SMALL GRAIN PRODUCTION: SEEDING DATES AND CLIPPING FREQUENCY

By

LARRY JAMES PHILLIPS

Bachelor of Science

Oklahoma Panhandle State University

Goodwell, Oklahoma

1972

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1975

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DATES AND CLIPPING FREQUENCY

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to extend his sincere appreciation to his major adviser, Dr. Wilfred McMurphy, for his patient guidance and assistance throughout the course of this research. The author also wishes to thank Dr. Lavoy Croy and Dr. Lawrence Morrill for their help and suggestions while serving as members of the author's graduate committee.

Appreciation is extended to the Department of Agronomy of Oklahoma State University for the use of its facilities to carry out the research.

A special recognition is due my parents, Mr. and Mrs. K. L. Phillips, and my aunt, Mrs. Metta Ediger, for their help and encouragement during this graduate study.

Special thanks goes out to Lynda Hochderffer and Kathy Henslick for their assistance in the preparation and typing of this thesis.

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CHAPTER I

INTRODUCTION

The primary purpose of planting small grains in Oklahoma has usually been for the grain production, but a considerable acreage has always been pastured. Numerous studies have evaluated either the forage or grain yield that could be produced. Only a limited amount of information is available comparing both the forage and grain yields from the same areas.

Pasturing of small grains by livestock has long been a common practice since this provided a highly palatable and nutritious forage during the winter and early spring months. The pasturage is a cheap source of feed and furnishes the animal with an excellent source of protein and vitamin A at a time when it is badly needed. Now with the rising production costs and the increased price of grain, more emphasis should be placed on management practices such as time of planting, fertilization, and grazing sequence as it affects forage and grain production.

The primary objectives of these studies were to determine forage production with respect to the effect of seeding date, time of harvest, clipping frequency, and species. When possible the effect of some of these variables on grain production was also evaluated.

CHAPTER II

LITERATURE REVIEW

The importance of small grains for winter pasture and forage production has been the major emphasis in many of the articles reviewed. With new varieties being developed that are superior in forage production, as well as grain yield, more literature has become available evaluating different management practices on the forage and grain value of small grains.

Seeding Date

The advantage of early seeding of small grains for pasture has been generally recognized by farmers and agronomists. In Oklahoma, Finnel (1929) stated that wheat pasture provided a highly palatable forage and recommended the practice of sowing in early September in order to obtain extra fall pasture.

Similar results were shown by Aldous (1935) in Kansas who reported that all the grain cereals were very palatable and nutritious to livestock. Their use made it possible to extend the pasture season about two months in the fall when planted in late August or early September. Crowder (1954) working in Georgia found that it was better to plant small grains in mid-September before the recommended mid-October planting date for grain to increase fall and winter forage. Complete utilization of the small grains as a grazing crop was suggested if a grain crop was not needed.

In another study from Georgia, Cummins et al. (1964) concluded that planting on September 1, two weeks before the recommended September 15 planting date, increased fall forage production without decreasing total production. They observed that moisture conditions were better in early fall and the hazard of stand failure was reduced by taking advantage of this better moisture for seed germination and plant establishment

Small grains planted in mid-September produced about twice as much fall and winter forage as those planted in mid-October as shown by Harper (1961) in a study conducted in Oklahoma. Larter et al. (1971) verified that the earliest planting date of spring wheat resulted in the highest forage yield in Canada.

Elder (1960) compared six planting dates during four seasons, using clipped forage yields as a measurement. The seeding dates were September 10, September 25, October 10, October 25, November 10 and November 25. The September 10, September 25, and the October 10 plantings gave the same total production for the year. However, the September 10 date produced twice as much forage before January 1 as did the October 10 planting. Seeding later than October 25 eliminated all possibility of pasturing before March. One day's growth in September was equal to about five to ten days in the winter months.

Time of Harvest

Winter cereal grains form a rosette of growth in the fall of the year with extensive tiller initiation and very little internodal elongation. Tiller production appears to continue in spring until climate or maturity bring about jointing or internodal elongation. This dynamic change in growth pattern is delayed by fall grazing. The time, at which the terminal bud is raised from its protected position at or near the surface of the soil and is pushed by elongating internodes to within reach of the grazing animals, is the critical time to remove the animals if a grain crop is desired. Sprague (1954) observed in New Jersey that fall grazing delayed the time of jointing and appeared to account for the increased yields of grain. He further stated that it most certainly lengthened the time during which small grains may be grazed in the spring without injuring the terminal bud.

Swanson (1935) using cattle as grazing animals on winter wheat during the fall and winter months in Kansas, reported that in seasons of adequate rainfall the yield of grain was not reduced when grazing was properly managed, and that under favorable conditions for growth, the grain yield may be increased.

Cutler et al. (1949) in Indiana showed that growing conditions during the early spring months (March and April) may be so favorable as to stimulate a very rapid vegetative growth of the winter wheat crop. The top growth may become so excessive as to lodge and react detrimentally upon grain yield and quality of the harvested crop. Under favorable temperature and rainfall conditions during March and April, the clipping of forage from April 1 to April 20 significantly increased grain yield. Clipping treatments after this date greatly reduced the yield.

Kiesselback (1926) found that pasturing winter wheat in Nebraska in late March through April not only prevented lodging but provided feed equivalent to 1600 lb/acre of alfalfa, as well as increasing the grain yield from 14 to 19 bu/acre when grazed for approximately 35 days.

Hubbard and Harper (1949) found that grain yields were correlated with yearly environmental conditions and severity of clipping. Reduction in height of mature plants was correlated with the date at which clipping was terminated in the spring. Clipping to March 25 in Oklahoma reduced grain yields of certain cereals, exceptions being oats and barley.

Staten and Elder (1946) reported that clipping hard and soft wheat varieties in Oklahoma during the fall and winter months up to and including March 25 reduced the yield of grain 3 to 5 bu/acre.

Grain yields of rye, barley, and hard and soft wheats were found by Jones et al. (1944) in Oklahoma to be slightly reduced by clipping March 25 and drastically reduced by an April 14 clipping. Clipping to March 25 increased tillering in approximately one-half of the varieties studied, however, it was noted that the number of tillers on some varieties might have been greater on plots clipped to March 25 because of winter killing on non-clipped plots. Clipping to April 14 decreased the number of culms and resulted in a more prostate growth habit and less winter killing.

After five years of research in Oklahoma to find the best crop or variety for temporary pastures, the best ways of handling them, their value as feed, and the effects of pasturing on grain yield, Staten and Heller (1949) reached the following conclusions:

1. The nutritive value of winter small grains was so high that farmers might profitably graze them the entire season without taking a grain crop.
2. The protein content of small grain forage when young, green

and succulent was high, about 30%.

3. Grain yield was not seriously affected by grazing until plants reached the jointing stage of growth.
4. The forage yield was about tripled if grains were completely pastured out instead of taking the cattle off when grazing began to affect grain yield.

Clipping Frequency

In a study conducted in Texas, Holt (1962) showed that frequent clipping resulted in reduced forage yields. A period of at least four to six weeks between clippings was necessary for recovery and regrowth. Height of clipping influenced total plant development and rapidity of recovery following clipping but not total yield of harvested forage. According to Elder (1960) yield of forage from small grains increased as the interval between cuttings was extended from 15 to 60 days.

Warren et al. (1963) from Canada reported that more forage and root growth was produced by clipping every four weeks instead of every two weeks and found rye varieties produced more forage under frequent clipping than did oats, but the oats were more productive than rye with less frequent clippings.

Aldrich (1959) in England concluded that repeated clipping reduced grain yields and kernel size of winter wheat.

Species

Small grain palatability tests conducted in Oklahoma by Staten and Elder (1946) indicated cattle preferred winter barley, rye, soft wheat, ryegrass, oats, and hard wheat in that order for fall grazing. In the spring they preferred soft wheat, hard wheat, oats, barley, rye, and ryegrass in that order. Later similar tests by Elder (1967) revealed different results. He reported that in a three year study animals preferred oats, rye, wheat, and barley in that order.

Washko (1947) at Tennessee, stated that rye, barley, and oats produced approximately equal amounts of forage in the fall, whereas wheat produced the least fall forage. In the spring, rye furnished the greatest amount of forage, wheat and barley next best, and oats the smallest amount. Rye had the greatest total forage production, but only minor differences occurred among barley, wheat, and oats in total forage yields. Wheat and rye produced most of their forage in the spring.

Denman and Arnold (1970) in Oklahoma noted that on a seasonal basis, rye usually is the top forage producer during the fall and early winter months. It flourishes again in March and declines rapidly during April and May. Wheat becomes productive in March and remains productive somewhat longer than barley, oats, or rye.

In Oklahoma, Chaffin and Graumann (1943) reported wheat was the most important small grain crop for pasture. This was mainly due to the large acreage of wheat planted in the state. They found rye furnished more grazing than winter wheat, barley, or oats and was more winter hardy.

Other work in Oklahoma by Jones et al. (1944) showed barley produced quick growth and high forage yields early in the fall. Rye produced the highest total yield of forage followed in order by oats, hard wheat, barley, and soft wheat. Hubbard and Harper (1949) found that rye produced more forage than any other cereal followed by wheat then barley.

Morey (1972) reported that rye is the most important grazing crop in Georgia. In most years with proper management it can furnish excellent grazing from November until April.

Nitrogen Fertilization

Because of intensive cultivation, higher yielding varieties, and improved farming practices, the nitrogen level in many soils has decreased to the point where the use of nitrogenous fertilizers has become essential.

Applied nitrogen must be positionally and chemically available for plant absorption at the proper time to be effective in increasing crop yields. Factors that may alter the effectiveness of applied nitrogen are time of application, method of application, chemical properties of the soil, and climate.

Many workers have studied the effects of nitrogen on the yield characteristics of winter wheat. In almost each of the studies they reported grain yield increases with the application of nitrogen on winter wheat. The percent increase was largely dependent upon the amount of nitrogen already available in the soil and the soil moisture content (Lamb and Salter, 1936; Worzella, 1943; Hobbs, 1953; Morris and Gardner, 1958; Rhode, 1963; Stanford and Hunter, 1973).

Olson and Rhoades (1953) evaluated research in Nebraska from 1916 to 1952 and observed that winter wheat absorbed most of its nitrogen between the period when growth begins in the spring and heading stage. They stated that the most efficient use of supplemental nitrogen for grain production would usually result when the application was made early during this period rather than at planting time or late in the period. Even when there was no yield difference between spring and fall application of nitrogen, total plant uptake of nitrogen was greater with spring application than with fall application.

Doll (1962) noted that wheat grain yields from two silt loam soils in Kentucky were lower in four of seven experiments for fall-applied nitrogen than for spring-applied nitrogen. In none of the experiments were yields higher with fall application than with spring application. Nelson and Uhland (1955) observed that nitrogen fertilizer was applied to winter wheat at the time of fall seeding was not as effective as top-dressing the following spring. Welch et al. (1966) recommended the practice of applying nitrogen in the spring. They revealed that nitrogen applied in the spring increased yields more than the same nitrogen rate applied in the fall.

Ramig and Rhoades (1963) revealed that a split application of 20 pounds of nitrogen in the fall and 20 pounds in the spring resulted in grain yields that were practically the same as those obtained with a single application of 40 pounds of nitrogen in either the fall or spring. Wells and Keogh (1963) also noted that splitting the application of nitrogen did not result in increased grain yields of small grain planted in Arkansas.

Elder (1967) conducted a small grain forage fertilizer test in eastern Oklahoma with ten fertilizer treatments. His findings showed that both nitrogen and phosphorus, alone, or in combination, increased the forage production. Fall and spring application of nitrogen produced greater amounts of forage than equivalent amounts of nitrogen applied entirely in the fall.

Morris and Jackson (1959) conducted a three year study in Georgia comparing nitrogen applications on rye forage. They reported that 120 lb/acre of nitrogen split equally for application at planting in October and topdressing in February increased forage production over a single application at planting by 230 lb/acre. The increase obtained from split applications of nitrogen was not significant the first year but was highly significant the last two years of the experiment. Although the increased forage yield would more than pay for the extra cost involved in applying the split applications of nitrogen, Southwell and Parham (1955) recommended applying all the nitrogen to small grain at planting time so as to obtain the maximum amount of grazing during the fall and winter months. However, Morris and Jackson (1959) found early forage yields were increased an average of only 109 lb/acre by applying all the nitrogen at planting. This increase was significant only one year out of the three years.

Morey et al. (1969) concluded that the amount of nitrogen used on small grains influenced forage quality, although phosphorus and potassium also were important. Since large amounts of nitrogen increased the danger of lodging, more nitrogen could be used when the crop was to be used for grazing or hay than when it was to be harvested for grain.

CHAPTER III

MATERIALS AND METHODS

Three individual studies were evaluated at the Agronomy Research Station at Perkins, Oklahoma in a two year period from 1972-1974. Two of the experiments were planted in the fall of 1972 while the third study was planted in the fall of 1973. All three studies were located in the same general area on a Teller loam soil (Udic Argiustoll). Soil samples were taken from the 0-6 inch level for each study prior to planting.

Each individual plot in all the experiments was made up of five rows, 12 inches apart and 20 feet in length. The plots were planted with a one row planter at a 100 lb/acre seeding rate. Clipping was done with a three foot sickle type mower cutting the three center rows from each plot. Forage moisture samples were oven dried and production is reported as oven dry lb/acre.

For the grain yield, two 8 foot rows were cut and bundled from the grain plots. After the samples were threshed, they were weighed and converted to bu/acre.

Precipitation and resultant soil moisture conditions during the growing seasons were above average for all of the studies (Appendix Table X).

Centurk Wheat 1972-1973

The experimental design used for this study was a randomized block with factorial arrangement of treatments including four seeding dates X five clipping treatments X two nitrogen fertility levels for a total of 40 treatments replicated four times.

Centurk wheat (Triticum aestivum L.) was planted on four seeding dates at two week intervals, August 22, September 5, September 10, and October 13. The fertilizer treatments consisted of a high level and low level of nitrogen. The low level of nitrogen was a single application of 60 lb of actual N/acre at planting. This nitrogen was broadcast applied to seeding date one and two on September 5, seeding date three on September 18, and October 4 for seeding date four. The high level of nitrogen received the 60 lb/acre at planting and an additional 60 lb/acre on November 8, and March 17 for a season total of 180 lb/acre.

Soil test results showed a pH of 5.1, 51 lb/acre of NO_3-N, 20 lb/acre of P, and 190 lb/acre of K. A uniform application of 75 lb of P_2O_5/acre using treble super phosphate (0-46-0) was made on September 8.

The clipping treatments planned were for four last forage harvest dates plus a check (never harvested). However, in actuality, two of these treatments terminated on the May 23 date. Therefore, the forage production study had four treatments, the last harvest dates being March 17, April 26, and May 23 (two observations). The grain production had three treatments, a check (never harvested for forage), and the last clipping dates of March 17 and April 26. When the forage was harvested on May 23 the regrowth was insufficient for further grain or forage harvest.

Centurk Wheat 1973-1974

The experimental design for this study was a partial factorial arrangement of four seeding dates X different clipping treatments for a total of 18 treatments with four replications. Centurk wheat was planted on four seeding dates, August 23, September 18, October 17, and November 30. Nitrogen fertilizer was broadcast applied to all plots at a rate of 60 lb of actual N/acre on September 11, November 2, and December 21 for a season total of 180 lb/acre.

Soil test results revealed a pH of 5.0, 54 lb/acre of NO_3-N, 66 lb/acre of P, and 265 lb/acre of K.

Clipping treatments were an incomplete factorial with a final date for forage harvest. These final dates for the August 23 seeding were: check (never harvested), October 26, December 14, March 25, and April 18; for September 18 seeding: check (never harvested), December 14, March 25, and April 18; for October 17 seeding: check (never harvested), March 25, and April 18; for November 30 seeding: check (never harvested) and April 18.

Centurk Wheat, Bonel Rye, and Centurk-Bonel Mixture 1972-1973

The experimental design for this study was a randomized block with factorial arrangement of treatments including three species combinations X seven clipping treatments for a total of 21 treatments, replicated four times.

Two species, Centurk wheat, Bonel rye (*Secale cereale* L.), plus a mixture (50-50%) of the two were planted on August 23, 1972. Eighty lb of P_2O_5/acre using treble super phosphate (0-46-0) were applied to each plot on September 13. Nitrogen was broadcast applied at a rate of 60 lb of actual N/acre on September 5, December 21, and March 16 for a total of 180 lb/acre of nitrogen on each of the plots.

Seven clipping treatments were designed to evaluate the effect of clipping versus no clipping at different dates throughout the season on forage production. This study involved only forage production, and grain production was not a variable to be measured.

CHAPTER IV

RESULTS AND DISCUSSION

Centurk Wheat 1972-1973

Forage Production

The mean forage production as shown in Table I revealed that for each two week delay in planting there was a significant reduction of approximately 1000 lb/acre in fall and winter production. The first seeding, August 22, produced 4514 lb/acre while the last seeding, October 3, produced only 1218 lb/acre.

Spring growth after March 17 was significantly greater from the late seeding, October 3, but the difference in spring production was only 737 lb/acre between the high (October 3) and the lowest production (August 22 seeding).

Total forage production was significantly reduced by later seeding dates. The mean value for the August 22 seeding was nearly 7000 lb/acre compared to 4431 lb/acre from the October 3 seeding.

The high level of nitrogen consistently produced a significant increase in forage production. The greatest increase from the higher rate of nitrogen was in fall and winter production, 611 lb/acre, compared to only 142 lb/acre increase in the spring production.

A graphic illustration of accumulated forage production for the high nitrogen treatments (Figure 1) and the low nitrogen (Figure 2)

TABLE I

MEAN FORAGE PRODUCTION OF CENTURK WHEAT 1972-1973

Seeding Date	Pounds per Acre: Low Nitrogen	High Nitrogen	Mean
	Fall and Winter Growth Through March 17		
Aug. 22	4254	4774	4514
Sept. 5	2909	3739	3324
Sept. 19	2256	2723	2490
Oct. 3	905	1530	1218
Mean	2581	3192	
LSD (P = .05)	396	396	280
	Spring Growth After March 17		
Aug. 22	2342	2610	2476
Sept. 5	2766	2832	2799
Sept. 19	2793	2629	2711
Oct. 3	3015	3411	3213
Mean	2729	2871	
LSD (P = .05)	439	439	310
	Total Forage Production		
Aug. 22	6596	7384	6990
Sept. 5	5675	6571	6123
Sept. 19	5049	5352	5201
Oct. 3	3920	4941	4431
Mean	5310	6062	
LSD (P = .05)	392	392	277

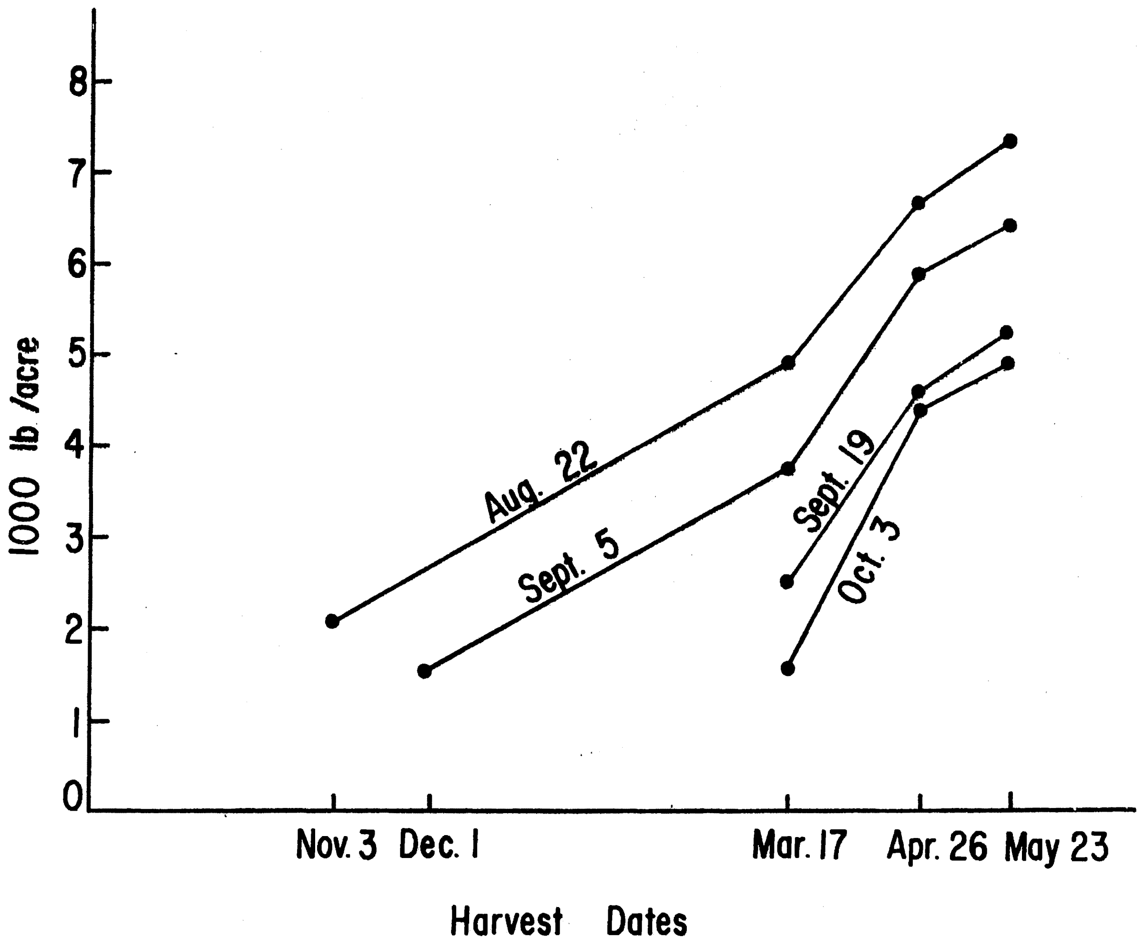

Figure 1. Accumulated Forage Production Comparing Four Seeding Dates with the High Level of Nitrogen on Centurk Wheat 1972-1973.

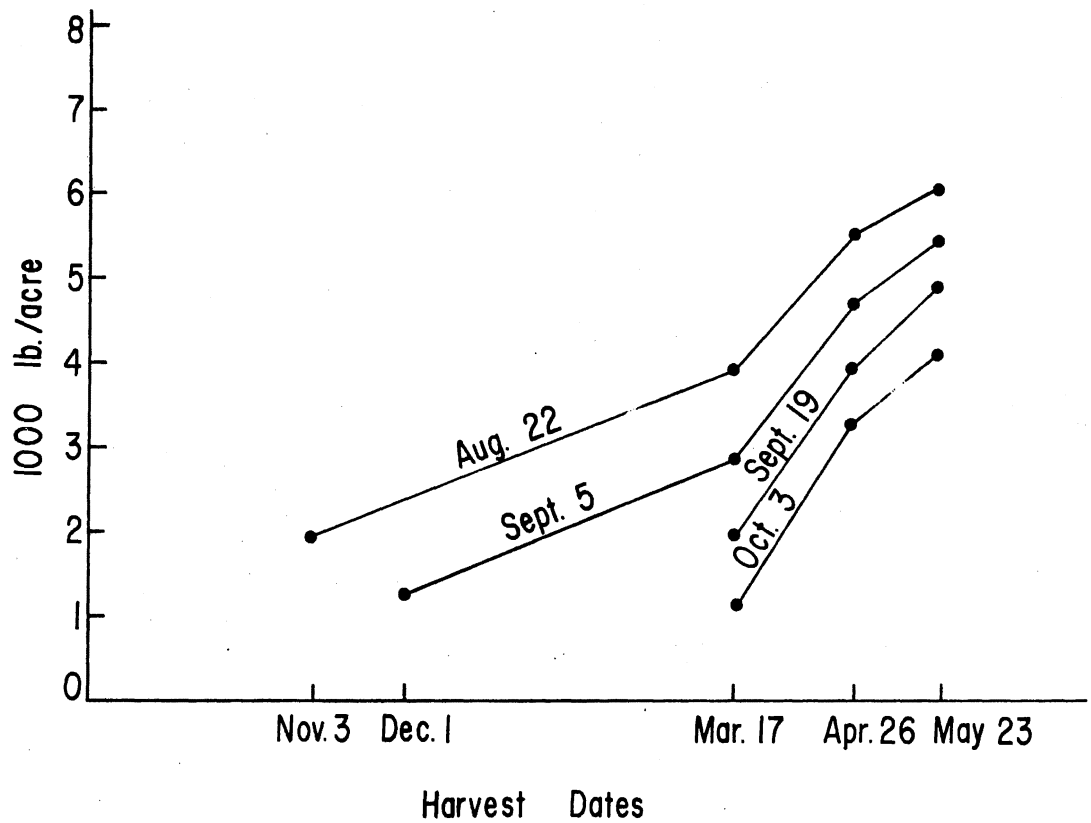

Figure 2. Accumulated Forage Production Comparing Four Seeding Dates with the Low Level of Nitrogen on Centurk Wheat 1972-1973.

are presented. Precipitation was above normal and the data represent the potential production from good moisture conditions.

Grain Production

Highest grain yields in this study were from the unclipped plots at the low nitrogen level (Table II and Table III). The low nitrogen produced significantly more grain at each seeding date than the high level. A significant nitrogen X clipping interaction indicated that clipping on March 17 was less detrimental to grain production from the high nitrogen plots than from the low nitrogen plots. The unclipped plots at the high nitrogen level produced a dense amount of forage which shaded the lower leaves of the plants causing increased lodging to occur. A final clipping on April 26 severely reduced grain production at both nitrogen levels.

Seeding date did not have a significant effect on grain production.

Centurk Wheat 1973-1974

Effect of Seeding Date on Accumulated Forage Production

The early seeding date of August 23 was superior to all other seeding dates in accumulated forage production throughout the season (Figure 3). The least total forage production came from the latest seeding date, November 30.

Delaying the planting time from four to six weeks reduced total forage production by 1200-1700 lb/acre (Figure 3). This supports the data from the previous study where delaying planting by four weeks reduced the total forage production by about 1750 lb/acre (Figure 1 and

TABLE II

CENTURK WHEAT GRAIN YIELD AS AFFECTED BY SEEDING DATE AND TIME OF LAST FORAGE HARVEST 1972-1973

Last Forage Harvested on	Bushels per Acre by Seeding Dates: Aug. 22 Low N	Aug. 22 High N	Sept. 5 Low N	Sept. 5 High N	Sept. 19 Low N	Sept. 19 High N	Oct. 3 Low N	Oct. 3 High N
Never Harvested	45	26	42	32	52	34	45	35
Mar. 17	40	30	31	35	35	27	36	31
Apr. 26	3	2	4	2	6	5	7	3

TABLE III

EFFECT OF HARVEST DATE AND NITROGEN LEVEL
ON GRAIN PRODUCTION OF CENTURK
WHEAT 1972-1973

Last Forage Harvested on	Bushels per Acre Low Nitrogen	High Nitrogen	Mean
Never Harvested	46	32	39
March 17	36	31	34
April 26	5	3	4
Mean	29	22	
LSD (P = .05)	4	4	7

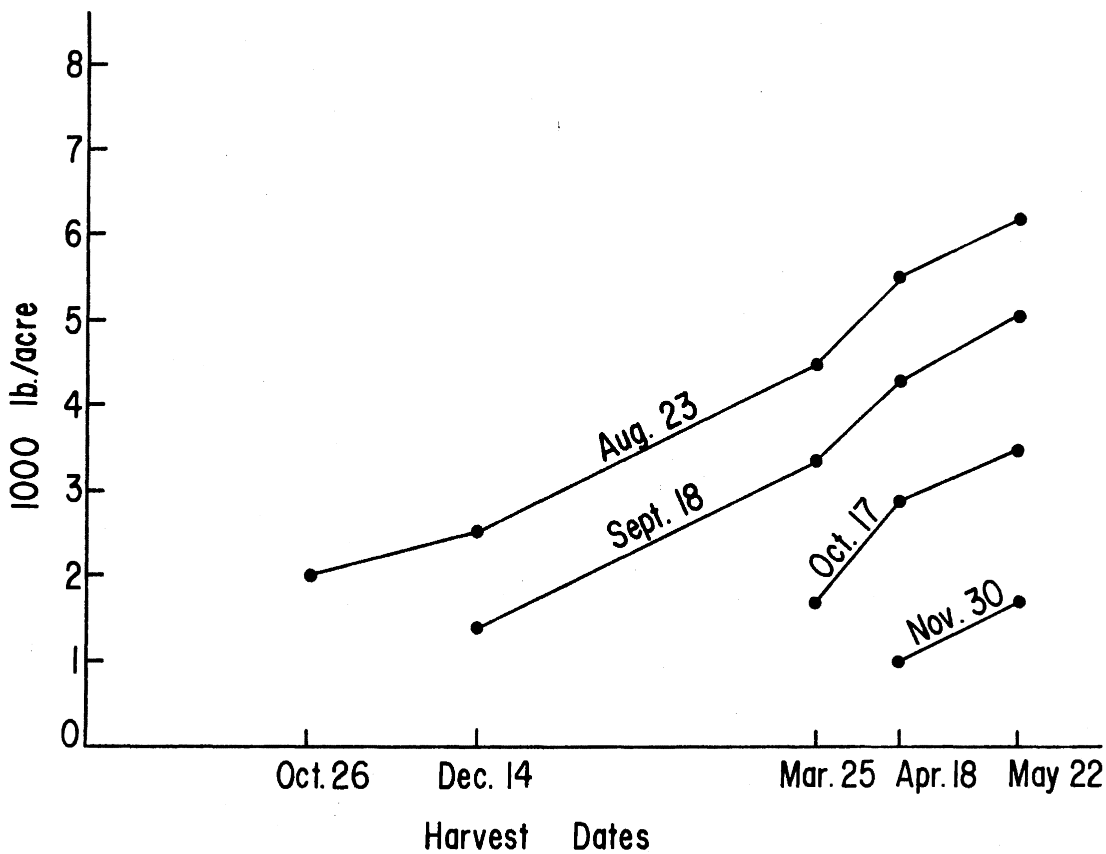

Figure 3. Accumulated Forage Production of Centurk Wheat Planted at Four Seeding Dates, 1973-1974.

Figure 2).

Grain Production

Harvesting the fall forage production was beneficial for increasing the grain production from the August 23 to September 18 seeding dates (Table IV). The highest grain yields from these seeding dates had the fall growth removed on December 14. The August 23 seeding was clipped twice by December 14 and then produced the best grain yield of the test. Clipping the forage March 25 significantly reduced grain yield of the early seeding dates. The April 18 forage clipping was disastrous to grain production.

The later plantings on October 17 and November 30 did not produce adequate growth until spring so that any clipping treatment drastically reduced grain production.

These data lend support to the conclusion that if sufficient fall forage for grazing is produced, then it should be removed to benefit the grain production. However, this study revealed that March 25 was too late to be removing forage, but it did not reveal how much later than December 14 one could benefit by forage removal.

Two replications in this study were inadvertently destroyed before grain could be harvested so that only two replications were evaluated.

Centurk Wheat, Bonel Rye and Centurk-Bonel Mixture 1972-1973

Effect of Fall Harvest

Fall harvesting was beneficial to forage production, not only in production to March 15 but also total production (Table V). Removal

TABLE IV

CENTURK WHEAT GRAIN YIELD AS AFFECTED BY SEEDING DATE AND TIME OF LAST FORAGE HARVEST 1973-1974

Last Forage Harvested on	Bushels per Acre Seeding Dates Aug. 23	Sept. 18	Oct. 17	Nov. 30
Never Harvested	13	19	27	24
Oct. 26	21	No. Hv.[1/]	No. Hv.[1/]	No. Hv.[1/]
Dec. 14	30	26	No. Hv.[1/]	No. Hv.[1/]
Mar. 25	19	16	21	No. Hv.[1/]
Apr. 18	0	2	3	4

[1/] Forage growth was insufficient to have a harvest at this early date after seeding or it was before seeding.

TABLE V

EFFECT OF FALL HARVESTS ON FALL FORAGE PRODUCTION CENTURK-BONEL STUDY 1972-1973

Pounds per Acre					
Harvest Dates			Accumulated Total To:		
Oct. 9	Dec. 1	Mar. 15	Dec. 1	Mar. 15	May 22
Centurk Wheat					
1790	989	2300	2799	5079	8626
No Hv.[1/]	2370	1962	2370	4332	7535
No Hv.[1/]	No Hv.[1/]	4008		4008	7268
Bonel Rye					
1730	1167	2492	2870	5362	7990
No Hv.[1/]	3000	1855	3000	4855	7407
No Hv.[1/]	No Hv.[1/]	4483		4483	6289
Centurk-Bonel Mixture					
1937	1187	2370	3124	5494	8568
No Hv.[1/]	3118	2109	3118	5227	7861
No Hv.[1/]	No Hv.[1/]	4316		4316	6821
LSD (P = .05)			495	561	983
Clipping Treatment Means					
1819	1114	2387	2931	5312	8394
No Hv.[1/]	2829	1975	2819	4805	7601
No Hv.[1/]	No Hv.[1/]	4269		4269	6793
LSD (P = .05)			285	324	568

[1/]No harvest on this date.

of the first 1700-1900 lb/acre of forage on October 9 was beneficial to further growth and performance of the plants. There was no evidence that forage removal on October 9 and December 1 might have any detrimental effect on fall and winter production or the total yield. There was a significant difference in fall forage production among the species with rye and the rye-wheat mixture being most productive.

Effect of a March 15 Harvest

A single forage harvest on March 15 severely reduced the production to April 14 (Table VI). This March 15 harvest of 1975 lb/acre plus regrowth of 578 lb/acre was only 2553 lb/acre total compared to 5494 lb/acre from the plots not clipped on March 15. Thus, forage growth from December 1 to April 14 was reduced by over 50% by the March 15 clipping.

However, after April 14 the regrowth was greatest on plots previously harvested on March 15. This higher production was 2219 lb/acre compared to 1043 lb/acre or about 112% greater production.

Thus, the March 15 harvest reduced the winter and early spring production by 2941 lb/acre, but increased growth after April 14 by 1176 lb/acre. This greater growth after April 14 did not adequately compensate for the earlier loss and total production was significantly reduced by about 1800 lb/acre by the single March 15 clipping.

There was a significant species difference in that rye and the rye-wheat mixture still were producing the greatest total forage to April 14.

TABLE VI

EFFECT OF A MARCH 15 HARVEST ON SPRING FORAGE PRODUCTION CENTURK-BONEL STUDY 1972-1973

Species	Pounds per Acre: Harvest Date Dec. 1	Harvest Date Mar. 15	Harvest Date Apr. 14	Total to Apr. 14	Harvest Date May 22	Total
Centurk	2370	1962	537	4869	2666	7535
Centurk	2670	No Hv.[1/]	5166	7836	1131	8967
Bonel	3000	1855	693	5548	1859	7407
Bonel	3441	No Hv.[1/]	5674	9115	797	9912
Centurk-Bonel	3118	2109	503	5730	2131	7861
Centurk-Bonel	3046	No Hv.[1/]	5643	8509	1202	9711
LSD (P = .05)	442			756	739	983
		Clipping Treatment Means				
	2829	1975	578	5382	2219	7601
	3052	No Hv.[1/]	5494	8487	1043	9530
LSD (P = .05)	ns[2/]			436	426	568

[1/]No harvest on this date.

[2/]Non-significant

Effect of an April 14 Harvest

Clipping April 14 drastically reduced the spring forage production (Table VII). The April 14 harvest of 537 lb/acre plus the regrowth of 2264 lb/acre on May 22 was only 2801 lb/acre total compared to 4002 lb/acre from the plots not clipped April 14. Thus, forage growth was reduced 30% by the April 14 clipping. Since this May 22 harvest was the last clipping harvest the reduction in growth caused by the April 14 harvest was also reflected in the seasonal total.

There was a significant species difference in that the wheat produced the greatest total forage to May 22 (Table VIII and Table IX). Spring production for the wheat was 681 to 882 lb/acre greater compared to the rye-wheat mixture and the rye, respectively.

A significant species X clipping treatment interaction was detected in the May 22 harvest (Table VIII). This indicated that the rye and the rye-wheat mixture when harvested only once prior to March 15 and only once after that, on May 22, produced less regrowth during that spring growing period. Thus, in order to achieve maximum spring regrowth from rye it should be harvested more than once prior to March 15. However, this spring regrowth of wheat was not significantly affected by the number of harvests prior to March 15.

Total Forage Production

There was no significant difference in total forage production among the species, however, a significant species X season interaction was observed (Figure 4, Figure 5, and Table IX). Greatest fall production occurred with Bonel rye and the mixture containing Bonel rye. Greatest spring production was from Centurk wheat, but the wheat

TABLE VII

EFFECT OF AN APRIL 14 HARVEST ON TOTAL FORAGE PRODUCTION, AVERAGE OF SPECIES, AND CLIPPING TREATMENTS CENTURK-BONEL STUDY 1972-1973

	Pounds per Acre			
Number of Previous Clippings	Total to Mar. 15	Apr. 14	May 22	Total to May 22
3	5312	608	2474	8394
3	5547	No Hv.[1/]	4207	9755
2	4805	578	2219	7601
2	5021	No Hv.[1/]	4252	9272
1	4269	424	2099	6793
1	4354	No Hv.[1/]	3546	7900
LSD (P = .05)	561			983
	Clipping Treatment Means			
	4795	537	2264	7596
	4974	No Hv.[1/]	4002	8976
LDS (P = .05)	324			568

[1/]No harvest on this date.

TABLE VIII

EFFECT OF AN APRIL 14 HARVEST ON TOTAL FORAGE PRODUCTION WITHIN SPECIES CENTURK-BONEL STUDY 1972-1973

Number of Previous Clippings	Pounds per Acre: Total to Mar. 15	Apr. 14	May 22	Total to May 22
	Centurk Wheat			
3	5079	646	2900	8625
3	5162	No Hv.[1/]	4378	9540
2	4332	537	2666	7535
2	4413	No Hv.[1/]	4652	9065
1	4008	510	2750	7268
1	4095	No Hv.[1/]	4494	8589
	Bonel Rye			
3	5362	555	2073	7990
3	5831	No Hv.[1/]	4057	9888
2	4855	693	1859	7407
2	5432	No Hv.[1/]	3948	9380
1	4483	338	1468	6289
1	4498	No Hv.[1/]	3251	7749
	Centurk-Bonel Mixture			
3	5494	624	2450	8568
3	5650	No Hv.[1/]	4187	9837
2	5227	503	2131	7861
2	5217	No Hv.[1/]	4155	9372
1	4316	425	2080	6821
1	4470	No Hv.[1/]	2893	7363
LSD (P = .05)	561		739	983

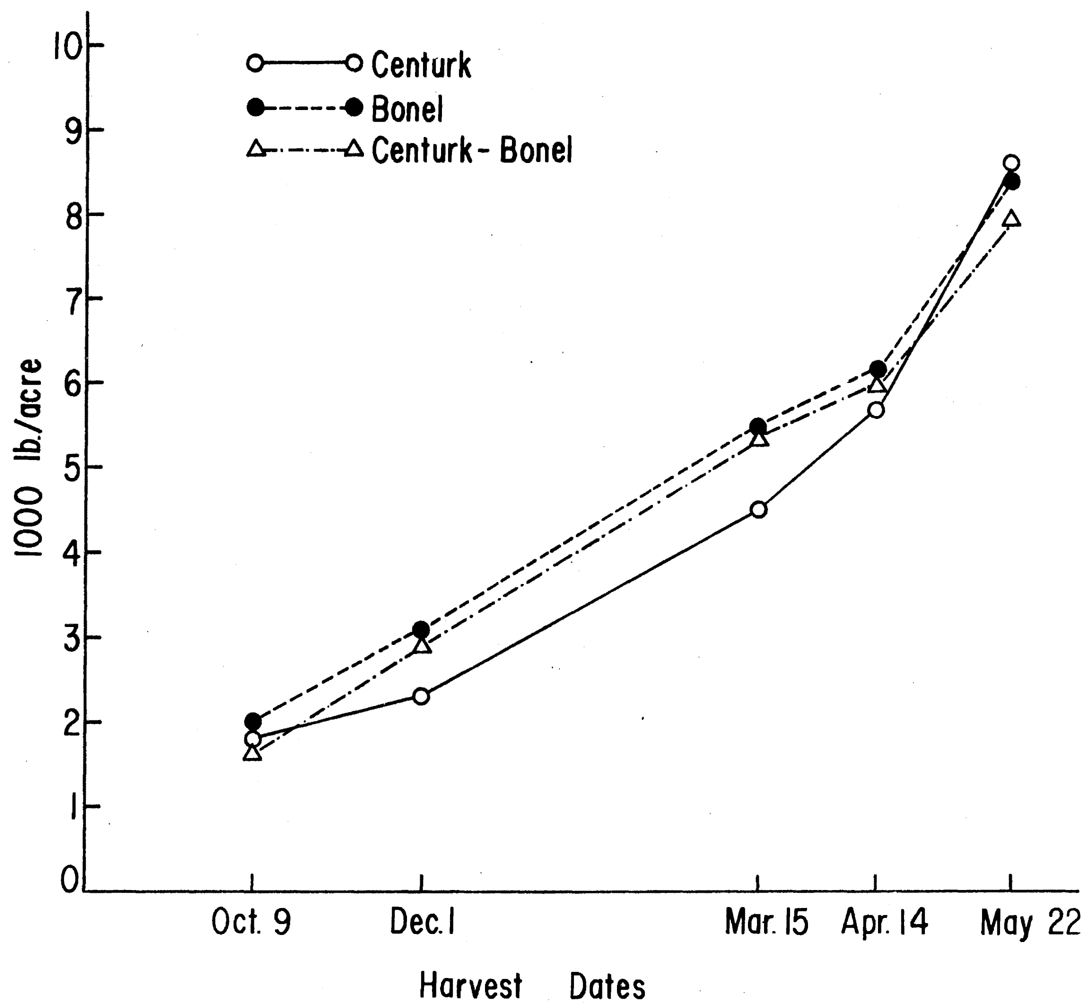

Figure 4. Accumulated Forage Production of Centurk Wheat, Bonel Rye, and Centurk-Bonel Mixture, 1972-1973.

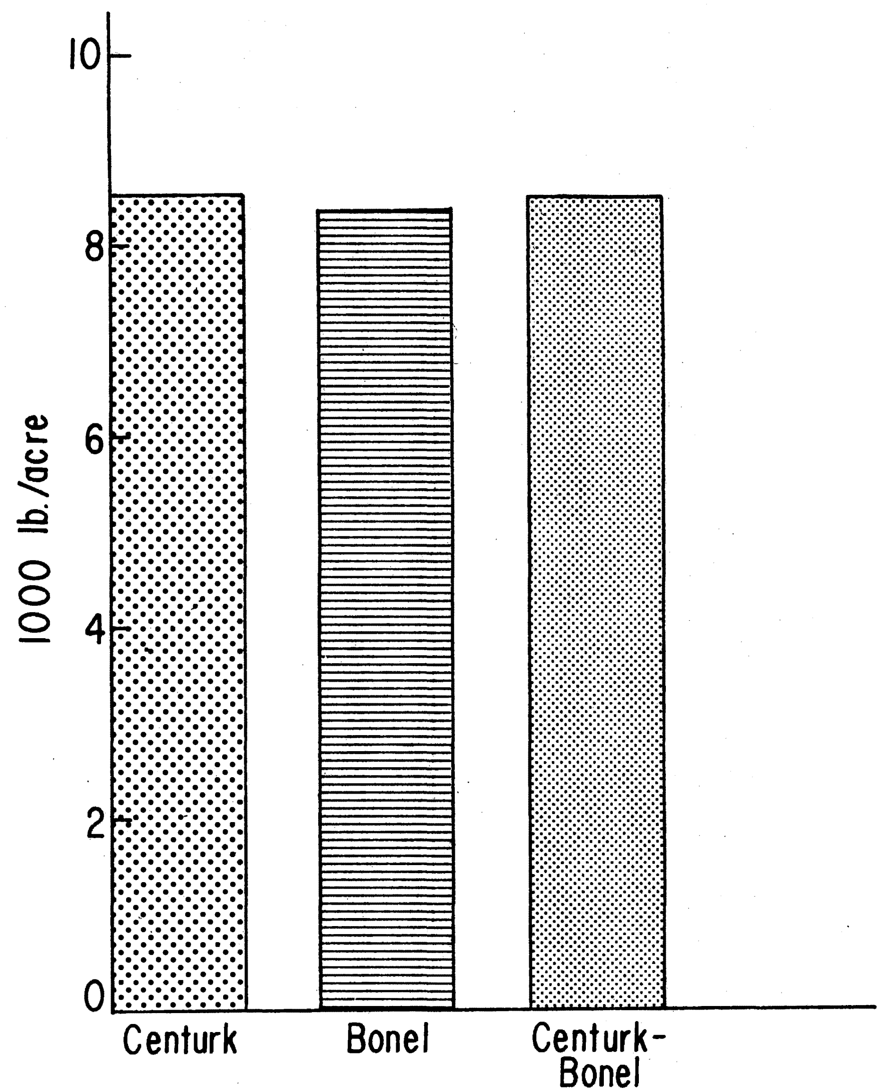

Figure 5. Total Forage Production for Centurk Wheat, Bonel Rye, and Centurk-Bonel Mixture, 1972-1973.

TABLE IX

SPECIES X SEASON INTERACTION FOR PRODUCTION
CENTURK-BONEL STUDY 1972-1973

	Pounds per Acre		
	Season		
Species	To Mar. 15 Fall	After Mar. 15 Spring	Total
Centurk Wheat	4515	3922	8437
Bonel Rye	5077	3040	8417
Centurk-Bonel	5062	3241	8303
LSD (P = .05)	315	315	ns[1/]

[1/] Non-significant

and rye mixture did not reflect any significant benefit from the wheat. Thus, rye was important for greater fall production and was also beneficial in a rye-wheat mixture. Wheat was important for spring production but only in a monoculture.

CHAPTER V

SUMMARY AND CONCLUSIONS

Small grain forage production as affected by seeding date, time of harvest, clipping treatment, and species was evaluated in three field experiments at the Agronomy Research Station, Perkins, Oklahoma. When possible the effect of some of these variables on grain production was also studied.

Centurk Wheat 1972-1973

Every two week delay in seeding date reduced fall and winter forage production by about 1000 lb/acre. The earliest planting, August 22, produced the greatest amount of forage by November 3 and March 17. Spring forage production was significantly greater from the latest seeding, October 3, but this added growth did not compensate for reduced fall growth. Total forage production was greatest from the earliest seeding date of August 22. A four week delay in seeding reduced total forage production by about 1750 lb/acre.

Plots receiving the high level of nitrogen produced significantly more forage than the low level, especially during the fall.

Seeding date did not have any significant effect on grain production. The highest grain yields came from the unclipped plots at the low nitrogen level, while those plots at the high nitrogen level produced lower grain production due to the dense forage that enhanced lodging. Thus, nitrogen had a significant negative effect on grain production, but a significant nitrogen X clipping interaction was observed. Clipping the forage March 17 reduced grain production 10 bu/acre at the low level of nitrogen but did not have a detrimental effect on those plots at the high nitrogen rate. Plots clipped April 26 at both levels of nitrogen severely reduced grain production.

Centurk Wheat 1973-1974

The early planting on August 23 was superior to all other seeding dates in total forage production throughout the season. Lowest total production came from the latest planting on November 30. Delaying planting from four to six weeks reduced total production by 1200-1700 lb/acre.

Highest grain production was obtained from the earliest seeding dates, August 23 and September 18, which had their forage removed through December 1.

The later seedings on October 17 and November 30 did not produce adequate forage until late spring and any clipping drastically reduced grain production.

Basically, it appeared that if fall growth was sufficient for grazing, it probably should be removed to enhance grain production. Removal of this excess forage was beneficial if done by December 14 but our next harvest on March 25 was too late in that this late harvest reduced grain production.

Centurk Wheat, Bonel Rye and Centurk-Bonel Mixture 1972-1973

Removing the forage in the fall was beneficial to both fall and total forage production. A forage harvest on March 15 reduced growth from December 1 to April 14 by over 50%. However, those plots harvested March 15 then grew faster after the April 14 harvest and partially compensated for the reduced growth prior to April 14. Forage production for the growth period of March 15 to May 22 was reduced from a potential of 4002 lb/acre to a yield of 2801 lb/acre by harvesting on April 14. Greatest fall production occurred with Bonel rye and the mixture containing Bonel rye. Greatest spring production was from the Centurk Wheat, but the wheat and rye mixture did not reflect any significant benefit over the wheat. There were no significant differences in total production among the species.

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APPENDIX

TABLE X

MONTHLY AND ANNUAL PRECIPITATION AT
PERKINS AGRONOMY FARM

Month	1972	1973	1974	Long Term[1/] Mean
Jan.	.30	3.00	.45	1.53
Feb.	.72	.43	2.26	1.46
Mar.	2.77	7.83	2.66	2.20
Apr.	2.49	2.61	3.13	3.16
May	1.86	3.68	6.28	5.09
June	2.83	1.48	5.35	4.58
July	3.94	3.37	.78	3.45
Aug.	6.46	2.52	3.87	3.19
Sept.	2.30	6.69	6.29	3.81
Oct.	5.72	3.10	7.15	3.21
Nov.	2.36	3.29	6.03	1.90
Dec.	.77	1.50	2.17	1.42
Total	32.52	39.50	46.42	35.00

[1/]Long time mean (30 yrs.) from city of Perkins located about 2 miles south of the research area.

TABLE XI

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
1972-1973 FALL AND WINTER GROWTH

Source	df	Mean Squares	F Value
Total	127		
Reps	3	0.460	0.764
Seeding Dates	3	116.989	194.334**
Nitrogen	1	22.629	37.590**
Clip	3	0.511	0.849
D X N	3	0.389	0.646
D X C	9	0.597	0.992
N X C	3	0.040	0.066
D X N X C	9	0.605	1.005
Error	93	0.602	

CV = 19.5%   Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 439 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XII

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
1972-1973 SPRING GROWTH

Source	df	Mean Squares	F Value
Total	95		
Reps	3	0.340	1.854
Seeding Dates	3	3.979	8.743**
Nitrogen	1	1.188	6.482**
Clip	2	9.944	54.251**
D X N	3	0.549	2.995**
D X C	6	0.065	0.356
N X C	2	0.309	1.687
D X N X C	6	0.198	1.082
Error	69	0.183	

CV = 12.2%   Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 439 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XIII

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
1972-1973 TOTAL FORAGE PRODUCTION

Source	df	Mean Squares	F Value
Total	127		
Reps	3	0.900	1.530
Seeding Dates	3	84.933	144.346**
Nitrogen	1	33.794	57.434**
Clip	3	120.649	205.046**
D X N	3	1.072	1.822
D X C	9	1.050	1.785
N X C	3	0.357	0.607
D X N X C	9	0.786	1.336
Error	93	0.589	

CV = 11.6%   Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 784 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XIV

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
1972-1973 GRAIN PRODUCTION

Source	df	Mean Squares	F Value
Total	95		
Reps	3	8031.288	3.245
Seeding Dates	3	3603.204	1.456
Nitrogen	1	121197.093	48.970**
Clip	2	1119231.010	452.228**
D X N	3	6090.650	2.461
D X C	6	4988.913	2.016
N X C	2	33471.032	13.524**
D X N X C	6	2804.545	1.133
Error	69	2474.925	

CV = 19.7% Data were (gm/2 X 8 Ft. plot)

LSD (.05) 4 observations = 7 bu/acre

** Denotes highly significant difference (P = 0.01).

TABLE XV

FORAGE PRODUCTION CENTURK
WHEAT 1973-1974

	Pound per Acre by Harvest Date					
	Oct. 26	Dec. 14	Mar. 25	Apr. 18	May 22	Total
			August 23 Seeding Date			
	1868					1868
	2080	499				2579
	1811	554	1875			4240
	1911	664	1935	1129		5639
	2003	534	1957	1053	670	6217
Mean	1934	562	1922	1091		
			September 18 Seeding Date			
		940				940
		1272	1924			3196
		1399	1826	947		4172
		1369	1993	913	782	5057
Mean		1245	1914	930		
			October 17 Seeding Date			
			1385			1385
			1138	1437		2575
			1677	1169	606	3452
Mean			1400	1303		
			November 30 Seeding Date			
				1336		1336
				984	735	1719
Mean				1160		
LSD (P = .05)						
	ns[1]	521	ns	313	ns	689

[1]Non-significant

TABLE XVI

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
TOTAL FORAGE PRODUCTION 1973-1974

Source	df	Mean Squares	F Value
Total	55		
Reps	3	1.006	2.231
Clip	13	21.682	48.069**
Error	39	0.453	

CV = 15.4%   Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 699 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XVII

ANALYSIS OF VARIANCE FOR CENTURK WHEAT
GRAIN PRODUCTION 1973-1974

Source	df	Mean Squares	F Value
Total	25		
Reps	1	432.154	0.250
Clip	12	17733.487	10.253**
Error	12	1729.654	

CV = 24.1%   Data were (gm/2 X 8 ft. plot)

LSD (0.05) 2 observations = 9 bu/acre

**Denotes highly significant difference (P = 0.01).

TABLE XVIII

ANALYSIS OF VARIANCE FOR CENTURK-BONEL STUDY
THROUGH DECEMBER 1, 1972

Source	df	Mean Squares	F Value
Total	59		
Reps	3	0.673	2.925
Species	2	4.179	18.152**
Clip	4	0.504	2.189
Sp X C	8	0.336	1.459
Error	42	0.230	

CV = 11.5% Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 497 lb/acre

** Denotes highly significant difference (P= 0.01).

TABLE XIX

ANALYSIS OF VARIANCE FOR CENTURK-BONEL STUDY
THROUGH MARCH 15, 1973

Source	df	Mean Squares	F Values
Total	71		
Reps	3	0.784	2.642
Species	2	4.679	15.776**
Clip	5	5.952	20.068**
Sp X C	10	0.225	0.759
Error	51	0.297	

CV = 8.1% Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 561 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XX

ANALYSIS OF VARIANCE FOR CENTURK-BONEL STUDY
THROUGH APRIL 14, 1973

Source	df	Mean Squares	F Value
Total	23		
Reps	3	0.629	1.171
Species	2	4.033	7.505**
Clip	1	109.697	204.163**
Sp X C	2	0.646	1.202
Error	15	0.537	

CV = 7.7%   Data were (lb/3 x 20 ft. plot)

LSD (.05) 4 observations = 756 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XXI

ANALYSIS OF VARIANCE FOR CENTURK-BONEL STUDY TOTAL FORAGE PRODUCTION THROUGH MAY 22, 1973

Source	df	Mean Squares	F Value
Total	83		
Reps	3	0.522	0.574
Species	2	0.323	0.355
Clip	6	27.764	30.534**
Sp X C	12	1.372	1.509
Error	60	0.909	

CV = 8.2%   Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 979 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XXII

ANALYSIS OF VARIANCE FOR CENTURK-BONEL
STUDY DECEMBER 1 HARVEST 1972

Source	df	Mean Squares	F Value
Total	59		
Reps	3	0.586	3.219
Trts	14	7.497	41.192**
Error	42	0.182	

CV = 14% Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 442 lb/acre

**Denotes highly significant difference (P = 0.01).

TABLE XXIII

ANALYSIS OF VARIANCE FOR CENTURK-BONEL STUDY
MAY 22 HARVEST 1973

Source	df	Mean Squares	F Value
Total	83		
Reps	3	0.150	0.292
Trts	20	11.115	21.625**
Species	2	0.992	1.930
Clip	6	30.277	58.905**
Sp X C	12	3.221	6.267**
Error	60	0.514	

CV = 18.4% Data were (lb/3 X 20 ft. plot)

LSD (.05) 4 observations = 739 16/acre

** Denotes highly significant difference (P = 0.01).

TABLE XXIV

ANALYSIS OF VARIANCE FOR SPECIES X SEASON INTERACTION CENTURK-BONEL STUDY 1972-1973

Source	df	Mean Squares	F Value
Total	143	1213.628	
Reps	3	33.386	0.154
Species	2	309.573	1.427
Clip	5	7188.128	33.140**
Error a	51	216.901	
Season	1	79212.759	267.864**
Sp X Se	2	7285.515	24.637**
C X Se	5	2262.995	7.653**
Sp X C X Sc	10	186.450	0.631
Error b	54	295.720	

CV = 13.1% Data were (lb/acre)

LSD (.05) for Sp X Se (24 observations) = 315 lb/acre

** Denotes highly significant difference (P = 0.01).

VITA ~2

Larry James Phillips

Candidate for the Degree of

Master of Science

Thesis: SMALL GRAIN PRODUCTION: SEEDING DATES AND CLIPPING FREQUENCY

Major Field: Agronomy

Biographical:

Personal Data: Born September 4, 1949, at Mooreland, Oklahoma, the son of Kenneth and Doris Phillips.

Education: Graduated from Sharon High School, Sharon, Oklahoma, in May, 1967; received the Bachelor of Science degree in Agronomy from Oklahoma Panhandle State University, Goodwell, Oklahoma, in May, 1972; completed the requirements for the Master of Science degree at Oklahoma State University in July, 1975.

Professional Experience: Worked for Woodward Conservation District during the summers of 1971 and 1972 along with part-time farming. Employed by the Department of Agronomy, Oklahoma State University, as a graduate research assistant, September, 1972 to June 1975.

Professional Organizations: Society for Range Management; American Society of Agronomy; Crop Science Society of America.