so each location was statistically analyzed separately. There were no significant interactions between date of first cutting and alfalfa seeding rate at either location, therefore, the effects of dates of cutting are averaged over alfalfa seeding rate and seeding rates are averaged over cutting dates.

Seedling stands of alfalfa, when seeded alone varied from a low of 42 plant/m^2 at Location II to a high of 315 plants/m^2 at Location I (Table 1). The number of alfalfa plants at both locations increased significantly as alfalfa seeding rate increased. The number of alfalfa plants in plots overseeded to cheat was generally similar at respective seeding rates in plots not overseeded with cheat. However, at Location I there was a significant reduction in alfalfa plants (27 and 61 plants /m^2 respectively) at the 13.5 and 22.5 kg/ha alfalfa seeding rate associated with the cheat overseeding. Competition for available water in the surface of the soil at this site may have caused this reduction since no significant reduction in alfalfa plants could be attributed to cheat overseeding at Location II which has a finer textured soil and had better moisture conditions following seeding.

The average number of cheat seedlings in overseeded plots was

Table 1. Alfalfa and cheat stand counts at Location I and II as affected by alfalfa seeding rate.

	Location					
	Location I[a]			Location II[b]		
Alfalfa seeding rate	Cheat-free	Cheat Overseeded		Cheat-free	Cheat Overseeded	
	Alfalfa	Alfalfa	Cheat	Alfalfa	Alfalfa	Cheat
(kg/ha)	(plants/m^2)					
4.5	66	57	195	42	36	170
9.0	126	113	187	117	107	150
13.5	206	179	183	158	152	146
22.5	315	254	200	274	268	146
$LSD_{0.05}$	24		NS	24		NS

[a] Plant counts taken October 22, 1980.

[b] Plant counts taken October 29, 1980.

190 and 153 plants/m^2 at Location I and II respectively. Alfalfa seeding rates did not have a significant effect on the number of cheat plants emerging at either location. Populations of cheat seedlings in both studies were considered adequate for full competition after establishment since the cheat plants tillered and occupied essentially all of the area.

The physiological alfalfa growth stage varied somewhat at each first harvest cutting. These variations ranged from pre-bud to budding at 'early' cut, to 5 to 30% bloom (average 10%) at 'normal' cut, to 70 to 100% bloom at the 'late' cut. In general the more advanced stages were associated with the lower seeding rates. The main effects of first cutting date on alfalfa and cheat dry matter production averaged over seeding rates are presented in Table 2. The most significant effect at both locations at first harvest was the large increase in cheat production associated with delayed cutting. This increase from 'early' to 'late' harvest reflected continued cheat growth which totaled 970 kg/ha at Location I and 1480 kg/ha at Location II. Alfalfa production in cheat seeded plots was significantly reduced at all dates of cutting. Significant increases in alfalfa production associated with the 'late' cutting in cheat-free plots was observed at both locations but no consistent increases in alfalfa production in cheat seeded plots were noted. Nominal plant heights varied from 35 cm for alfalfa and 45 cm for cheat at 'early' cutting to 45 cm for alfalfa and 90 cm for cheat at the 'late' cutting. Although light intensity at the surface of the alfalfa canopy was not determined, similarities between this study and its results to Stern's and Donald's findings (21) indicate that in both, competition for light has arrested the growth of the shorter legumes.

Table 2. Dry matter production of alfalfa and cheat at Location I and II as affected by time of first cutting.

Cheat seeding rate	Time of first cutting	First Harvest Alfalfa	First Harvest Cheat	First Harvest Total	Second Harvest Alfalfa	Third Harvest Alfalfa	Fourth Harvest Alfalfa	Fifth Harvest Alfalfa	Season Totals Alfalfa	Season Totals Total
(kg/ha)		(kg/ha)								
LOCATION I										
17	Early	650	1930	2580	2830	2420	2290	1960	10160	12090
	Normal	1010	2450	3460	3120	2050	2480	2080	10290	13180
	Late	940	2900	3840	3170	1810	2350	2020	10740	13190
0	Early	2880	-	2880	3960	2970	2530	1890	14220	14220
	Normal	3070	-	3070	4660	2470	2640	2000	14830	14830
	Late	3350	-	3350	4860	2220	2540	1870	14850	14850
$LSD_{0.05}$		340	460	430	a	a	260	b	820	730
LOCATION II										
17	Early	910	2720	3630	2340	1150	-	-	4410	7130
	Normal	900	3310	4210	1790	940	-	-	2790	6990
	Late	840	4200	5040	1250	700	-	-	3620	6930
0	Early	2719	-	2710	2950	1160	-	-	6830	6830
	Normal	2510	-	2510	2470	880	-	-	5820	5820
	Late	3080	-	3080	2090	650	-	-	5870	5870
$LSD_{0.05}$		250	690	490	a	a	c	c	450	630

[a] Not statistically analyzed due to variations in regrowth periods.

[b] Means of cheat seeding rate (averaged over cutting date) are significant at P=.05 level.

[c] Data not available due to loss of alfalfa stand.

Total herbage production at first harvest in 'late' cut plots at Location I averaged 1260 and 470 kg/ha more dry matter than the 'early' cut plots in cheat seeded and cheat-free plots respectively. There was a significant increase in herbage production in cheat seeded plots over cheat free plots at 'late' cuttings not seen at the first two cutting times.

Trends in first harvest herbage production for Location II were similar to Location I except that all dates of first cutting resulted in increased yields in those plots having cheat overseeded.

Length of regrowth periods at second and third harvest were varied in order to bring harvest dates together by third harvest. Since alfalfa is normally harvested according to growth stage and not number of days of growth, statistical comparisons on the effects of date of first cutting on these harvests would be confounded and hence were not analyzed.

Fourth and fifth harvests were taken at Location I only and are represented in Table 2. There were some significant differences at fourth harvest due to treatments but reductions due to cheat competition at any one date of first cut were not significant. There were some significant increases at fifth harvest in alfalfa yield from plots seeded to cheat when averaged over cutting dates, however, within weed-free or cheat seeded treatments no differences were noted among dates of cutting at either harvest.

Total seasonal herbage production at Location I was significantly reduced by cheat competition. Time of first cutting did not significantly affect total seasonal herbage production in cheat-free plots but did have an affect on cheat overseeded plots. There was significantly more total forage production with the two later cutting dates and this was attributed, in part, to the increased cheat production at first harvest. There was some decreased seasonal production of alfalfa associated with 'early' first cutting but these differences were insignificant. Total seasonal alfalfa production was reduced at least 4000 kg/ha by cheat overseeding regardless of the time of first harvest.

Season total values for Location II could not be compared to Location I since these values are accumulations of forage through the third harvest only. However, total forage production comparisons among treatments are valid and indicate that cheat overseeding significantly reduced alfalfa production regardless of time of first cutting. Total alfalfa production was significantly increased with the 'early' cutting both with and without cheat competition. There was wilting of alfalfa plants due to dry soil conditions at first harvest and it is possible that removing the forage at this time resulted in less stress to the alfalfa plants and more available soil water for regrowth than with the later cutting dates.

The main effects of alfalfa seeding rate averaged over first cutting dates on alfalfa dry matter production at first harvest were similar at both locations (Table 3). In general, the amount of alfalfa harvested from both cheat-free and cheat overseeded plots increased with increasing seeding rates. Alfalfa production in cheat overseeded plots varied from a low of 420 kg/ha at Location I with the 4.5 kg/ha seeding rate to a high of 1400 kg/ha at Location II with the 22.5 kg/ha seeding rate. Cheat production was significantly reduced at both locations with the higher alfalfa seeding rates. At Location I total cheat-alfalfa

Table 3. Dry matter production of alfalfa and cheat at Location I and II as affected by alfalfa seeding rate.

Cheat seeding rate	Alfalfa seeding rate	First Harvest Alfalfa	First Harvest Cheat	First Harvest Total	Second Harvest Alfalfa	Third Harvest Alfalfa	Fourth Harvest Alfalfa	Fifth Harvest Alfalfa	Season Totals Alfalfa	Season Totals Total
----(kg/ha)----		----------	----------	----------	----------	(kg/ha)	----------	----------	----------	----------
LOCATION I										
17	4.5	420	2740	3160	2350	1860	2200	2010	8850	11580
	9.0	770	2660	3430	3060	2200	2470	2050	10550	13210
	13.5	1020	2280	3300	3260	2130	2390	1990	10790	13070
	22.5	1270	2080	3290	3500	2180	2420	2020	11390	13400
0	4.5	2420	-	2420	4470	2500	2540	1850	13800	13800
	9.0	3070	-	3070	4570	2640	2600	1970	14850	14850
	13.5	3500	-	3500	4430	2620	2610	1930	15100	15100
	22.5	3410	-	3410	4490	2450	2530	1920	14800	14800
$LSD_{0.05}$		320	310	470	320	180	145	a	610	450
LOCATION II										
17	4.5	450	4280	4730	1380	1030	-	-	2870	7150
	9.0	670	3750	4240	1760	980	-	-	3420	6990
	13.5	1010	3420	4430	2030	860	-	-	3910	7340
	22.5	1400	2360	3760	1990	830	-	-	4220	6590
0	4.5	2280	-	2280	2450	1030	-	-	5750	5750
	9.0	2760	-	2760	2570	920	-	-	6260	6260
	13.5	3000	-	3000	2470	870	-	-	6330	6330
	22.5	3040	-	3040	2530	780	-	-	6350	6350
$LSD_{0.05}$		280	400	540	270	150	b	b	650	a

[a] Means of cheat seeding rate (averaged over alfalfa seeding rate) are significant at P=.05 level.

[b] Data not available due to loss of alfalfa stand.

herbage production at first harvest exceeded cheat-free alfalfa production only at the 4.5 kg/ha seeding rate. At Location II total herbage production was increased in the cheat seeded plots at all seeding rates of alfalfa. The largest increase was at the 4.5 kg/ha seeding rate where total production in cheat seeded plots averaged 2540 kg/ha more herbage than in cheat-free plots. Alfalfa yield at second harvest was significantly reduced at both locations by cheat competition. These reductions were most severe at the lowest seeding rate with yield losses of 2120 and 1070 kg/ha at Location I and II respectively. There were no differences in yield at second harvest due to seeding rate in cheat-free alfalfa at either location.

At location I third harvest alfalfa dry matter yields from plots not overseeded to cheat was still significantly higher than yields from cheat overseeded plots. This varied from an increase of 640 kg/ha at the 4.5 kg/ha seeding rate to an increase of 270 kg/ha at the 22.5 kg/ha seeding rate. Limited moisture conditions resulted in low third harvest yield with no increase for the cheat-free plots. Under these dry conditions the alfalfa yields tended to increase as seeding rate was reduced in both cheat overseeded and cheat-free plots.

At fourth and fifth harvest yields of cheat-free alfalfa remained relatively constant over seeding rates. In the fourth harvest a trend to reduced yields in cheat seeded plots was observed at all seeding rates but is only significant at the 4.5 and 13.5 kg/ha alfalfa seeding rates where losses totaled 340 and 220 kg/ha respectively. At fifth harvest reduction trends due to cheat were reversed with an average yield of 2120 kg/ha in plots overseeded to cheat and 1920 kg/ha in weed-free plots. This increase is statistically significant when averaged over both dates of first cutting and seeding rates and may be attributed to a delayed use of moisture in the rooting zone by alfalfa plants since production was less in these plots at the first four harvests.

Based on total season alfalfa production at Location I there were no significant differences among the three higher seeding rates but production at the 4.5 kg/ha alfalfa seeding rate was significantly less (at least 1000 kg/ha) in both cheat-free and cheat seeded plots. Losses in alfalfa dry matter, attributed to cheat competition at this location, varied from 3410 to 5000 kg/ha at the 22.5 and 4.5 kg/ha seeding rates respectively. At location II there was some decreased alfalfa production at the 4.5 kg/ha seeding rate for both cheat-free and cheat seeded plots. This decrease was significant in the plots where alfalfa was growing in competition with cheat. When averaged over seeding rate alfalfa plus cheat produced more total herbage at this location (7020 kg/ha) than cheat-free alfalfa (6170 kg/ha).

The percent crude protein of both cheat and alfalfa decreased significantly with each delay in cutting date (Table 4). This amounted to a 17 and 40% reduction in protein respectively for alfalfa and cheat from 'early' to 'late' harvests. The alfalfa seeding rate had no effect on protein concentration of alfalfa or cheat when averaged over time of cuttings. When crude protein percentages were converted to a protein yield basis (kg/ha) it was found that protein yields were essentially constant over harvest stages and increased with higher seeding rates. This increase was attributed to the increase in alfalfa production associated with the higher seeding rates (Table 3). There was a significant decrease in total protein yield in cheat overseeded

Table 4. First harvest crude protein of alfalfa and cheat at Location I as affected by time of cutting and alfalfa seeding rate.

Treatment	Protein concentration		Total protein yield	
	Alfalfa	Cheat	Cheat-free	Cheat overseeded
	---------(%)---------		-----------(kg/ha)-----------	
Time of first cutting				
Early	19.9	8.4	560	300
Normal	17.4	6.6	530	330
Late	16.6	5.0	530	260
$LSD_{0.05}$	0.6	1.3	75	
Alfalfa seeding rate (kg/ha)				
4.5	18.0	6.7	430	240
9.0	18.3	6.6	500	270
13.5	17.6	6.2	630	310
22.5	18.3	7.1	600	370
$LSD_{0.05}$	NS	NS	35	

plots (Table 4) and this was primarily attributed to replacing the high protein alfalfa component with the low protein cheat (Table 3).

Alfalfa growing in competition with cheat, when averaged over dates of first cutting and seeding rate, had a significantly greater protein percent (18.5%) than alfalfa grown in cheat-free plots (17.6%). Since laboratory methods measure percent nitrogen from which all crude protein percents are determined these figures may represent various forms of nitrogen concentrated in the stunted alfalfa plants. Similar results are reported by Pritchett and Nelson (15) for alfalfa grown under low light intensity.

There was an increase in alfalfa stem number at both locations associated with the 'early' cutting in cheat-free plots but not in cheat overseeded plots (Table 5). Cowett and Sprague (5) suggested that an increase in stem number indidated an increase in vigor. However, this did not appear to be the case with our study at Location I, since the lowest yields also occurred at the 'early' harvest (Table 2).

Effects of alfalfa seeding rate averaged over cutting dates on alfalfa stem number both with and without competition from cheat are also listed in Table 5. Alfalfa stem numbers at both locations with and without cheat competition increased as seeding rate increased. There was always a reduced stem number associated with the cheat competition and the reductions were significant at the lower seeding rates (42 and 33% reduction respectively at Locations I and II at the 4.5 kg/ha seeding rate).

Table 5. Alfalfa stem counts at Location I and II as affected by time of cutting and alfalfa seeding rate.

	Location			
	Location I[a]		Location II[b]	
Treatment	Cheat-free	Cheat Overseeded	Cheat-free	Cheat Overseeded
	(Stems/m^2)			
Time of first cutting				
Early	570	400	380	290
Normal	460	370	350	280
Late	390	400	330	280
$LSD_{0.05}$	55		45	
Alfalfa seeding rate (kg/ha)				
4.5	340	200	270	180
9.0	450	390	340	290
13.5	520	440	390	320
22.5	580	550	400	350
$LSD_{0.05}$	60		40	

[a] Stem counts taken after second harvest.

[b] Stem counts taken after third harvest.

V. CONCLUSIONS

Cheat competition was found to reduce alfalfa production at all four seeding rates and with all three dates of first cutting. In general these reductions were greatest at the 4.5 kg/ha alfalfa seeding rate with little difference noted among the three higher seeding rates. At Location I some loss of vigor was also attributed to cheat competition and was expressed by a decrease in total seasonal herbage production in plots having cheat overseeded. The increased season total herbage production at Location II in plots seeded with cheat was attributed to abnormal moisture conditions and insufficient time for weed-free alfalfa to mature and maximize production.

Although the 'early' date of first cutting at Location II had less alfalfa production at first harvest than later dates of cut, the alfalfa production at the second and third harvest was greater. It was concluded that this increase was due to the new regrowth of 'early' cut plants more efficiently using the limited available water for herbage production at second and third harvests. At Location I, where soil moisture conditions were better, cutting 'early' at first harvest generally caused reductions in total season alfalfa and total herbage.

At first harvest some differences between 'normal' and 'late' first cuttings occurred at both locations but, with the exception of cheat seeded alfalfa at Location II, were not significant in seasonal totals.

Although the percent of crude protein at first harvest was significantly reduced by successively later dates of cutting, protein yield was found to be associated with the amount of alfalfa harvested and not growth stage or alfalfa plant density. Protein yield reductions of 30 to 50% were common in cheat seeded plots since extremely low protein cheat often made up more than 70% of the forage component at first harvest.

Stem numbers in cheat-free alfalfa plots varied as a result of first harvest cutting dates at both locations. The greater stem numbers at the earlier cutting dates may be attributed to enhanced light and temperature conditions. The failure of stem numbers alone to translate into yield increases at Location I may be attributed to other, more controlling parameters such as plant density, root-shoot ratio, or leaf area index. Alfalfa stem numbers in cheat seeded plots remained relatively constant over all dates of first cutting and did not reflect the trends seen in cheat-free stands. There was no indication in the observed data that cheat competition at the tested level was responsible for alfalfa stand loss or would severely affect long-term (second season and beyond) alfalfa production.

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VITA 1

David R. Pike

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF ALFALFA SEEDING RATE AND DATE OF FIRST CUTTING ON CHEAT-ALFALFA COMPETITION

Major Field: Agronomy

Biographical:

Personal Data: Born in Rochester, Mn., May 8, 1951, the son of Ralph and Elaine Pike. Married. Three children.

Education: Graduated from John Marshall Sr. High School, Rochester, Mn. in June 1969; received Bachelor of Science from Brigham Young University, Provo, Utah in May 1980 with a major in agronomy; completed requirements for the Master of Science degree with a major in agronomy at Oklahoma State University in May, 1982.

Experience: Raised and worked on family dairy farm in Rochester, Mn.; eight years with the USAF in various capacities, two overseas tours; worked for the Soil Conservation Service during the summer of 1979 in Muscatine, Iowa; worked as agronomy research and teaching assistant during the fall of 1979 and spring of 1980 at Brigham Young University; employed at Oklahoma State University from May, 1980 to May, 1982 as a graduate research assistant.

Memberships: Weed Science Society of America, American Society of Agronomy, Crop Science Society of America, Alpha Zeta.