EFFECT OF DIFFERENT INTENSITIES OF CLIPPING ON THE FORAGE PRODUCTION OF SMALL GRAINS

By

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INTRODUCTION

The utilization of small grains as dual purpose crops from the standpoint of grain production and forage is widely accepted in the wheat belt of the southwest. In the farming and ranching enterprise, livestock and forage crops are economically inseparable. The major part of the annual expense involved in maintaining livestock generally is the cost of feeding animals during the winter months. During certain years, some of the costs may be offset by the grazing of small grains that were planted primarily for grain production. Conversely, we find the cereal crops occasionally planted solely for forage production. However, it is known that differences exist as to the time and amounts of forage produced by different varieties within and between crops. Not so well known, however, are the effects of various grazing pressures throughout the winter months on grain yield.

The research problem reported herein was designed to obtain an estimate of the time and amount of forage production from various small grains under different grazing intensities and the subsequent effect on grain yield. The objectives were: (1) to measure the relative effect of various clipping heights on forage production of nine small grain varieties; (2) to determine the period of maximum forage production as influenced by variety and clipping height; (3) to determine the time of emergence of the floral primordia and its rate of elongation in relation to time and height of clip; and (4) to measure the effect of different clipping intensities on seed production by crop and variety.

LITERATURE REVIEW

An experiment conducted by Finnell (8)[1] at the Oklahoma Panhandle Experiment Station in 1929 indicated that grazing up to April 1 did not affect the number of tillers produced by the wheat plant, delay maturity, nor reduce the grain yield. Wheat grazed until April 26 produced fewer heads per plant than normal and considerably less grain, though the time of maturity was the same as unpastured wheat. It was pointed out that an examination of the stage of growth at that time showed that, although the majority of shoots were not tall enough to expose the bud or young head to destruction, the full crop of tillers had formed and were just ready to begin the rapid period of growth in which the joints appear. Finnell noted that close grazing at this time seemed to prevent the full development of the heads formed by unbalancing the plant at a critical stage of growth. Grazing until May 9 completely destroyed the young head and required an entirely new growth from the crown and so delayed maturity that the crop was a near failure. It was further pointed out that seasonal conditions were backward in the instances cited and that a safer indication of when to stop grazing would be to follow the progress and stage of growth of the wheat plant.

In a study conducted in Kansas by Swanson (19), 24 percent of the wheat growers surveyed reported a gain in yield from one to three bushels per acre when wheat was pastured. Sixty-nine percent felt that grazing

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[1] Figures in parenthesis refer to literature cited.

wheat had neither a stimulating nor depressing influence on the yield, but that the pasturage was of great value. Seven percent of the operators reported a loss of one bushel or less. A few farmers were opposed to pasturing wheat under any conditions. Swanson reported, however, that when conditions are unfavorable for the growth of the wheat plant, grazing may result in heavy losses in grain yield. In conclusion, Swanson pointed out that, when properly managed, a good growth of wheat may be moderately grazed during the winter months without reducing the grain yields. Under extra favorable conditions for growth the yield of winter wheat may be increased from grazing, according to Swanson.

Sprague (17) conducted grazing management studies on wheat, rye and oats in New Jersey to determine the potentials of the three crops for meeting fall and spring grazing needs and to establish the best methods of grazing management for greatest returns from forage and grain. In the four year study it was found that rye, wheat and oats yielded forage in approximately 3, 2, 1 relationship. Sprague found that grain production was increased by fall grazing and decreased by grazing in the spring. This increase was much more pronounced in seasons of cool temperatures and adequate rainfall than during seasons which were hot and dry. It was also found that fall grazing delayed internodal elongation in the spring which might account in part for greater grain production. Also of interest was the fact that spring grazing without previous fall grazing reduced the yields of grains severely.

In agreement with Welton and Morris (24), Sprague (17) found that lodging seemed to be reduced by grazing or clipping. Sprague found that no lodging occurred following spring grazing and less than five percent

of the plants were lodged on plots that were fall grazed. However, Welton concluded that lodging is due to many factors. He reported that clipping tends to reduce the number and height of culms and hence to reduce lodging, but it is not a highly successful practice for so much depends on the character of the subsequent season that it is impossible to determine the most appropriate time at which to make the clipping.

Cutler et al. (6) found that when weather conditions in Indiana in early spring (March and April) were very favorable and a rapid growth of plants was stimulated, clipping or pasturing in April may reduce plant height and reduce lodging.

It was noted by Hubbard and Harper (11) that on the average, severe clipping produced slightly less forage and appreciably lower grain yields than did moderate clipping. However, it was pointed out that cereals were not affected so adversely by severe clipping in favorable as in unfavorable growing seasons. They found that winter oats and barley varieties did not tolerate clipping as well as rye or most of the wheat varieties tested. Also, according to Hubbard and Harper, to avoid a reduction in grain yield, clipping or grazing should be discontinued when dissection of the stem reveals the developing spike at a height at which it may be lost by clipping or grazing.

Grain yields of rye, barley and hard and soft wheats were found by Jones et al. (13) to be slightly reduced by clipping March 25 and drastically reduced by an April 14 clipping. It was noted that oats clipped March 25 yielded the most grain. The most severe winter killing was observed in the non-clipped plots. 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 more winter killing on non-clipped plots. Clipping to April 14 decreased the number of tillers in all small grain varieties studied. Clipping also decreased the number of culms and resulted in a more prostrate growth habit and in less winter killing.

In a study conducted in Georgia by Morris and Gardner (14), grain yields of oats and rye were increased by a high nitrogen fertilization of 120 pounds per acre, but wheat yields were not affected. The high nitrogen application was especially effective in maintaining grain yields of oats and rye clipped to mid-February. It was also noted that clipping to February 15 resulted in only slight decreases in grain yield of all small grains, but extending the clipping period to March 15 reduced grain yields 75 percent or more. Also, clipping to this date destroyed the young panicle primordia which developed rapidly during winter and early spring. Grain yields of rye were increased by clipping to as late as February 15 due to delayed maturity and a corresponding decrease in cold injury.

Working with small grains, annual ryegrass and rescuegrass, Gardner and Rogers (10) found that winter growth of all grasses was low at all test locations in Georgia during January and February. However, rye and wheat were first to initiate rapid growth, each producing significantly higher yields than other grasses during February. In this study Southland oats formed floral initials and began stem elongation during the rapid fall growth period which made it sensitive to clipping and resulted in weak recovery after clipping. Calhoun barley started stem elongation and rapid growth approximately a month later than wheat. As spring progressed, wheat, rye and barley declined rapidly in

production as a result of clipping injury to jointing stems associated with peak growth. Floral initiation and jointing occurred a month or more later in winter oats and rescuegrass with a consequent later growth peak and higher spring production. A close association between floral initiation with jointing stems and seasonal growth peaks was evident in the grasses studied.

A study conducted by Washko (22) showed that differences in forage production between erect and prostrate varieties of the same small grains were minor and did not appear to be related to growth habit. Grazing with sheep, as practiced in the experiment, was detrimental to grain production of all the four small grains. However, the prostrate types suffered less grain reduction than the erect types. In the same study it was also found that grazing reduced plant height and tillering and postponed ripening from four to eight days. However, the height of prostrate varieties was reduced less by grazing than the erect varieties.

In a study conducted on oats, Crowder (5) found that clipping in the fall, winter and spring resulted in a loss of grain. However, October planted oats yielded more grain regardless of the clipping treatment imposed. It was also found that clipping after March 1 drastically lowered grain yields, however, Crowder was of the belief that the value of forage obtained should compensate for this loss.

Cappelle Desprez wheat was clipped on three separate dates; March 29, April 5 and April 12 in a study conducted by Aldrich (2). Results indicated that clipping caused a reduction in the yield of straw, but a single clipping on the second or third dates, increased grain yield and size. However, repeated clipping reduced grain yield and grain size

to a level similar to that of the nonclipped control. Aldrich suggested that continuous grazing of cereals even at low stocking rates might result in subsequent damage due to the repeated defoliation.

In a similar study conducted by Staten and Elder (18), clipping to about March 25 reduced grain yields of all the hard and soft wheat varieties three to five bushels per acre. The grain yields of rye were reduced five to seven bushels per acre. Clipping to about March 24 did not affect the grain yields of oats and barley. However, clipping to about April 15 materially reduced grain yield of all small grain varieties studied.

Grain yields of Wintok oats, Michigan winter, Ward, Missouri Early Beardless and Manchuria barley were slightly increased by the March 30 clipping in a study conducted by Muncrief (15). All other varieties studied were slightly reduced by the March 30 clipping. Muncrief reported that all small grain varieties were drastically reduced by the April 14 clipping. However, the seed yields of ryegrass were greater on the later clipped plots. He further noted that the test weight and general quality of all varieties, with the exception of barley, was lowered by late clipping.

In another study conducted by Finnell (9), cultural and management combinations for direct comparison of grazed and ungrazed winter wheat grain yields were utilized. Average grain yields of the comparisons were 14.6 bushels per acre for grazed fields and 14.8 bushels per acre for ungrazed fields. As to the effect of varying the amounts of forage dry matter removed per acre by grazing on grain yields, no significant relation was observed. Finnell reported that early sowing did not enhance pasturage, however, late seeding was favorable to higher grain yield.

It was reported that grain yield was not dependent on the amount of pasturage obtained from the fall and winter growth of wheat. Finnell concluded that it was apparently not the amount of forage removed by grazing, but length of time the grazing period was extended that reduced grain yield.

In an evaluation of small grains from a forage production standpoint, Huffine et al. (12) found that no single crop or variety tested in Oklahoma was consistently high in forage production throughout the entire growing season.

Similarly, a study conducted by Adams (1) indicated that barley, wheat, Elbon and Balbo rye produced a higher percentage of their total forage earlier than did oats, Tetraploid rye and ryegrass. It was therefore concluded, that the forage producing period of the small grain should coincide with the desired time of grazing.

Cayton (4) found that no single combination of small grains was consistently high in forage production throughout the entire growing season. It was shown, however, that the best overall combination and most consistent high forage producer was Wintok oats, Rogers barley, Concho wheat and Elbon rye.

An evaluation of the forage production of winter oats was conducted by Wax (23). He found Arkwin to be a high forage producer in the fall in comparison to Bronco and Wintok. Bronco was the outstanding variety in late spring and was the highest total forage producer.

In a four year study conducted by Elder (7), no significant differences were found in the total yearly forage production of small grains clipped at heights of two and four inches. The October production was greater for the two inch clipping height and the four inch height of

clip was more productive during the spring period.

Vasil'yev (21), a Russian worker, carried out an experiment to compare the growth of leaves in mowed and unmowed perennial wheat variety 34085, which showed particularly good growth after mowing. Vasil'yev reported that when plants were approximately three weeks of age four leaves had formed on each. At this time some of the plants were cut at the base. They immediately began to grow back and six new leaves appeared on each within five to six weeks. The leaves appeared at about the same time that the next leaves on the uncut plants developed. It was found that the difference in viability between the two sets of plants became more pronounced the longer the leaves continued to grow. The uncut plants aged more rapidly, as was shown by earlier yellowing of the leaves, while the cut plants looked fresher and greener.

In a comparative study of frost resistance in mowed and unmowed winter rye variety Vyatka, Vasil'yev (21) found that the uncut control plants died due to lowered frost resistance caused by extremely early sowing. The cut plants remained alive for some time and died later. It was noted that the experiments showed an appreciable rise in the hardiness of plants rejuvenated by cutting as compared with uncut plants. There was also a difference in resistance in relation to time of cutting reported by Vasil'yev.

In a study conducted by Robertson (16), seedlings of six range and pasture grasses, including bromegrass, a cool season perennial, were grown in soil in the greenhouse and their development was studied after each of several clipping treatments. It was reported that growth of tops, as measured in dry weight, decreased due to clipping. Width and number of leaves and number of tillers were reduced by clipping. Also,

removal of tops invariably retarded root penetration. It was also pointed out that, in general, clipping reduced growth of roots, as based on dry weight, about twice as much as that of tops.

Another study conducted by Brougham (3), involving a pasture association comprising short-rotation ryegrass, red clover and white clover, was subjected to three different intensities of defoliation by cutting down to one, three and five inches. It was found that the rate of growth increased until complete light interception was approached, and thereafter, an almost maximum rate was sustained. Brougham reported that light interception at the one inch level of defoliation was almost nil when cut but increased rapidly to almost complete interception of approximately 24 days after cutting. At the three inch level of defoliation, 16 days were required to reach complete interception and at the five inch level sufficient herbage remained to intercept nearly all the incident light immediately following defoliation. It was found that the more intense the defoliation the lower the initial regrowth rate and the longer the time taken to attain maximum growth rate, but the maximum rate attained was approximately the same under all treatments. Brougham also pointed out that the rate of increase of leaf area in each treatment followed the same pattern as rate of growth of total herbage dry matter yields. Thus, the more intense the defoliation the lower the initial leaf efficiency. However, a higher maximum leaf efficiency was obtained after intense defoliation. According to Brougham, results suggested that for maximum production of herbage the amount of leaf left following mowing or grazing should be sufficient to ensure complete interception of light so that pasture regrowth is maintained at the maximum rate.

METHODS AND MATERIALS

Nine varieties of small grains including three each of wheat and oats, two of rye and one of barley were included in this study. Varieties studied were: Triumph, Concho and Kaw wheat; Arkwin, Cimarron and Wintok oats; Elbon and Balbo rye; and Rogers barley. The crops were planted September 22, 1961, in a split plot in strip design having the main plots in five replications. Each main plot consisted of five rows thirty feet long spaced one foot apart. Each row was subdivided into three clipping treatments, ten feet long. The study was established on a Vanoss sandy loam soil at the Perkins, Oklahoma, Agronomy Research Station. The soil was fertilized with an equivalent of 0-35-66 per acre on August 29 and 60-0-0 on September 6, prior to planting. In addition, 80-0-0 was applied October 30, 1961. The extremely dry spring of 1962 necessitated a supplemental irrigation of the plots on May 8.

The relative forage yields were determined for each variety at each of three heights of clip, 2, 4 and 6 inches above the soil surface. Plots were harvested when the plants attained a height of not less than 2 inches above the designated clipping height. A "Jari" sickle mower with a three-foot cutter bar was used to harvest the forage at all heights of clip. At the 4 and 6 inch levels of clip, support wheels were attached to each end of the sickle bar and adjusted to the proper cutting height. The center three rows of each plot were harvested for forage yield determinations. The total green weight of the forage was determined in the field. A sample was drawn and weighed, then placed in a drying oven.

The samples were dried at approximately 160°F. for about 72 hours. After the samples were dried and weighed, yields were calculated in pounds of oven-dry forage per acre.

Forage yields were taken throughout the year. At each date of clip only the varieties that had attained a height at least 2 inches above the designated clipping height were harvested.

Measurements of the rate of primordia elongation above the soil surface started on March 1 and continued at various intervals. These measurements for each variety and treatment were taken from five randomly selected plants in each replication. Measurements were made by clipping individual tillers at the soil surface, then splitting the stem lengthwise with a sharp knife to determine the location of the spike or panicle primordia. The distance from the base of the stem to the tip of the developing primordia was measured in centimeters. This phase of the study was designed to measure the rate of primordia elongation as affected by the various clipping intensities. Forage yield measurements were terminated just before the floral primordia had attained a height at which they might be damaged or severed by clipping. Plants were then allowed to form and mature seed so that grain yields by variety and clipping intensity could be determined.

Grain production was measured by harvesting the three center rows of each variety and clipping height. The grain was threshed, cleaned, weighed in pounds and converted to bushels per acre for each of the crops studied. Grain yields were determined to measure the effect the various clipping intensities had upon production by crop and variety.

RESULTS AND DISCUSSION

Forage and grain production estimates and the rate of elongation of floral primordia are presented under separate headings for simplicity and convenience of discussion.

Forage Production

Forage yields of four small grain crops were found to vary significantly among crops, dates of harvest and clipping intensity. Crop, variety, seasonal response and height of clip were the major factors contributing to the differences in yields.

Wheat

The total forage yields were significantly different among the wheat varieties, Triumph, Concho and Kaw at each height of clip. The yields obtained at the 2 inch height indicated (Table I) that Kaw was the most productive variety studied with the possible exception of Concho during the spring period. A comparison of forage production by season and height of clip from all varieties of wheat is shown in Figure 1. Triumph produced the least amount of forage in the fall and spring seasons. Observations made during the study gave the author the impression that Triumph would produce slightly more forage during very early spring than either Kaw or Concho. Yet, from the standpoint of total forage production, Triumph appeared the least desirable at all heights of clip.

TABLE I

AVERAGE YIELDS PER ACRE IN POUNDS OF OVEN-DRY FORAGE PRODUCED BY NINE VARIETIES OF SMALL GRAINS WHEN CLIPPED AT THREE HEIGHTS IN EACH OF THREE SEASONS.

	Average Yields of Oven-dry Forage in pounds/acre								
	Fall			Winter			Spring		
Crop Variety	2	4	6	2	4	6	2	4	6
Wheat									
Triumph	52	-	-	193	-	-	736	470	313
Concho	105	-	-	181	-	-	991	756	505
Kaw	189	-	-	268	-	-	968	764	671
Oats									
Arkwin	603	215	-	194	-	-	88	273	-
Cimarron	249	-	-	410	-	-	262	354	-
Wintok	41	-	-	135	-	-	286	144	210
Rye									
Elbon	665	159	-	1075	832	351	438	-	-
Balbo	934	229	-	1080	868	566	660	-	-
Barley									
Rogers	749	113	-	336	-	-	955	830	268

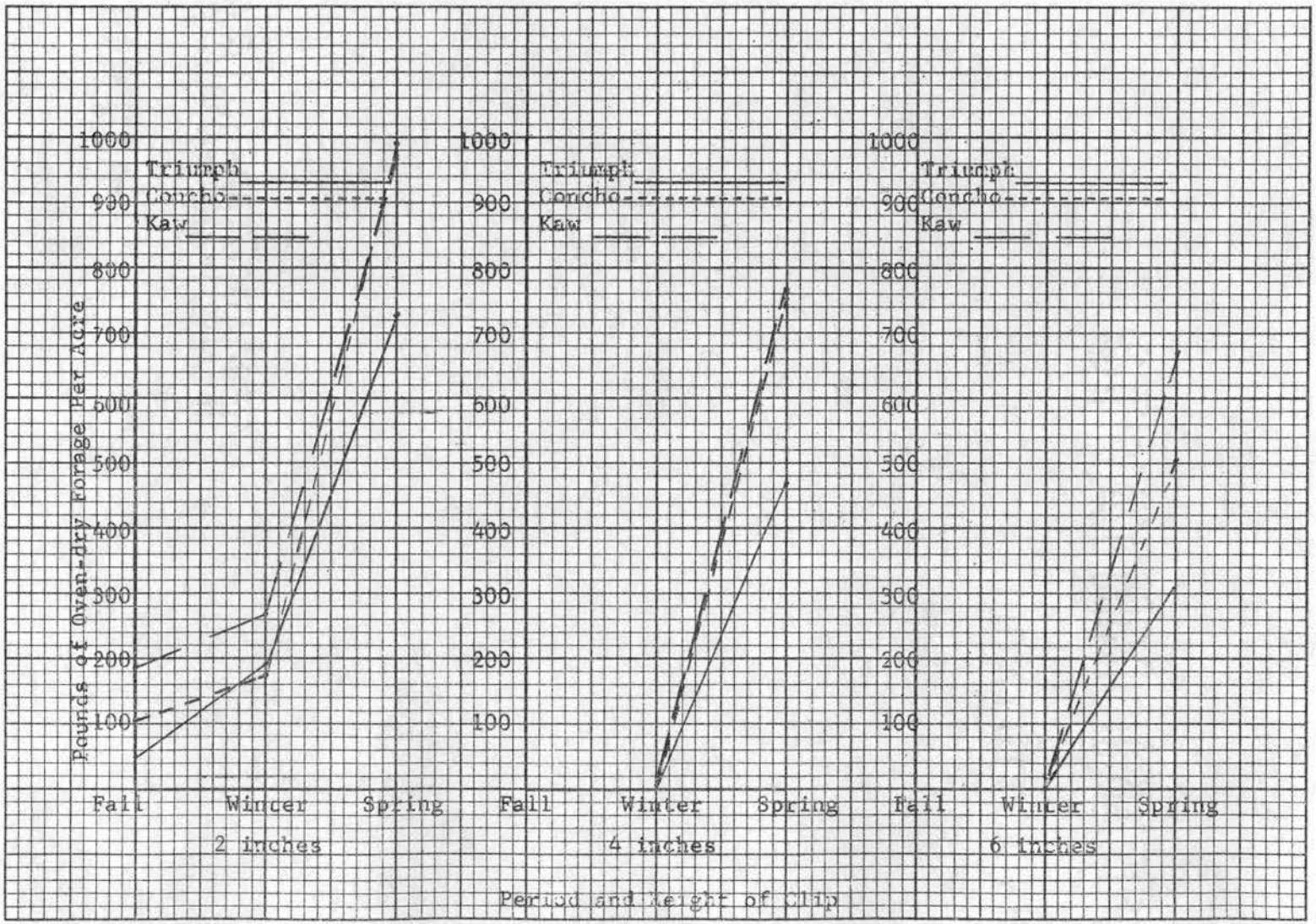

Figure 1. Seasonal Production of Oven-dry Forage of Three Wheat Varieties at Each of Three Heights of Clip.

Total oven-dry forage production for all wheat varieties as shown in Table II, was greater from the 2 inch height of clip treatment than from either the 4 or 6 inch levels. The lower the height of clip the more frequent the harvest and the higher the forage yields. During the fall and winter months of this experiment, plant growth regardless of variety, did not exceed a height substantially above 4 inches. Perhaps this was the result of the canopy of freeze-damaged tissue that shaded the lower green leaves and reduced the net photosynthesis.

Fall moisture was adequate in general during the 1961-62 crop year as indicated in Appendix Table I (20). However, extended periods of cold day and night temperatures with frequent hard frost occurred which probably contributed substantially to the results obtained.

Oats

Forage produced by oats varied as to variety, height of clip and season of growth. The forage production of oats, in general, exceeded that of wheat during the fall. A comparison of forage production among the three oat varieties in each season of production at three heights of clip is shown in Figure 2. Arkwin oats produced a significantly higher yield in the fall than either Cimarron or Wintok. This was evident by the pounds of oven-dried material produced at the 2 inch height of clip and by the fact that a harvest was obtained only from this variety at the 4 inch height of clip. However, during the winter months the variety Cimarron produced the highest amount of forage from the 2 inch clipping. Two forage cuttings were obtained during the winter from both Cimarron and Wintok but only one from Arkwin. Most of the forage production by Wintok oats occurred in the spring. The seasonal forage

TABLE II

AVERAGE INDIVIDUAL SEASONAL AND TOTAL YIELD OF NINE VARIETIES OF SMALL GRAINS IN POUNDS OF OVEN-DRY FORAGE PER ACRE FOR THREE HEIGHTS OF CLIP.

Season	Height of Clip Inches	Harvest Date	Average yields of oven-dry forage in pounds per acre								
			Wheat			Oats			Rye		Barley
			Triumph	Concho	Kaw	Arkwin	Cimarron	Wintok	Elbon	Balbo	Rogers
Fall[1]	2	Nov.11	52	105	189	603	249	41	665	934	749
	4	Nov.24				215			159	229	113
Winter	2	Jan. 3				194	250	66	338	378	85
		Feb.21	193	181	268		160	69	737	702	251
		Total	193	181	268	194	410	135	1075	1080	336
	4	Jan. 3							78	75	
		Feb.21							754	793	
		Total							832	868	
	6	Feb.21							351	566	
		Total							351	566	
Spring	2	Mar.26	736	991	968		88		181	264	195
		Apr.14				88	174	286	257	396	760
		Total	736	991	968	88	262	286	438	660	955
	4	Mar.26	470	756	764						68
		Apr.14				273	354	144			762
		Total	470	756	764	273	354	144			830
	6	Mar.28	313	505	671						
		Apr.14						210			268
		Total	313	505	671			210			268
Total	2		981	1276	1424	886	922	462	2179	2675	2040
	4		470	756	764	488	354	144	992	1097	943
	6		313	505	671			210	351	566	267

[1] No harvests were obtained at the 6 inch height in the fall period.

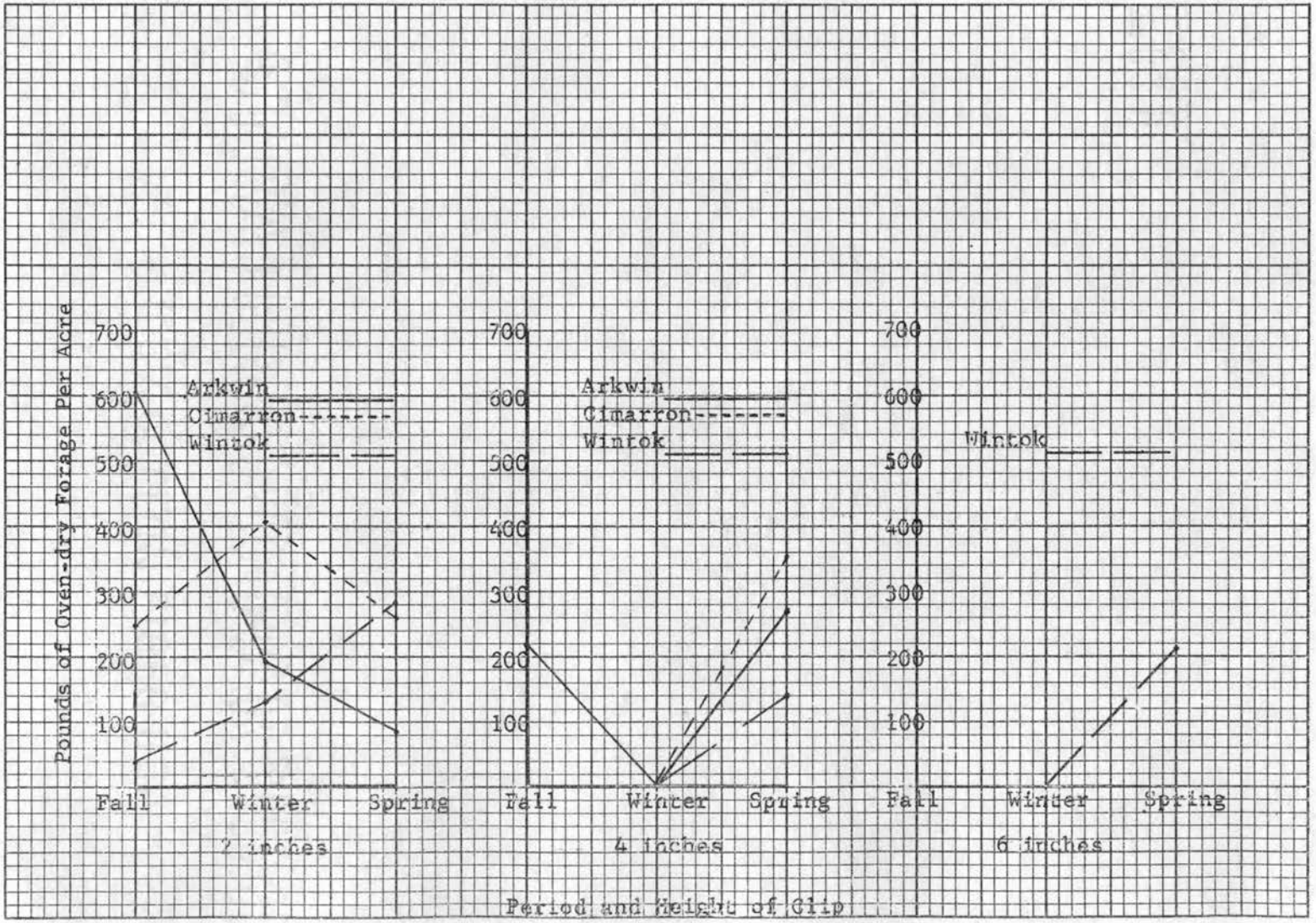

Figure 2. Seasonal Production of Oven-Dry Forage of Three Oat Varieties at Three Heights of Clip.

production of each oat variety at the three heights of clip is shown in Figure 3.

Low forage yields as measured in the spring from Arkwin oats were due in part to injury from earlier severe frosts and winter killing. It was noted that on Arkwin oats there was less winter injury at the 4 inch height of clip as compared to the 2 and 6 inch levels. This indicates perhaps that a moderate amount of grazing may be desirable prior to severe weather to maintain a satisfactory stand. Evidence in support of this theory was indicated by the fact that plots which were to be clipped at a 6 inch height were never harvested as they were severely damaged by the adverse weather conditions. Neither Arkwin nor Cimarron was clipped at the 6 inch height during the spring. In this period Cimarron exhibited a slow rate of growth while Arkwin failed to recover from winter injury. A comparison of the total forage produced by the three oat varieties at the three heights of clip is shown in Figure 4.

Rye

The forage production of both Elbon and Balbo rye was much greater during both the fall and winter periods than from any other small grain. Spring production of rye, however, was low when compared with wheat or barley. In this study Balbo and Elbon forage yields, as shown in Figure 5, were similar during the winter months. This was somewhat unexpected since Balbo is naturally a later maturing variety and presumably would produce the greater portion of its forage later in the growing season. Perhaps the winter weather in 1962 was more conducive for growth of the Balbo rye than would commonly be found. The fact that

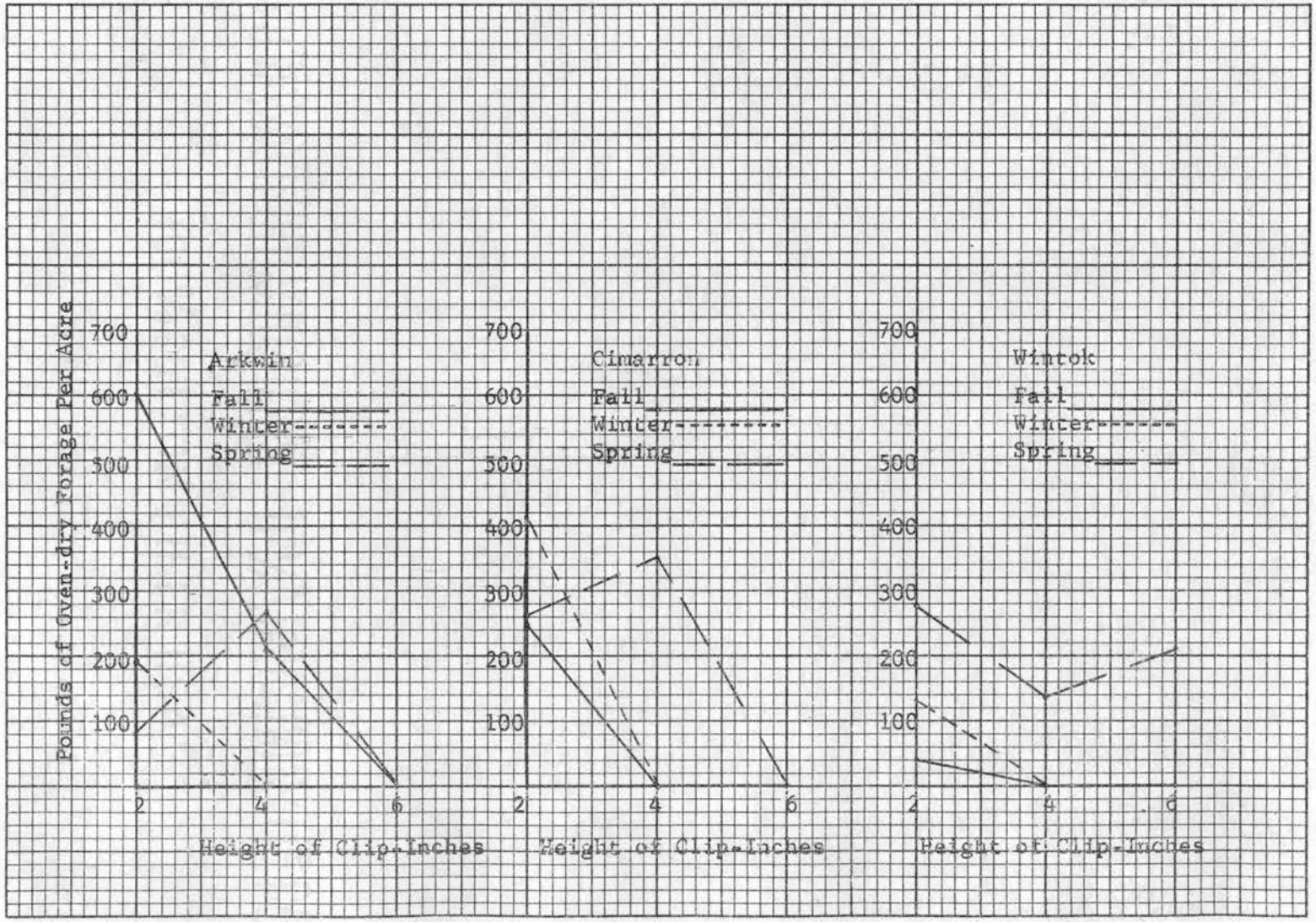

Figure 3. Seasonal Forage Production at Three Clipping Heights for Individual Oat Varieties.

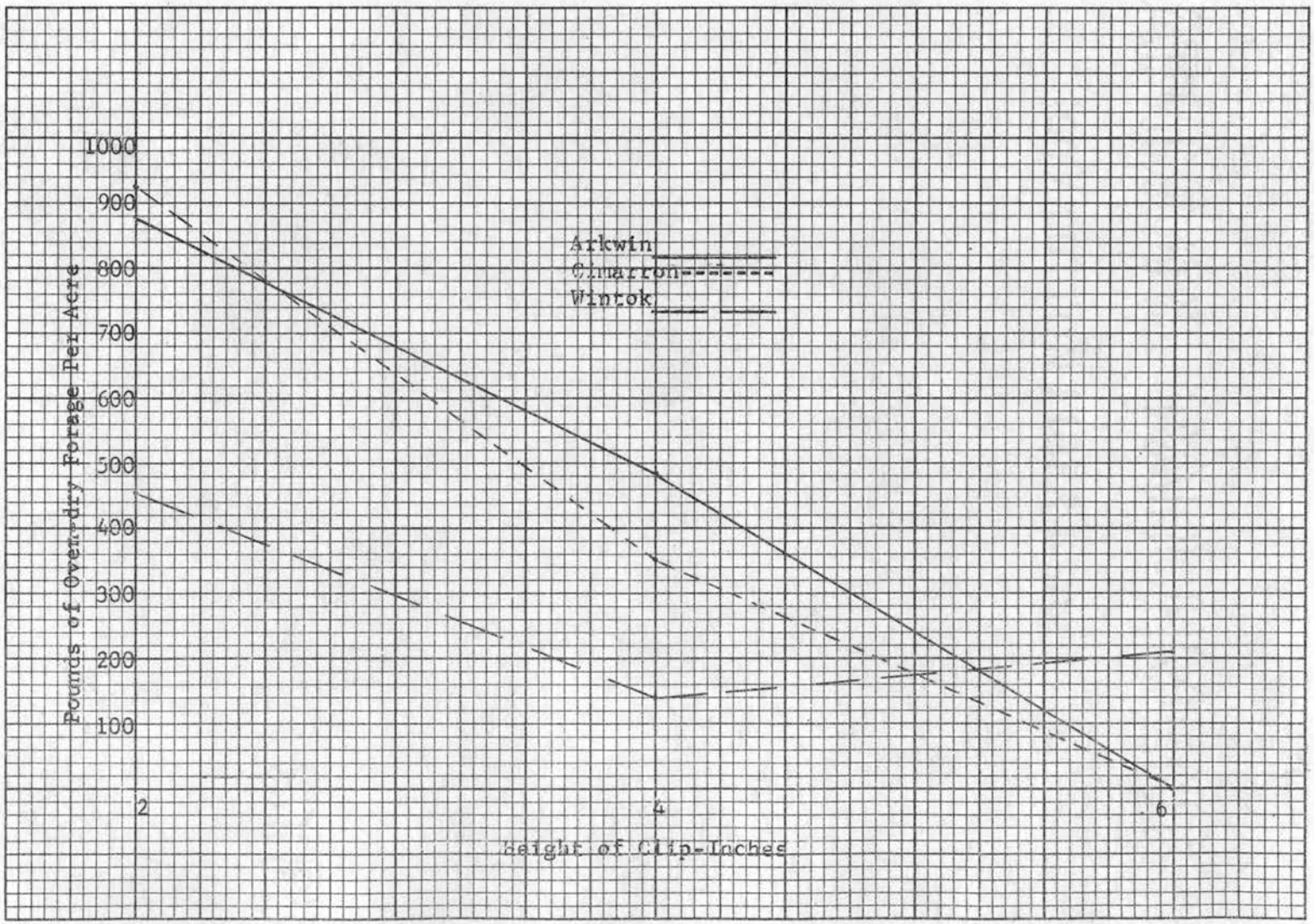

Figure 4. Total Oven-Dry Forage Produced by Three Oat Varieties at Three Heights of Clip.

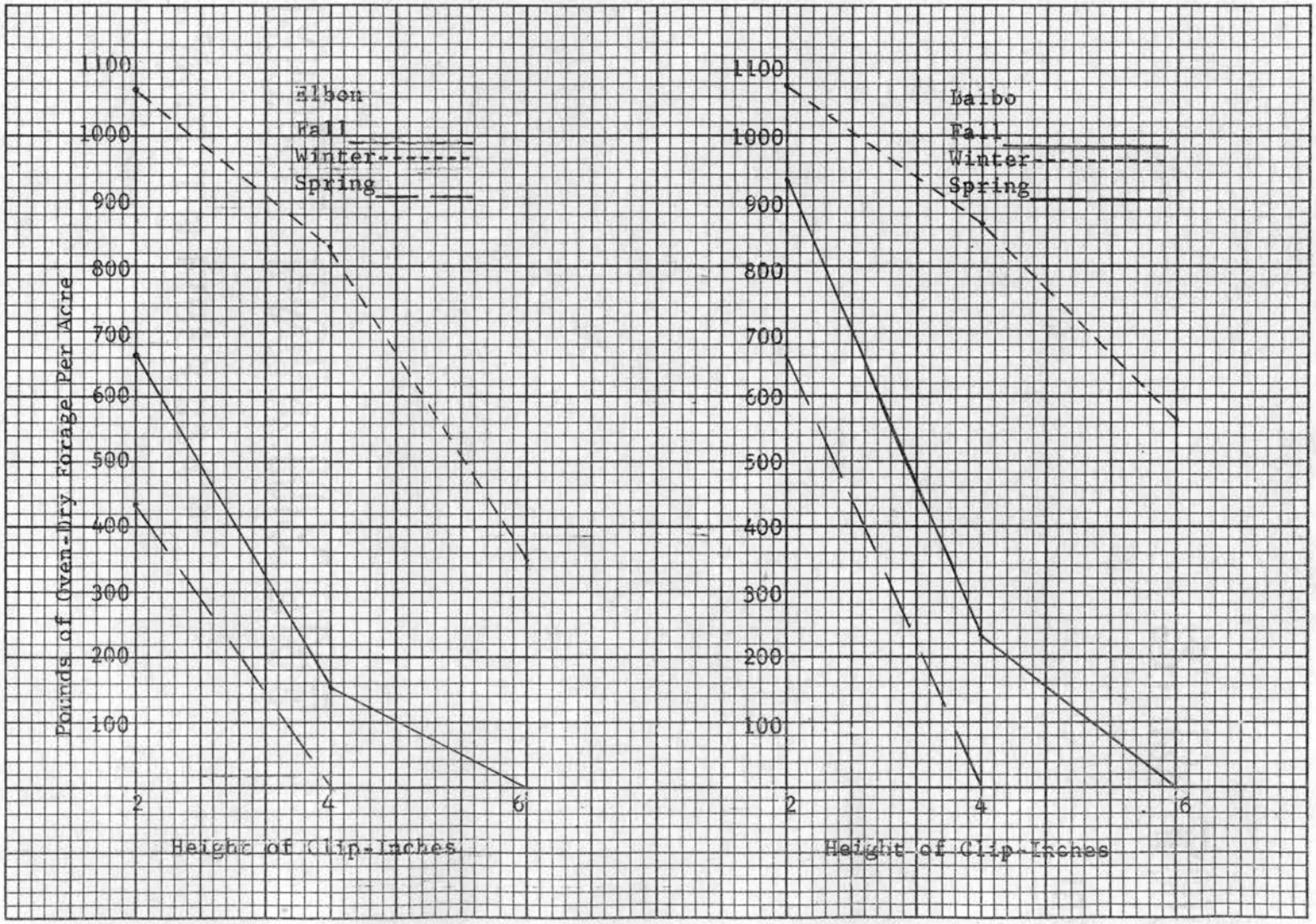

Figure 5. Seasonal Forage Production at Three Clipping Heights for Individual Rye Varieties.

plant growth was such that harvests were made at the 2 and 4 inch heights during the fall and at 2, 4 and 6 inches during the winter on both Elbon and Balbo rye emphasizes the value of rye as a winter forage.

Barley

Although Rogers barley was injured somewhat by severe winter temperatures, good fall and spring forage yields were obtained. The yields as shown in Table II, compared favorably with rye during the fall and with wheat in the spring.

Elongation of Floral Primordia

Occasionally small grain crops may be established in pure stands for the dual purpose of forage for livestock and grain production. If the crops are grazed what effect would the forage harvesting by livestock have on the yield of seed? An attempt was made to answer this question by a study of the rate of floral primordia elongation and grain production as affected by different clipping intensities.

Wheat

The rate of inflorescence elongation above the soil surface was extremely rapid in the spring for all three wheat varieties as shown in Table III. Due to the rapid rate of floral primordia elongation in the spring only one clipping, as shown in Table II, was obtained at each of the three heights of clip.

Although Concho wheat was the last of the three varieties to show the inflorescence above the soil surface its rate of growth was such that clipping had to be discontinued at the same time as Triumph and

TABLE III

RATE OF ELONGATION OF THE FLORAL PRIMORDIA OF NINE VARIETIES OF SMALL GRAINS ABOVE THE SOIL SURFACE AS AFFECTED BY HEIGHT OF CLIP, CROP AND CROP VARIETY

Clipping Height	Date of Measurements	Wheat			Oats			Rye		Barley
		Triumph	Concho	Kaw	Arkwin	Cimarron	Wintok	Elbon	Balbo	Rogers
2 in.	March 6	*	*	*	*	*	*	1.58	1.66	*
"	March 21	1.16	.18	1.26	*	*	*	1.01	2.84	*
"	March 28	3.10	1.28	3.07	*	*	*	2.37	1.79	.48
"	April 12	7.19	8.20	4.78	*	*	.54	4.19	3.13	.92
"	April 18	**	**	**	1.03	1.74	2.40	**	**	3.42
4 in.	March 6	*	*	*	*	*	*	3.05	3.62	*
"	March 21	2.10	.41	2.67	*	*	*	8.51	11.40	*
"	March 28	5.92	2.29	5.08	*	*	*	**	**	*
"	April 12	14.72	12.16	12.88	*	1.36	2.80	**	**	4.54
"	April 18	**	**	**	3.40	8.54	4.22	**	**	10.39
6 in.	March 6	*	*	*	*	*	*	3.12	3.52	*
"	March 21	2.73	.76	3.08	*	*	*	7.96	13.80	*
"	March 28	7.61	4.44	8.67	*	*	*	**	**	*
"	April 12	17.88	15.63	12.63	*	.23	2.98	**	**	7.23
"	April 18	**	**	**	4.87	8.29	4.76	**	**	12.82

* Inflorescences had not appeared above soil surface
** Inflorescences had attained a height at which clipping had stopped.

Kaw. This rapid rate of growth was exhibited at all levels of clipping. These data tend to indicate that forage clippings after March 28, as shown in Table IV, would be damaging to developing floral parts of the plant and subsequent grain yields of these three wheat varieties.

Oats

In contrast to wheat, all oat varieties were very slow in the initial rate of inflorescence elongation. Neither Arkwin nor Cimarron oats attained sufficient growth in those plots that were to have been clipped at a 6 inch height to measure the rate of elongation of the inflorescence.

Rye

Both Elbon and Balbo rye varieties exhibited a very early elongation of the inflorescence as shown in Table III. At the time measurements were started the rate of elongation was rather slow in wheat, oats and barley as compared with the rye varieties. However, a rapid increase in rate was noted shortly after the inflorescence emerged above the soil surface especially in wheat and rye varieties. The sharp increases in rate of elongation are shown in Figure 6. With the exception of those plants subjected to the 2 inch height of clip, the rate of inflorescence elongation of rye was so rapid that no clippings were taken during the spring period. It should be noted that many of the inflorescences measured in the plots which were clipped at the 2 inch height were from new tillers arising from old crowns whose initial stems had stopped growing for all practical purposes. This initiation of new tillers permitted clipping to be continued at the 2 inch level until mid-April.

TABLE IV

DATES OF FINAL HARVEST OF FOUR CEREAL CROPS AT EACH OF THREE HEIGHTS OF CLIP.

Crop Variety	Clipping Heights 2 in.	4 in.	6 in.
Wheat			
Triumph	March 26, 1962	March 26, 1962	March 28, 1962
Concho	March 26, 1962	March 26, 1962	March 28, 1962
Kaw	March 26, 1962	March 26, 1962	March 28, 1962
Oats			
Arkwin	April 14, 1962	April 14, 1962	No Clippings
Cimarron	April 14, 1962	April 14, 1962	No Clippings
Wintok	April 14, 1962	April 14, 1962	April 14, 1962
Rye			
Elbon	April 14, 1962	Feb. 21, 1962	Feb. 21, 1962
Balbo	April 14, 1962	Feb. 21, 1962	Feb. 21, 1962
Barley			
Rogers	April 14, 1962	April 14, 1962	April 14, 1962

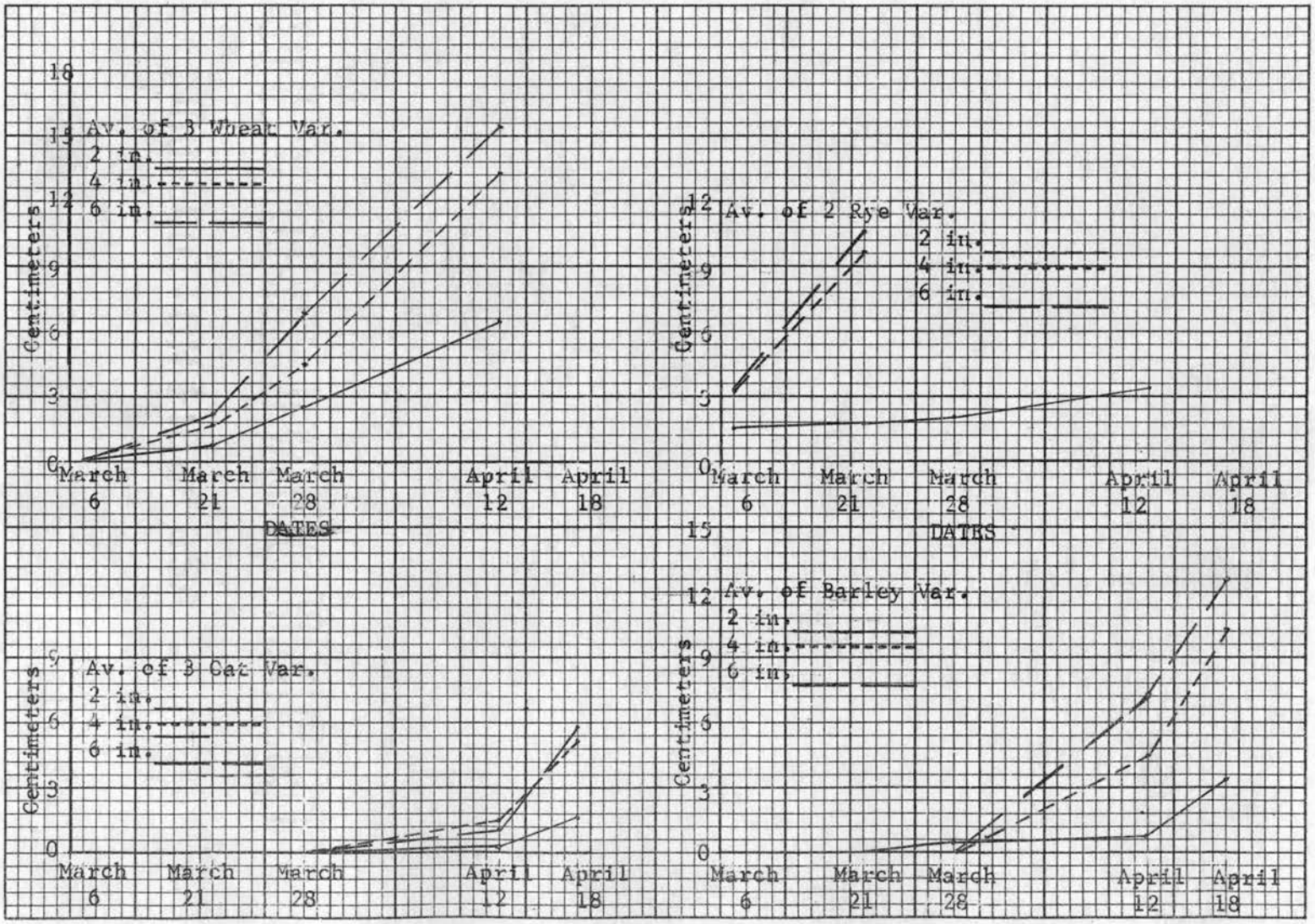

Figure 6. Rate of Floral Primordia Elongation Above the Soil Surface by Crop, Height of Clip and Date of Measurement

Barley

The inflorescence rate of elongation of Rogers barley behaved in much the same manner (Figure 6) as the three oat varieties. Floral elongation above the soil surface at all clipping levels did not begin until late March, which permitted clippings to be taken to mid-April.

Grain Production

Grain yields of the four small grain crops were found to be significantly different among crops and clipping intensities.

In general, the most severe clipping intensity was less injurious to wheat varieties than any of the crops studied as shown in Table V, with the possible exception of Rogers barley and Wintok oats. The relative comparisons of grain yields of the various small grain crops are presented in Figure 7 at the three heights of clip.

Wheat

No significant differences in yield were obtained among any of the varieties of wheat at any of the clipping heights. However, yields obtained from the variety Concho were consistently higher but not significantly so, at each height of clip than from the varieties Triumph and Kaw. It would appear that grain production in these varieties was only slightly affected if any by the more severe clipping intensities. One explanation perhaps, would be that forage removal ceased at a date early enough to ensure that the elongating inflorescence would not be damaged or clipped off.

TABLE V

AVERAGE YIELD OF SEED IN BUSHELS PER ACRE OF FOUR CEREAL CROPS BY CROP AND CROP VARIETY AT THREE HEIGHTS OF CLIP.

Crop	Variety	Yield in Bushels per Acre Height of Clip 2 in.	4 in.	6 in.	Av.
Wheat					
	Triumph	8.1	11.7	13.7	11.2
	Concho	17.0	19.5	20.9	19.1
	Kaw	15.0	14.0	17.9	15.6
Oats					
	Arkwin	1.1	8.7	7.4	5.7
	Cimarron	12.4	17.4	20.3	16.7
	Wintok	17.3	8.5	11.0	12.3
Rye					
	Elbon	2.9	15.4	18.1	12.1
	Balbo	1.9	13.1	17.5	10.9
Barley					
	Rogers	17.0	10.6	14.0	13.8

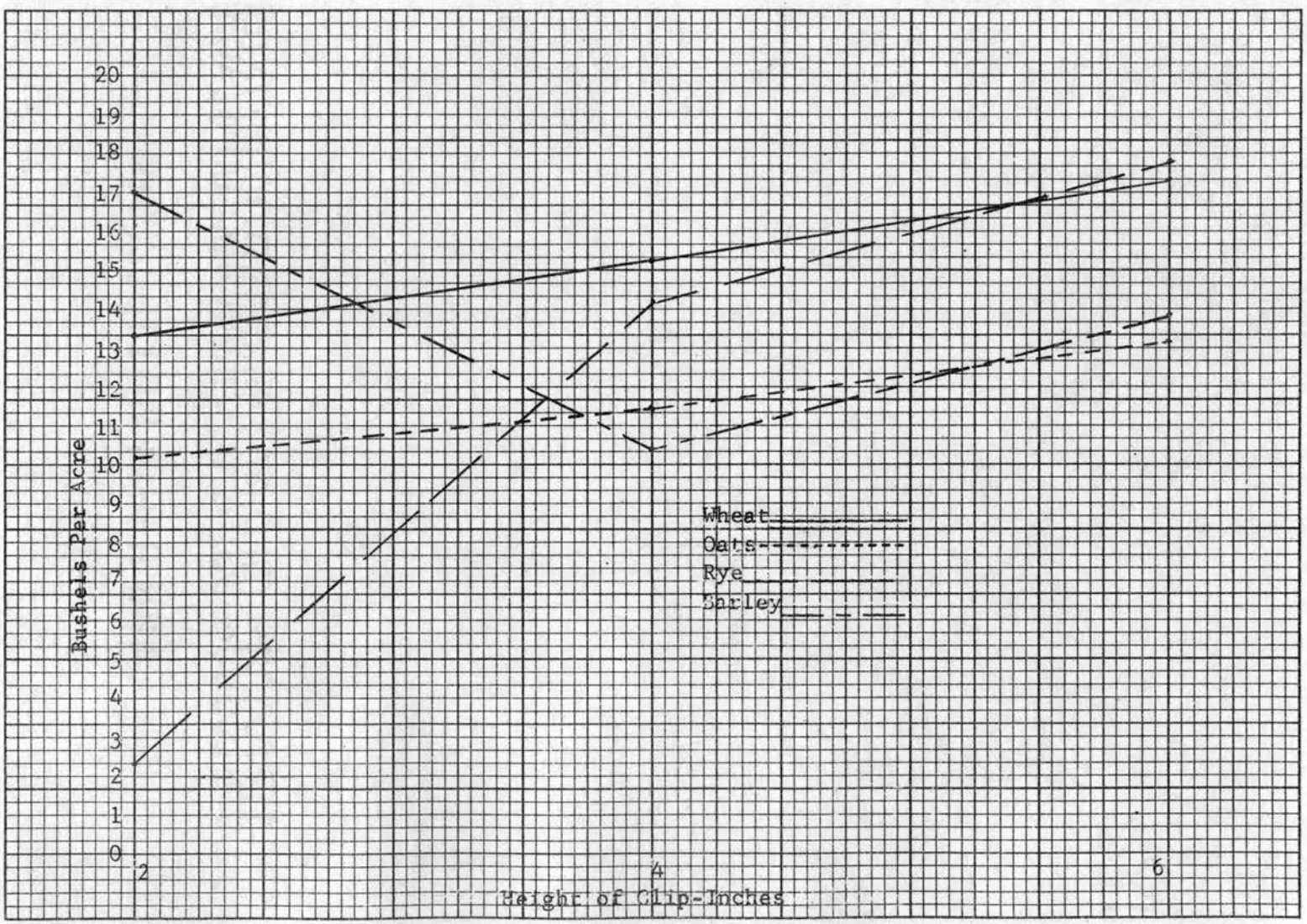

Figure 7. Total Grain Production by Crop as Determined by the Average for all Varieties Within Each Crop at Three Heights of Clip.

Oats

Oat varieties exhibited significant and erratic differences among varieties and clipping height by variety. However, severe cold injury especially to the variety Arkwin was considered a major factor in its influence on the overall yield. The comparative performances of the three oat varieties are illustrated in Figure 8 at each of the three heights of clip.

Rye

Differences in grain yield between rye varieties were not significant at any given clipping intensity although extreme differences were noted between clipping heights in either variety. It was interesting to note that while grain yield was lowest at the 2 inch height of clip the forage production was highest. This inverse pattern persisted also at the 4 and 6 inch levels of clip. It would appear from these data that severe clipping of either Elbon or Balbo rye during the growing season sharply reduces grain production. This perhaps is the result of damage or destruction of the older flowering culms.

Barley

Rogers barley behaved much the same as Wintok oats in that the lower height of clip (2 inch) seemed to favor grain production. Since both forage and grain yields were highest at the 2 inch height of clip, it would appear that this level would be most desirable when this variety is used.

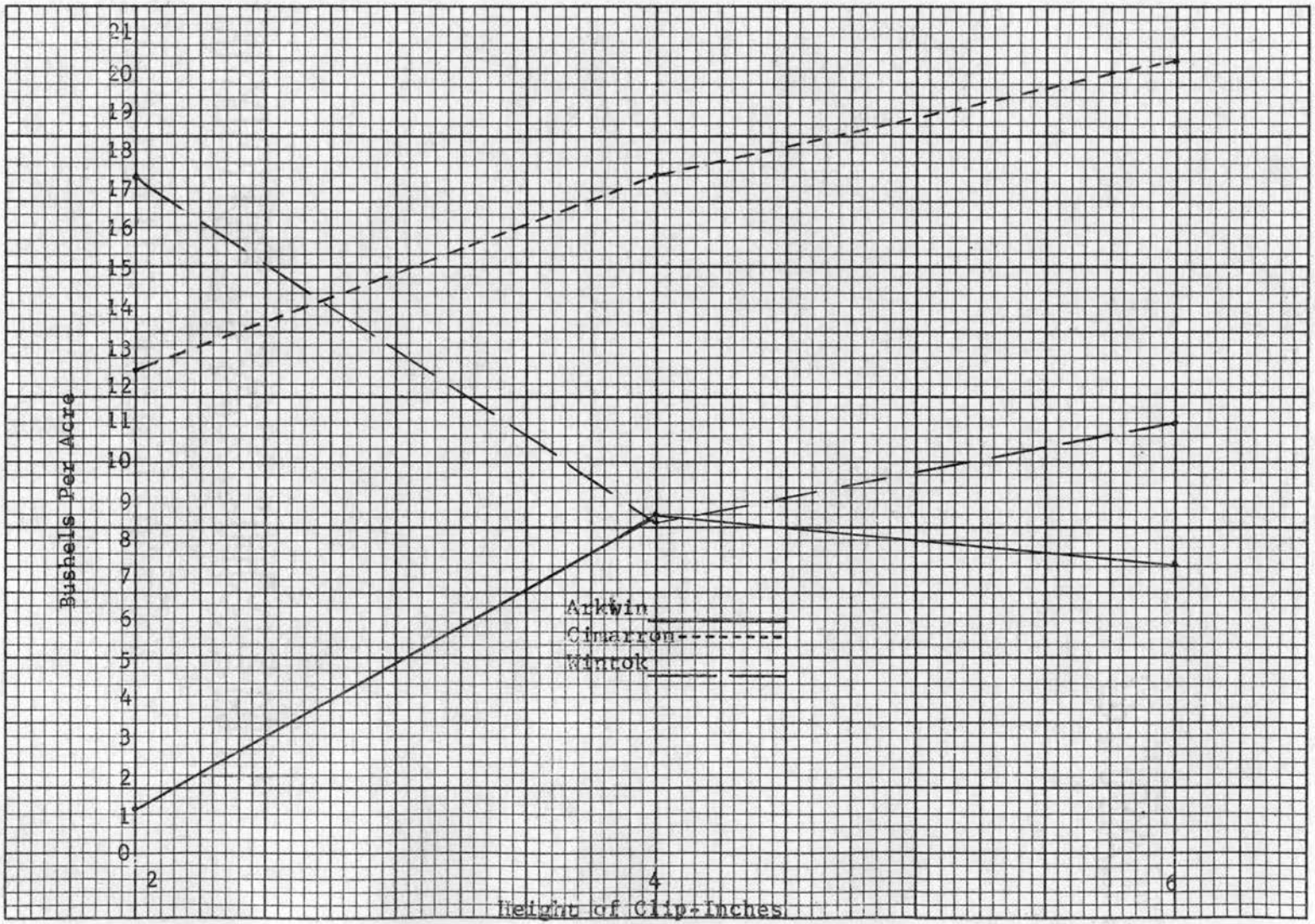

Figure 8. Total Grain Production of Three Oat Varieties at Three Heights of Clip.

SUMMARY AND CONCLUSIONS

A study to determine the effects of simulated grazing at different intensities on small grain forage production and grain yield was conducted in the fall of 1961 and spring of 1962 at the Oklahoma Agricultural Experiment Station located near Perkins, Oklahoma.

In this study 9 varieties of small grains were used including 3 each of wheat and oats, 2 of rye and 1 of barley clipped at 3 different heights. A split plot in strip design having the main plots in 5 replications was used. Each main plot consisted of 5 rows, 30 feet long and spaced 1 foot apart. Each row was subdivided into 3 clipping treatments, 10 feet long. The inside 3 rows were harvested with a three foot sickle mower. The relative forage yields were determined for each variety at each of the 3 heights of clip, 2, 4 and 6 inches above the soil surface. Plots were harvested when the plants attained a height of not less than 2 inches above the designated clipping height.

On March 1, measurements of the rate of floral primordia elongation above the soil surface were started to determine the effect the various clipping intensities had upon the rate of elongation. Forage yield measurements were terminated just before the floral primordia had attained a height at which they might be damaged or severed by clipping. Plants were then allowed to form and mature seed, so that grain yields by variety and clipping intensity could be determined. Grain yields were taken in order to measure the effect the various clipping intensities had upon production by crop and variety.

Forage yields of the nine small grain varieties were found to vary significantly among crops, dates of harvest and clipping intensity. Without exception, all small grain varieties studied produced a greater amount of forage at the 2 inch height of clip than at the 4 and 6 inch heights. Among wheat varieties studied, Triumph from the standpoint of total forage production appeared the least desirable. The forage production of oats in general, exceeded that of wheat during the fall. Although Arkwin oats was the top forage producer in the fall, Cimarron produced the most forage in the winter months, with Wintok producing the greatest amount in the spring. The forage production of both Elbon and Balbo rye was much greater during both the fall and winter periods than either wheat, oats or barley. However, spring production of rye was low when compared with either wheat or barley. The yields of Rogers barley compared favorably with rye during the fall and with wheat in the spring.

Due to the rapid rate of floral primordia elongation in the spring only one clipping of wheat was obtained at each of the three heights of clip. In contrast to wheat, all oat varieties were very slow in the initial rate of inflorescence elongation. With the exception of those plants subjected to the 2 inch height of clip, the rate of elongation of rye floral primordia was so great that no clippings were taken during the spring. The rate of floral primordia elongation of Rogers barley behaved in much the same manner as the three oat varieties.

Grain yields of the four small grain crops were found to be significantly different between crops and clipping intensity. In general, the most severe clipping intensity was less injurious to the wheat varieties than any of the crops studied, with the possible exception

of Rogers barley and Wintok oats.

Grain production of the wheat varieties studied appeared to be only slightly affected, if any, by the more severe clipping intensities. It would seem perhaps, that forage removal ceased at a date early enough to ensure that the elongating inflorescence would not be damaged or clipped off.

Oats exhibited significant and erratic differences among varieties and clipping height by variety. Wintok oats did not appear to be affected adversely by the severe clipping intensity. Severe cold injury especially to the variety Arkwin was considered a major factor in its influence on overall yield.

In an inverse relationship to forage production the grain yield of both rye varieties was lowest at the 2 inch height of clip and highest at the 6 inch height. These indicate that severe clipping of either Elbon or Balbo rye during the growing season sharply reduces grain production. This perhaps is the result of damage or destruction of the older flowering culms.

Both forage and grain yields of Rogers barley were highest at the 2 inch height of clip and tends to indicate that this level would be the most desirable when this variety is used.

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APPENDIX

APPENDIX TABLE I

TEMPERATURE AND PRECIPITATION DATA FOR THE PERIOD BEGINNING JULY 1, 1961,

AND ENDING JUNE 30, 1962, AT STILLWATER, OKLAHOMA.

	Temperature						Precipitation						
		Depart. From						Depart. From	Greatest		Snow and Sleet Maximum		
	Av.	Means	Highest	Date	Lowest	Date	Total	Means	Day	Date	Total	Depth	Date
July	78.7	-4.0	97	19	56	10	4.15	1.28	1.50	7	0	0	--
August	78.1	-4.3	98	9	51	24	1.13	-2.11	.49	14	0	0	--
September	70.7	-3.4	98	2	44	25	9.43	6.23	3.85	13	0	0	--
October	63.3	-0.4	86	12	28	26	1.27	-1.14	1.19	10	0	0	--
November	48.3	-0.8	76	12	24	29	3.56	1.59	1.47	2	0	0	--
December	37.1	-3.5	70	3	6	13	1.17	- .14	.47	8	.5	1	8
January	32.5	-5.4	71	31	-4	20	.46	- .70	.16	18	5.7	5	19
February	45.9	3.7	88	12	7	28	.51	- .84	.37	15	.6	1	28
March	48.8	-0.8	81	28	9	1	.97	- .89	.55	24	0	0	--
April	58.8	-1.8	91	29	23	2	1.57	-1.29	.34	10	0	0	--
May	75.2	6.7	92	25	39	2	1.96	-2.66	1.17	29	0	0	--
June	75.5	-2.4	93	21	57	14	6.20	1.96	1.81	9	0	0	--

APPENDIX TABLE II

ANALYSIS OF VARIANCE OF FORAGE PRODUCTION DATA FOR FOUR SMALL GRAIN CROPS BY CROP, CROP VARIETY, PERIOD OF PRODUCTION AND CLIPPING INTENSITY.

Source	D.F.	S.S.	M.S.	F
Total	404	51,598,220		
Reps	4	374,650		
Species	8	6,318,610		
Among Crops (3)				
Var. in Wheat (2)		351,890	175,945.00	4.61*
" " Oats (2)		98,296	49,148.00	1.28N.S.
" " Rye (1)		185,320	185,320.00	4.86*
(Error) Reps x Species	32	1,220,560	38,142.50	
Clipping	2	9,824,700	4,912,350.00	191.5**
(Error) Reps x Clip	8	205,260	25,657.50	
Clipping x Species	16	3,008,600		
Clipping x Crop (6)		2,653,732		
Clip x Var. in Wheat (4)		18,240	4,560.00	N.S.
" " " " Oats (4)		269,108	67,277.00	5.73*
" " " " Rye (2)		67,520	33,760.00	2.88N.S.
(Error) Reps x Clip x Sp.	64	750,830	11,731.70	
Periods	2	4,380,240	2,190,120.00	39.93**
(Error) Reps x Period	8	438,780	54,842.50	
Periods x Species	16	17,881,240		
" " Crop (6)				
" " Var.in Wheat(4)		416,540	104,135.00	3.75*
" " " " Oats (4)		519,419	147,854.75	5.33*
" " " " Rye (2)		6,140	3,070.00	N.S.
(Error) Reps x Per. x Sp.	64 /1	1,776,730	27,761.40	
Period x Clip	4	233,620	58,405.00	2.22N.S.
(Error) Rep x Per. x Clip	16 /2	421,350	26,334.40	
Per. x Clip x Species	32	2,678,980		
" " " " Crop (12)				
" " " "Var.inWheat(8)		83,520	10,440.00	N.S.
" " " " " " Oats(8)		591,345	73,918.13	4.53*
" " " " " " Rye (4)		177,120	44,280.00	2.72*
(Error) Reps x Per. x ClipxSp.128	/3	2,084,070	16,281.80	

* Significant at the .05 level of confidence
** Significant at the .01 level of confidence
/1 32 D. F. used in denominator for Tab. "F"
/2 8 D. F. used in denominator for Tab. "F"
/3 64 D. F. used in denominator for Tab. "F"

APPENDIX TABLE III

ANALYSIS OF VARIANCE OF RATE OF FLORAL PRIMORDIA ELONGATION DATA FOR FOUR SMALL GRAIN CROPS BY CROP, CROP VARIETY, DATE OF MEASUREMENT AND CLIPPING INTENSITY.

Source	D.F.	S.S.	M.S.	F	
Total		6,680.556			
Reps	2	3.540	1.77200		N.S.
Species	8	495.637	61.95463	17.30	*
Among Crops	(3)				
Var. in Wheat	(2)	29.067	14.53350	4.06	*
" " Oats	(2)	12.981	6.49035	1.81	N.S.
" " Rye	(1)	9.920	9.92000	2.77	N.S.
(Error) Reps x Species	16	57.299	3.58119		
Clipping	2	249.351	124.67550		**
(Error) Reps x Clip	4	12.357	3.08925		
Clipping x Species	16	81.250	5.07813	2.12	*
Clip x Crops	(6)				
Clip x Var. in Wheat	(4)	9.048	2.26200		N.S.
" " " " Oats	(4)	5.323	1.33073		N.S.
" " " " Rye	(2)	5.349	2.67450	1.11	N.S.
(Error) Reps x Date x Sp.	32	76.928	2.40400		
Dates	4	802.107	200.52675		**
(Error) Reps x Dates	8	21.275	2.65938		
Dates x Species	32	3,640.145	113.75453	53.40	**
Dates x Crop	(8)				
Dates x Var. in Wheat	(8)	85.494	10.68675	5.02	*
" " " " Oats	(8)	62.755	7.84433	3.68	*
" " " " Rye	(4)	47.044	11.76100	5.52	*
(Error) Reps x Date x Sp.	64	136.335	2.13023		
Date x Clip	8	81.899	10.23738	8.01	*
(Error) Reps x Date x Clip	16	20.444	1.27775		
Date x Clip x Species	64	810.584	12.66538	8.47	*
" " " " Crop	(24)				
" " " "Var.in Wheat	(16)	24.012	1.50075	1.00	N.S.
" " " " " " Oats	(16)	29.678	1.85485	1.24	N.S.
" " " " " " Rye	(8)	9.275	1.15938		N.S.
(Error) Reps x DatexClipxSp.	128	191.401	1.49532		

* Significant at the .05 level of confidence
** Significant at the .01 level of confidence

APPENDIX TABLE IV

ANALYSIS OF VARIANCE OF GRAIN PRODUCTION DATA FOR FOUR SMALL GRAIN CROPS BY CROP, CROP VARIETY AND CLIPPING INTENSITY.

Source	D.F.	S.S.	M.S.	F
Total		6,620.49		
Reps	4	301.31	75.32750	1.82 N.S.
Species	8	1,821.83	227.72875	5.49 *
Among Crops (3)				
Var. in Wheat (2)		476.51	238.25500	5.74 *
" " Oats (2)		918.28	459.14000	11.07 *
" " Rye (1)		11.65	11.65000	N.S.
(Error) Reps x Species	32	1,327.76	41.49250	
Clipping	2	643.38	321.69000	12.63 *
(Error) Reps x Clip	8	203.76	25.47000	
Clipping x Species	16	1,444.98	90.31125	6.59 *
Clipping x Crops (6)				
" " Var.inWheat (4)		31.06	7.76500	N.S.
" " " " Oats (4)		473.92	118.48000	8.64 *
" " " " Rye (2)		3.80	1.90000	N.S.
(Error) Reps x Clip x Sp.	64	877.47	13.71047	

* Significant at the .05 level of confidence

APPENDIX TABLE V

FORAGE YIELDS OF NINE VARIETIES OF SMALL GRAINS OBTAINED IN THE FALL PERIOD WHEN CLIPPED ON NOVEMBER 21 AT THREE HEIGHTS IN EACH OF FIVE REPLICATIONS.

Variety	Height of Clip[2]	Yields in pounds oven-dry forage per acre[1] Replications I	II	III	IV	V	Total	Average
Triumph	2 in.	44	29	73	87	29	262	52
	4 in.							
Concho	2 in.	87	305	102	15	15	524	105
	4 in.							
Kaw	2 in.	116	711	73	29	15	944	189
	4 in.							
Arkwin	2 in.	247	711	668	682	711	3019	604
	4 in.	0	363	465	218	29	1075	215
Cimarron	2 in.	203	348	116	189	392	1248	250
	4 in.							
Wintok	2 in.	15	58	44	44	44	205	41
	4 in.							
Elbon	2 in.	523	711	581	711	799	3325	665
	4 in.	87	305	73	261	73	799	180
Balbo	2 in.	624	1045	871	1060	1074	4674	935
	4 in.	58	189	276	450	174	1147	229
Rogers	2 in.	668	799	857	726	697	3747	749
	4 in.	247	0	73	131	116	567	113

[1] Field data as it appeared prior to statistical analysis

[2] No clippings taken at the 6 inch height of clip

APPENDIX TABLE VI

FORAGE YIELDS OF NINE VARIETIES OF SMALL GRAINS OBTAINED IN THE WINTER PERIOD WHEN CLIPPED ON JANUARY 3 AND FEBRUARY 21 AT THREE HEIGHTS IN EACH OF FIVE FIELD REPLICATIONS.

Variety	Height of Clip	Yield in pounds oven-dry forage per acre/1 Replications I	II	III	IV	V	Total	Average
Triumph	2 in.	272	109	258	118	208	965	193
	4 in.							
	6 in.							
Concho	2 in.	189	258	303	51	102	903	181
	4 in.							
	6 in.							
Kaw	2 in.	298	398	205	287	151	1339	268
	4 in.							
	6 in.							
Arkwin	2 in.	102	199	240	205	224	970	194
	4 in.							
	6 in.							
Cimarron	2 in.	468	546	420	224	394	2052	410
	4 in.							
	6 in.							
Wintok	2 in.	44	160	208	154	112	678	136
	4 in.							
	6 in.							
Elbon/2	2 in.	1110	1113	1243	790	1123	5379	1076
	4 in.	1185	732	775	728	742	4162	832
	6 in.	344	351	248	427	386	1756	351
Balbo/2	2 in.	932	1051	1247	735	1437	5402	1080
	4 in.	690	902	867	927	955	4341	868
	6 in.	353	362	671	767	681	2834	567
Rogers	2 in.	317	310	371	253	428	1679	336
	4 in.							
	6 in.							

/1 Field data as it appeared prior to statistical analysis

/2 Only Elbon and Balbo rye produced forage at the 4 and 6 inch heights of clip during the winter period.

APPENDIX TABLE VII

FORAGE YIELDS OF NINE VARIETIES OF SMALL GRAINS OBTAINED IN THE SPRING PERIOD WHEN CLIPPED ON MARCH 26 AND APRIL 14 AT THREE HEIGHTS IN EACH OF FIVE FIELD REPLICATIONS.

Variety	Height of Clip	Yield in pounds oven-dry forage per acre[1] Replications I	II	III	IV	V	Total	Average
Triumph	2 in.	990	793	878	317	703	3681	736
	4 in.	677	389	754	48	486	2354	471
	6 in.	450	322	415	54	324	1565	313
Concho	2 in.	1005	1202	1188	635	926	4956	991
	4 in.	640	1249	876	215	804	3784	757
	6 in.	468	812	452	122	674	2528	506
Kaw	2 in.	1137	819	857	1144	883	4840	968
	4 in.	819	1166	672	751	412	3820	764
	6 in.	845	648	478	1172	215	3358	672
Arkwin	2 in.	86	54	80		157	377	75
	4 in.	122	430	263	170	383	1368	274
	6 in.	[2]						
Cimarron	2 in.	122	288	343	895	246	1894	379
	4 in.	173	613	83	195	706	1770	354
	6 in.							
Wintok	2 in.	186	404	266	64	301	1221	244
	4 in.	319	154	48	58	141	720	144
	6 in.	183	601	22	64	183	1053	211
Elbon	2 in.	317	496	419	458	442	2132	426
	4 in.							
	6 in.							
Balbo	2 in.	750	606	768	764	412	3300	660
	4 in.							
	6 in.							
Rogers	2 in.	761	1791	792	469	961	4774	955
	4 in.	1101	966	1048	186	848	4149	830
	6 in.	366	67	115	38	752	1338	268

[1] Field data as it appeared prior to statistical analysis

[2] Clippings not taken from plots in which blank spaces appear in table above.

APPENDIX TABLE VIII

GRAIN YIELDS OBTAINED FROM SOME VARIETIES OF FOUR KINDS OF SMALL GRAINS CLIPPED AT THREE HEIGHTS IN EACH OF FIVE FIELD REPLICATIONS.

Variety	Height of Clip	Yield in bushels per acre/1 Replications I	II	III	IV	V	Total	Average
Triumph	2 in.	15.6	3.5	6.7	5.2	9.9	40.9	8.2
	4 in.	16.6	11.4	12.9	5.3	12.7	58.9	11.8
	6 in.	19.1	14.6	12.9	9.2	12.9	68.7	13.7
Concho	2 in.	18.8	14.4	17.5	16.5	18.2	85.4	17.1
	4 in.	18.0	17.5	22.2	21.8	18.4	97.9	19.6
	6 in.	23.8	17.2	18.2	25.0	20.3	104.5	20.9
Kaw	2 in.	16.9	11.1	19.1	13.3	14.7	75.1	15.0
	4 in.	8.8	18.8	20.8	3.6	18.2	70.2	14.0
	6 in.	9.8	17.8	20.7	12.6	28.8	89.7	17.9
Arkwin	2 in.	.8	2.0	0	0	2.7	5.5	1.1
	4 in.	3.0	5.8	11.1	3.6	20.0	43.5	8.7
	6 in.	1.6	20.5	2.8	2.1	10.1	37.1	7.4
Cimarron	2 in.	5.5	14.5	20.5	11.9	9.9	62.3	12.5
	4 in.	19.1	24.5	15.4	8.7	19.3	87.0	17.4
	6 in.	18.5	27.9	19.4	14.3	21.6	101.7	20.3
Wintok	2 in.	5.3	19.9	29.0	17.6	14.8	86.6	17.3
	4 in.	2.3	14.0	9.6	12.0	5.0	42.9	8.6
	6 in.	2.8	12.0	10.5	12.0	18.1	55.4	11.1
Elbon	2 in.	3.6	2.9	2.2	3.7	2.3	14.7	2.9
	4 in.	13.2	15.7	16.1	15.4	16.6	77.0	15.4
	6 in.	15.4	16.0	17.5	19.7	21.9	90.5	18.1
Balbo	2 in.	1.6	2.8	2.1	.8	2.5	9.8	2.0
	4 in.	14.9	17.4	13.1	3.4	17.1	65.9	13.2
	6 in.	20.0	19.8	14.4	14.2	19.4	87.8	17.6
Rogers	2 in.	20.2	21.7	8.2	16.7	18.2	85.0	17.0
	4 in.	9.1	16.2	9.2	9.5	9.1	53.1	10.6
	6 in.	22.3	20.6	3.4	14.5	9.4	70.2	14.0

/1 Field data as it appeared prior to statistical analysis

VITA

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Master of Science

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