THE INFLUENCE OF STAGE OF MATURITY ON THE FORAGE YIELD, CRUDE PROTEIN CONTENT, AND IVDMD OF OATS AND TRITICALE

By

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Bachelor of Science in Agriculture

Central Luzon State University

Nueva Ecija, Philippines

1973

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
December, 1976

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ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to his major adviser, Dr. Wilfred E. McMurphy, for his assistance, guidance, and encouragement throughout the course of this study. Appreciation is also expressed to the other committee members, Dr. Lewis H. Edwards and Dr. Lawrence G. Morrill for their valuable assistance and constructive criticism in the preparation of this thesis.

I am grateful to the Agronomy Department of Oklahoma State University for the use of its facilities which made this study possible.

Special thanks goes out to Dr. Floyd Horn for his assistance in forage IVDMD analysis at Southwest Livestock and Forage Research Station, Ft. Reno, Oklahoma. Also, a note of thanks is given to Mr. Donald E. Hubbard, Mr. Stephen M. Molloy, and Mr. James E. Haught for their assistance in harvesting of this experiment.

Sincere gratitude is expressed to my parents, Mr. and Mrs. Tawat Sittigul, and my relative, Dr. Chaggrit Sawangkao, M.D., for their guidance, encouragement, and financial assistance while pursuing this degree.

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CHAPTER I

INTRODUCTION

Forage is a prime feed for ruminant livestock. More than one-half of the feed needed to raise these animals and produce their products is obtained from forage. As a forage crop, oats (Avena sativa) has been widely used for winter and spring pasture in Oklahoma for many years. Recently, there has been a considerable interest in the development of a new crop called triticale (Triticale hexaploide). Triticale is artificially created by the use of a chemical called colchicine to double the chromosome number of the sterile hybrid that results from a cross between wheat and rye. Triticale gets its name from the combination of the botanical name of the wheat genus Triticum, and Secale, the genus of rye. At the present time it is being evaluated as a forage crop.

Oat and triticale forages are a cheap source of feed and provide the animal with an excellent source of protein, vitamin A, and minerals. The stage of maturity at which the plants are harvested is one of the most important factors influencing their crude protein content, in vitro dry matter digestibility (IVDMD), and forage yield. However, in order to obtain the maximum meat and milk products from the ruminant livestock the time of harvesting the forage for feeding the animal should be considered.

The primary objectives of this study were to determine the crude protein content, IVDMD, and forage production of several oat and triticale varieties with respect to the different stages of maturity.

CHAPTER II

LITERATURE REVIEW

Influence of Stage of Maturity on Forage Yield

It is well recognized that the forage yield of small grains changes with advancing maturity. Ahlgren (1956) stated that harvest dates and stage of maturity greatly affect dry matter yield of oat forage. Burgess et al. (1972) in Canada observed that dry matter yield of forage oats increased significantly from the flag leaf to the milk stage of plant maturity. However, there was no appreciable increase in dry matter obtained from the milk stage to the hard seed stage of maturity. Similarly, Meyer et al. (1957) in California found that the dry matter of oat forage increased from jointing stage to milk stage, but after the milk stage it remained constant.

Studies were conducted at Perkins, Oklahoma from 1972-1973 by Rommann et al. (1973) to demonstrate the forage production of oats harvested at different dates. The results show that Walken produced 2,214 and a regrowth of 3,986 lb/acre, Chilocco produced 1,515 and a regrowth 3,899 lb/acre, T 208 produced 2,367 and a regrowth 3,151 lb/acre, when they were harvested on April 12 and May 24, respectively.

In Wisconsin, Smith (1960) showed the yield of oat forage cut at different ages. He found that the dry matter yield per acre was

highest at near ripeness but a higher proportion of important nutritional constituents was produced at the early dough stage. At the same time Klebesadel and Smith (1960) also reported that oats produced highest dry matter yields at near early dough stage.

During the winter season of 1970-1971, McMurphy and Denman (1972) evaluated the forage production of Cimarron oats at Perkins, Oklahoma. They obtained the forage yields of 352, 1,061 and 2,142 lb/acre when the oat was harvested on December 1, March 23, and April 30, respectively.

Thompson and Day (1959) stated that spring oats were successfully grown for winter forage in the Southwest. Spring oats produced more winter pasture forage than spring barley.

In eastern Oklahoma, McMurphy (1972) compared the total forage production from different varieties of small grains. He obtained 1,456 and 1,307 lb/acre of total dry matter from Cimarron and Chilocco oats. Rosner and Graze Grain 70A triticale produced the total forage yields of 1,519 and 926 lb/acre, respectively. However, the best wheat and rye varieties produced over 3,000 lb/acre.

In Georgia, Brown and Almodares (1976) stated that triticale cultivars have the ability to survive low temperatures during the winter season. They found that the triticale cultivars Fasgro 385 and Fasgro 514 produced as much forage as Jefferson oats.

Effect of Stage of Maturity on Crude Protein Content

Numerous investigators have studied the chemical composition of forage crops at various stages of maturity. Sullivan and Garber (1947)

stated that stage of growth is the most important factor influencing the chemical composition of pasture plants. In early spring all of them are succulent, with high moisture, high protein, and low fiber contents. As the season advances the plant, under the influences of day length and temperature, approaches the reproductive stage, leaf growth slows down, stems elongate and products of photosynthesis accumulate. The chemical composition changes in the direction of a lower percentage of protein and a higher percentage of carbohydrates. Similarly, Ahlgren (1956) mentioned that in the earlier stages the percentage of crude protein is higher, but the total production of this constituent is lower owing to a smaller production of dry matter at this time. When the stage of maturity advanced the feeding value of forage crops decreased.

Barnes (1973) said that the purposes of forage analysis are to estimate the feeding value of available forages and to assist the farmer in making management decisions to maintain the best quality of harvested forages for his livestock.

Western and Graham (1961) cited that in reporting crude protein content of oat forage, the nitrogen determined by the Kjeldahl procedure is usually multiplied by the factor 6.25. Also, Van Soest (1973) reported that all forages contain some protein, sugars, starch, and organic acid constituents. Usually the protein portion is expressed in terms of crude protein content and it can be obtained by multiplying the factor 6.25 by the total nitrogen found in the plant.

Morrison (1960) said that the term crude protein is commonly used to include all of the nitrogenous compounds in the plant. When it is desired to distinguish the substances which are actually proteins from

the simpler nitrogenous compounds, the term true protein is used. Van Soest (1973) stated that the crude protein content includes protein and nonprotein nitrogen (NPN). True protein is the actual protein in plant, which is approximately 70% of the total nitrogen in fresh forages and lower proportions in hay. Crampton and Harris (1969) said that the protein in plant may be reduced during processing. Heat, for example, may reduce the protein in most feeds.

Sullivan (1962) criticized the use of chemical analysis to predict forage quality, particularly for ruminants. The chemical methods most commonly used were those of the proximate scheme which include crude protein, crude fiber, ether extract, ash, and nitrogen-free extract. The analysis of only crude protein does not give the whole answer. A separate determination for the nonprotein nitrogen is advisable. However, when minor quantities of nonprotein nitrogen are present, they will be included as crude protein in the regular Kjeldahl procedure.

Thurman et al. (1957) conducted field experiments in Arkansas to investigate protein percentages in oat hay harvested at different stages of maturity. They found that the percentage of protein in oat hay decreased gradually from 13.1 to 8.9 between the boot and hard dough stages. Finally, they concluded that oat hay harvested when the grain is in the milk, soft-dough, or hard-dough stages of maturity are about equal in feeding value.

In North Dakota, Larson and Carter (1970) found a reduction of the protein percentage in oat forage from 10.8 in the milk stage to 8.5 in the mature stage of growth. However, the rate of dry matter increase was more rapid than the percent decrease in protein, which resulted in higher yield of protein per acre at the milk stage in oats.

Elder (1967) stated that small grain pastures are an important source of crude protein for wintering cattle in Oklahoma. When they are young they have a crude protein content which may reach a high of 30 percent and are seldom lower than 20 percent until head formation in the spring months.

Grabouski and Moline (1971) in Nebraska compared the level of crude protein content in winter wheat, forage wheat, oats, and rye. They found that oat forage was higher in crude protein than the other small grains. It contained 22 percent crude protein at the late boot and 16 percent at the early dough stages. They recommended early harvesting for a high protein percentage.

Under Canadian conditions, Tingle and Dawley (1974) studied the nutritive value of whole-plant cereals at a silage stage. They showed that the crude protein content of oats and triticale in the soft-dough stage were 9.4 and 9.7 percent, respectively.

Leonard and Martin (1961) mentioned that oats can be made into high quality silage for farm animals. The crop generally is cut for silage in the boot or in the milk stages of maturity. Such silage has a higher protein content, as well as a lower percentage of crude fiber, than that harvested at a later stage. However, oats harvested for silage when the grain is in the milk stage will return the highest yield of nutrients per acre. Oat plants cut for silage when the grain is in the hard-dough stage of maturity are difficult to pack into the silo because their stems are hard and dry and contain a lower moisture content.

In another study conducted in Canada, Burgess et al. (1972) used the standard Kjeldahl procedure to determine protein content of oat

forage harvested at four different stages of maturity. Their findings showed that the percent protein content of forages steadily declined from 16.4, 8.2, 6.9, to 5.0 at the flag leaf, milk, dough, and hard seed stages of maturity, respectively. Finally, they suggested that the oats should be harvested at the milk stage for high quality forage. Beyond this stage the quality of the material rapidly declined.

Klebesadel and Smith (1960) observed that protein yields were highest at the early dough stage or from harvests made whenever oats reached 12 to 16 inches.

Smith (1960) said that the percentages of protein of oat forage declined from early growth to maturity while the percentage of nitrogen-free extract increased. However, he indicated that the early dough stage was the best time to harvest oats for hay or silage because that is when it is the highest in protein production per acre.

In Iowa, Gardner and Allen (1961) stated that with oats, like other forages, the percentage of protein decreases as the plants mature. Crude protein content of the oat plants in their tests was 22 percent at the late boot stage but was only 11 percent at the late dough stage.

There were greater differences in protein content within any one variety than there was between varieties as shown by Rosen et al. (1953) in a study conducted in Arkansas.

In Georgia, Brown and Almodares (1976) compared the quality of triticale forage to the other small grains during 1971-1972 growing season. On January 19 and March 10 clipping dates, Funk's Rosner and Graze Grain 70 triticale varieties had the same percentage of crude protein content as Jefferson oats but on the last clipping date,

April 17, triticales contained significantly higher percent crude protein than oats.

Effect of Stage of Maturity on IVDMD

A measurement of the digestibility of forages used for ruminant livestock is obtained by feeding each forage to sheep or cattle in a conventional digestion trial. This method, according to Tilley et al. (1960), is laborious, expensive, requires large quantities of feed, and the number of forages which can be tested is limited. A considerable interest has developed in the use of in vitro rumen fermentation technique for the evaluation of forage quality. Shelton and Reid (1960) stated that the development of in vitro procedures is not a recent one; it was used at the end of the nineteenth century.

Mott (1973) said that only a small sample, 1 g or less, of plant material is required to make the test. However, the procedure most widely used in forage laboratories is the Tilley and Terry (1963) two-stage in vitro rumen fermentation system. This procedure involves incubation first with rumen liquor and then with acid pepsin.

In general, the stage of maturity has an effect on IVDMD. Trimberger et al. (1955) reported that the percentage of dry matter digestibility of roughage at the early date of cutting was high compared with the late cutting date. Moxon et al. (1951) in South Dakota found that the IVDMD was reduced only slightly in late-cut hay as compared to early-cut hay.

The experiments conducted in Canada by Burgess et al. (1972) determined the IVDMD of oat forage harvested at the flag leaf, milk, dough, and hard dough stages of maturity. Their results of IVDMD were

59.6, 51.6, 39.6, and 38.4 percent, respectively. Hawkins and Autrey (1955) compared the IVDMD of oat and alfalfa forages. They found the mean of 79.4 and 58.8 percent IVDMD in oats and alfalfa, respectively.

CHAPTER III

MATERIALS AND METHODS

This study was carried out in the spring of 1975 at the Agronomy Research Station, Perkins, Oklahoma. The soil was a Teller fine sandy loam with soil test revealing a pH of 5.0, 63 pounds of available P per acre, and 270 pounds of available K per acre. The experimental design used for this study was a split-plot. The 16 varieties of oats and triticale were assigned at random to the main plots within each block; the five harvest dates at different stages of maturity were assigned at random to the subplots within each main plot. The main plot design was a randomized complete block of four replications.

There were 16 main plots in each replication. Each individual plot was made up of four rows, 12 inches apart and 20 feet in length. The plots were planted with a four-row planter. The two outside rows of each plot were left as borders. The two center rows were divided into five subplots and randomly selected for harvest at different stages of maturity. Each subplot was two feet in length. There was no application of fertilizer at a planting time. However, a top-dressing of nitrogen fertilizer in the form of ammonium nitrate was applied over the plots at the rate of 50 pounds of actual N per acre on March 20, 1975.

The material evaluated in the study consisted of eight oat varieties and eight triticale varieties. One hundred seeds of each

variety were counted and weighed to determine the seeding rate which was equivalent to the standard of 3,000 seeds per plot or 38 seeds per square foot. Each variety was planted on January 27, 1975 at the seeding rate as shown in Table 1.

Precipitation, three inches above normal and well distributed, during the growing season (January-June, 1975) was sufficient for the growth of the crop. After the seedlings emerged, a freeze on April 3 and 4 (19 and 21 F respectively) may have prevented the varieties Nora, Checota, Rapida, Arl/Wtk//Cmr, Montezuma, and T205, from establishing a good stand.

The characters evaluated were: 1) forage yield, 2) crude protein content, 3) total N in the forage, and 4) IVDMD.

Forage Yield

Forage was harvested on five dates, May 16, May 22, May 30, June 6, June 13, 1975, for the different stages of maturity. The plots were hand clipped approximately one inch above the ground. The entire sample was placed in a paper bag and oven dried at a temperature of 140 F. Forage yields were recorded in grams per four square feet and then converted to pounds per acre.

Crude Protein Content

A small portion of each dried sample was ground and analyzed for nitrogen content in the Soil and Water Testing Laboratory, Agronomy Department, Oklahoma State University using micro Kjeldahl procedure. Values obtained were multiplied by 6.25 to convert to percent crude protein.

Table 1. Seeding rates of different varieties.

Variety	gm/100 Seeds	gm/Plot	lb/Acre
OATS			
Cimarron	2.5	75	90.0
Nora	4.5	135	162.0
Chilocco	3.0	90	108.0
Checota	3.2	96	115.2
Arl/Wtk//Cmr	2.6	78	156.0
Walken	2.4	72	86.4
Rapida	3.9	117	140.4
Montezuma	4.4	132	158.4
TRITICALE			
CL 72	2.0	60	72.0
T 204	2.1	63	75.6
T 205	2.5	75	90.0
T 208	2.0	60	72.0
T 418	2.1	63	75.6
T 409	2.5	75	90.0
Graze Grain 70	3.1	93	111.6
Rosner	2.7	81	97.2

Total N in the Forage

After the forage yield per acre was calculated and the percent N content for each sample was analyzed, the total N in the forage was calculated by multiplying the forage yield by percent N.

In Vitro Dry Matter Digestibility

Dry matter samples were then ground to pass through a 40 mesh screen using the micro grinder and sent to the Southwest Livestock and Forage Research Station, Ft. Reno, Oklahoma for the IVDMD analysis. Each sample was chemically analyzed using the IVDMD technique developed by Tilley and Terry (1963). Values obtained were percent IVDMD.

CHAPTER IV

RESULTS AND DISCUSSION

Date of emergence, forage production, crude protein content, total N in the forage, and IVDMD estimates as influenced by variety or by both variety and stage of maturity are presented under separate headings for simplicity and convenience of discussion.

Date of Emergence

Average date of emergence for oat and triticale varieties are shown in Table 2. Varieties differed significantly in date of emergence. With the exception of Rosner, all triticales emerged before oats. The last triticale to emerge was Rosner which emerged on the same date as Arl/Wtk//Cmr oat. This oat variety failed to establish a good stand after a freeze on April 3 and 4.

Forage Production

The forage production of all varieties of oats and triticale significantly increased with the advance in stage of maturity. Most of them produced the maximum forage yield on the last harvest date, June 13, except Walken and T 418 which produced the highest on the fourth harvest date, June 6 (Table 3). This may account for the significant variety X harvest date interaction that was observed for

Table 2. Mean of four dates of emergence of oats and triticale, seeded on January 27, 1975.

Variety	Date of Emergence	
TRITICALE		
T 208	February 26	a*
T 209	February 26	a
T 418	February 26	a
CL 72	February 26	a
T 204	February 28	a
T 205	February 28	a
Graze Grain 70	February 29	a
Rosner	March 7	b
OATS		
Arl/Wtk//Cmr	March 7	b
Cimarron	March 14	c
Walken	March 15	cd
Chilocco	March 17	cd
Nora	March 19	de
Montezuma	March 20	e
Checota	March 21	e
Rapida	March 21	e
LSD (P = 0.05) = 4 days		

*Means followed by the same letter are not significantly different at the 5% level.

Table 3. Mean forage production (lb/acre) of oat and triticale varieties at different harvest dates.

Variety	Date of Harvesting and Stage of Maturity[1]									
	May 16	Stage	May 22	Stage	May 30	Stage	June 6	Stage	June 13	Stage
Triticale										
T 208	2749	B	3540	EH	4744	EH	5918	FH	7289	FH
Graze Grain 70	2204	B	3492	EH	4295	EH	5325	FH	7259	FH
T 209	3037	LB	3666	EH	4498	EH	5978	FH	6864	FH
T 204	2851	LB	3288	EH	4738	EH	5906	FH	6720	FH
CL 72	2438	B	3330	LB	4474	EH	5762	FH	6648	FH
Rosner	2695	LB	3791	EH	4336	EH	4822	FH	6499	FH
T 418	2737	LB	3480	EH	5037	EH	6301	FH	6205	FH
Oats										
Cimarron	2066	LB	3001	EH	3684	FH	4965	FH	5331	FH
Chilocco	1965	LB	2677	EH	4103	EH	4211	FH	4971	FH
Walken	1887	PB	2605	B	3845	LB	4049	EH	3696	FH
Means	2469		3287		4375		5323		6499	
LSD (P = 0.05)	497		594		759		1187		1227	

LSD (P = 0.05) harvest date within variety = 849 lb/acre

LSD (P = 0.05) for the seasonal forage production means = 268 lb/acre

[1]Stages of maturity are: PB = Preboot succulent, B = Boot succulent, LB = Late boot succulent, EH = Early heading succulent, FH = Full heading succulent.

forage production. The increase of forage yield with time is illustrated more clearly in Figure 1.

Varieties and harvest dates significantly affected forage production. The triticale varieties consistently produced greater forage yields than oat varieties in every harvest date except June 6 when only Rosner triticale produced less forage than Cimarron oat (Table 3). As the oats and triticales matured, the mean forage yields significantly increased from May 22 to June 13. There were significant differences among varieties in forage production. On May 16, T 209 triticale produced a greater forage yield than Graze Grain 70 and CL 72. On June 6, T 418 produced more forage than Rosner. Cimarron oat produced a significantly higher forage yield than Walken on June 13. No other significant differences within the oat varieties were observed on the other harvest dates.

The triticale varieties T 208, Rosner, T 418, and T 208 were consistently among the highest producers at every harvest date. On June 13, T 208 produced 7,289 lb/acre of forage which was the highest yield in this study.

Walken oat matured more slowly than all other varieties and it was somewhat consistent in being the lowest producing variety.

One factor which undoubtedly had an influence on the low production of the oat varieties was the 7 to 17 day difference in emergence between oat and triticale varieties. The importance of early germination and growth, while not proven in this study, appears to deserve attention.

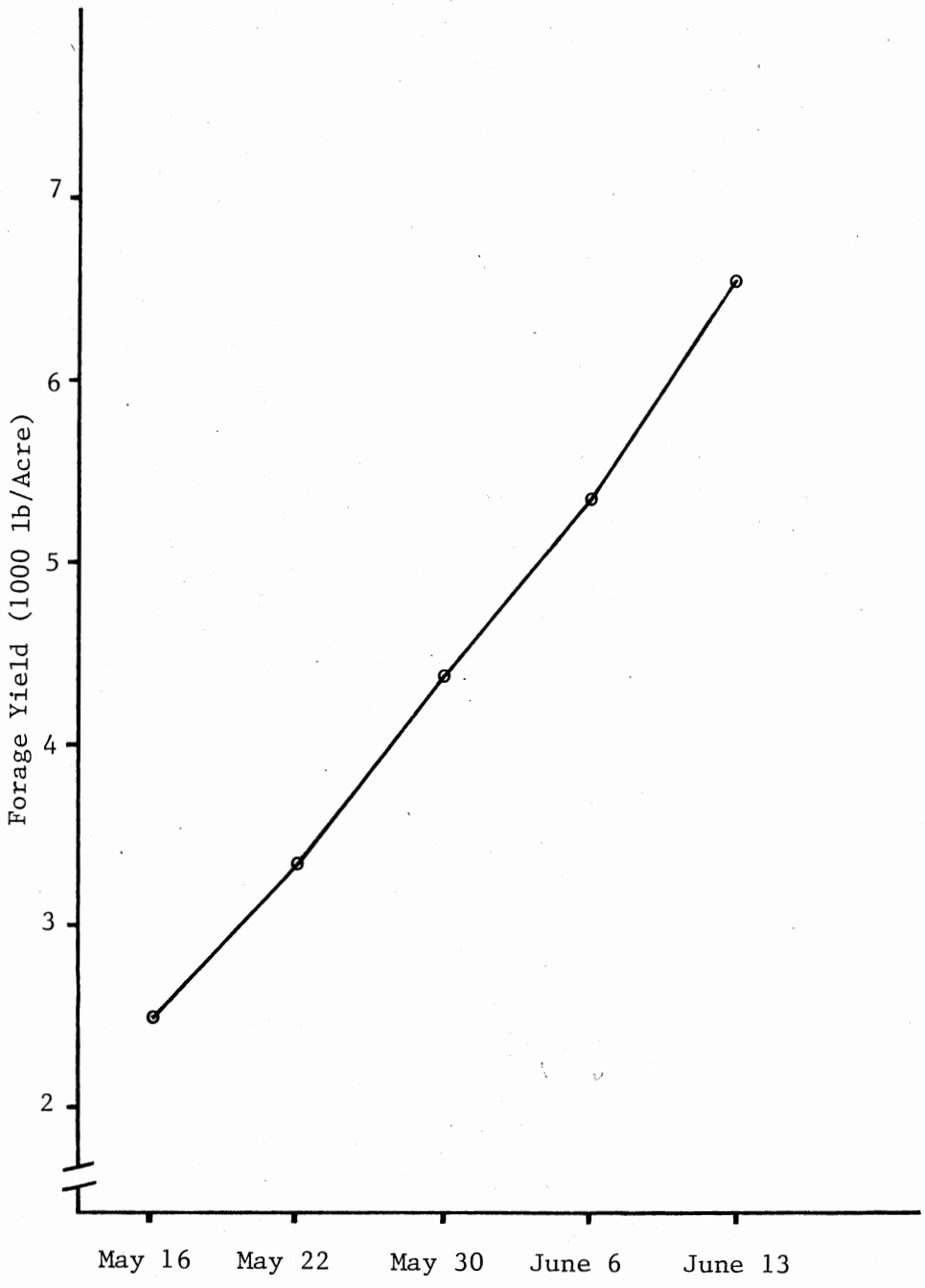

Figure 1. Forage Production (Means of 10 Entries) at Five Different Harvest Dates

Crude Protein Content

The percent crude protein content for all varieties was significantly reduced by later harvest dates (Table 4 and Figure 2). At the early stage of maturity the percent crude protein content was very high. Therefore, the highest percent crude protein for all varieties was obtained on the first harvest date, May 16. Most varieties had the lowest crude protein content on the last harvest date, June 13, except Chilocco oat which was lowest on the fourth harvest date, June 6 (Table 4).

A highly significant difference in percent crude protein content was found among varieties. Walken oat consistently had a greater percent crude protein content at each harvest date. This high percent crude protein content could be a reflection of the slow maturity of Walken oat and its low yield throughout the season.

Within the oats Walken was consistently higher in percent crude protein than the other oat varieties.

The triticale varieties generally had a lower percent crude protein content than the oats. Within the triticales there were no significant varietal differences in crude protein on May 30 and June 6. On June 13, the last harvest date, Graze Grain 70 triticale was significantly higher in crude protein content than T 204 and T 208 triticale varieties.

No significant variety X harvest date interaction was observed for percent crude protein content.

Table 4. Mean percent crude protein of oat and triticale varieties at different harvest dates.

Variety	Date of Harvesting and Stage of Maturity[1]									
	May 16	Stage	May 22	Stage	May 30	Stage	June 6	Stage	June 13	Stage
Triticale										
T 208	20.3	B	18.0	EH	14.4	EH	12.8	FH	9.1	FH
Graze Grain 70	23.2	B	18.6	EH	14.3	EH	12.8	FH	11.8	FH
T 209	19.5	LB	16.8	EH	14.9	EH	11.9	FH	10.9	FH
T 204	20.6	LB	16.4	EH	14.0	EH	11.6	FH	9.1	FH
CL 72	21.8	B	19.4	LB	15.6	EH	13.0	FH	10.1	FH
Rosner	22.7	LB	18.4	EH	14.4	EH	12.5	FH	10.0	FH
T 418	22.3	LB	17.8	EH	13.8	EH	11.6	FH	10.4	FH
Oats										
Cimarron	23.5	LB	19.8	EH	16.1	FH	13.8	FH	13.3	FH
Chilocco	22.4	LB	20.2	EH	16.5	EH	12.9	FH	13.5	FH
Walken	25.7	PB	23.9	B	19.6	LB	16.8	EH	16.4	FH
Means	22.2		18.9		15.3		13.0		11.5	
LSD (P = 0.05)	3.2		2.3		1.9		2.0		1.7	

LSD (P = 0.05) for seasonal crude protein = 0.67%

[1]Stages of maturity are: PB = Preboot succulent, B = Boot succulent, LB = Late boot succulent, EH = Early heading succulent, FH = Full heading succulent.

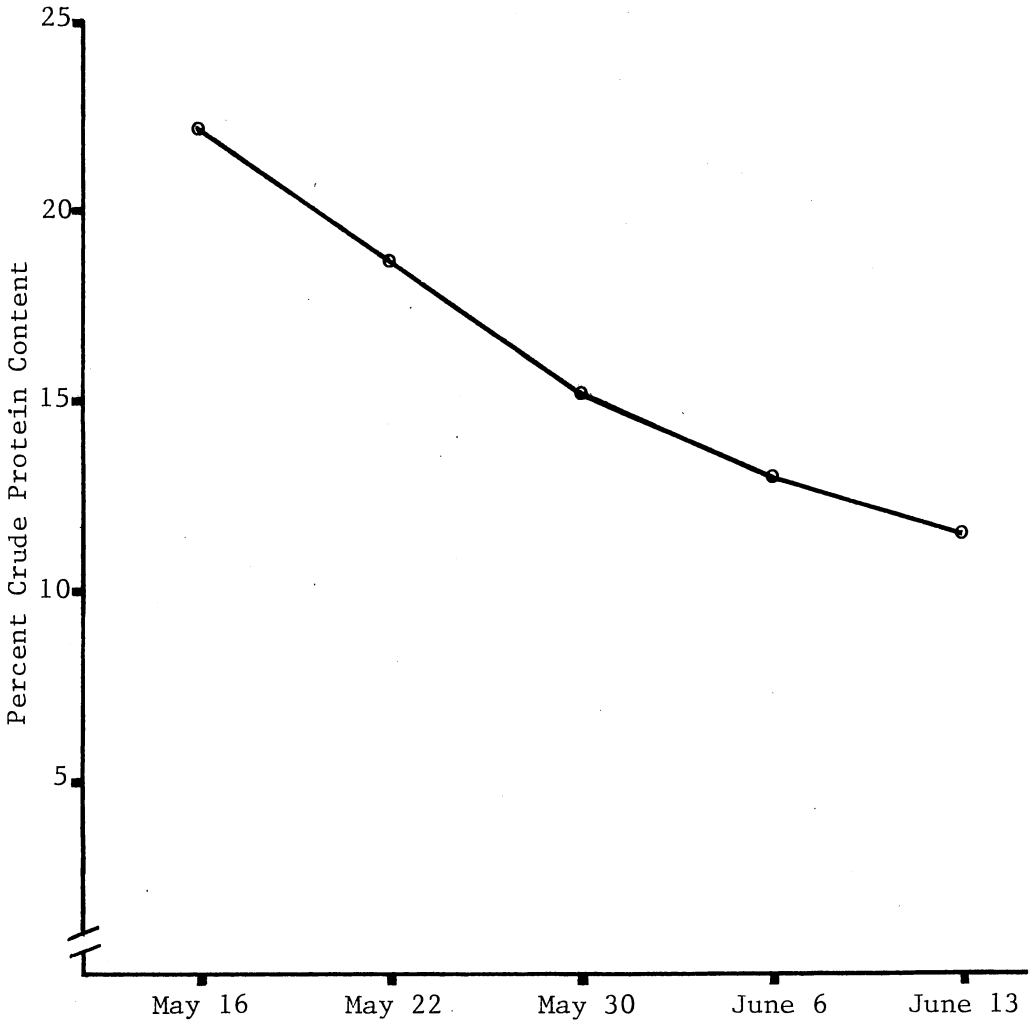

Figure 2. Percent Crude Protein (Means of 10 Entries) at Five Different Harvest Dates

Total N in the Forage

The mean total N in the forage at different stages of maturity for each harvest date are presented in Table 5. The total N in oats and triticales significantly increased after May 16, but the plants had accumulated most of their total N content by May 30 and June 6 (Figure 3). When examined on the basis of physiological stage of maturity, the early heading stage represented the point at which most varieties had accumulated much of their total N. This seems to indicate that much of the N which goes into the developing seed is translocated from the vegetative portion of the plant. The maximum mean N content of all varieties occurred on June 6.

Total N in the forage was significantly affected by harvest date, variety, and the date by variety interaction which indicated that some varieties reached a peak N yield before the last harvest, June 13, while others peaked before June 13 and then had a lower total N on June 13.

In Vitro Dry Matter Digestibility

The mean IVDMD percentages at different stages of maturity for each harvest date are shown in Table 6. The IVDMD percentages were significantly reduced due to the advance in stage of maturity of the plants at harvest time (Figure 4). The best IVDMD percentages were obtained from all varieties on May 16, the first harvest date. On June 13, when oats and triticale approached maturity the lowest IVDMD percentages were observed.

Table 5. Mean total N (lb/acre) in the forage of each variety at different harvest dates.

Variety	Date of Harvesting and Stage of Maturity[1]									
	May 16	Stage	May 22	Stage	May 30	Stage	June 6	Stage	June 13	Stage
Triticale										
T 208	90	B	101	EH	108	EH	120	FH	105	FH
Graze Grain 70	81	B	103	EH	98	EH	108	FH	138	FH
T 209	97	LB	98	EH	107	EH	113	FH	120	FH
T 204	94	LB	86	EH	107	EH	109	FH	98	FH
CL 72	84	B	103	LB	111	EH	118	FH	107	FH
Rosner	97	LB	111	EH	99	EH	95	FH	104	FH
T 418	97	LB	99	EH	111	EH	117	FH	104	FH
Oats										
Cimarron	77	LB	93	EH	94	FH	110	FH	113	FH
Chilocco	70	LB	86	EH	109	EH	87	FH	108	FH
Walken	77	PB	99	B	120	LB	109	EH	97	FH
Means	86		98		106		109		109	

LSD (P = 0.05) harvest date within variety = 20 lb/acre

LSD (P = 0.05) variety within harvest date = 21 lb/acre

LSD (P = 0.05) seasonal N production = 6 lb/acre

[1]Stages of maturity are: PB = Preboot succulent, B = Boot succulent, LB = Late boot succulent, EH = Early heading succulent, FH = Full heading succulent.

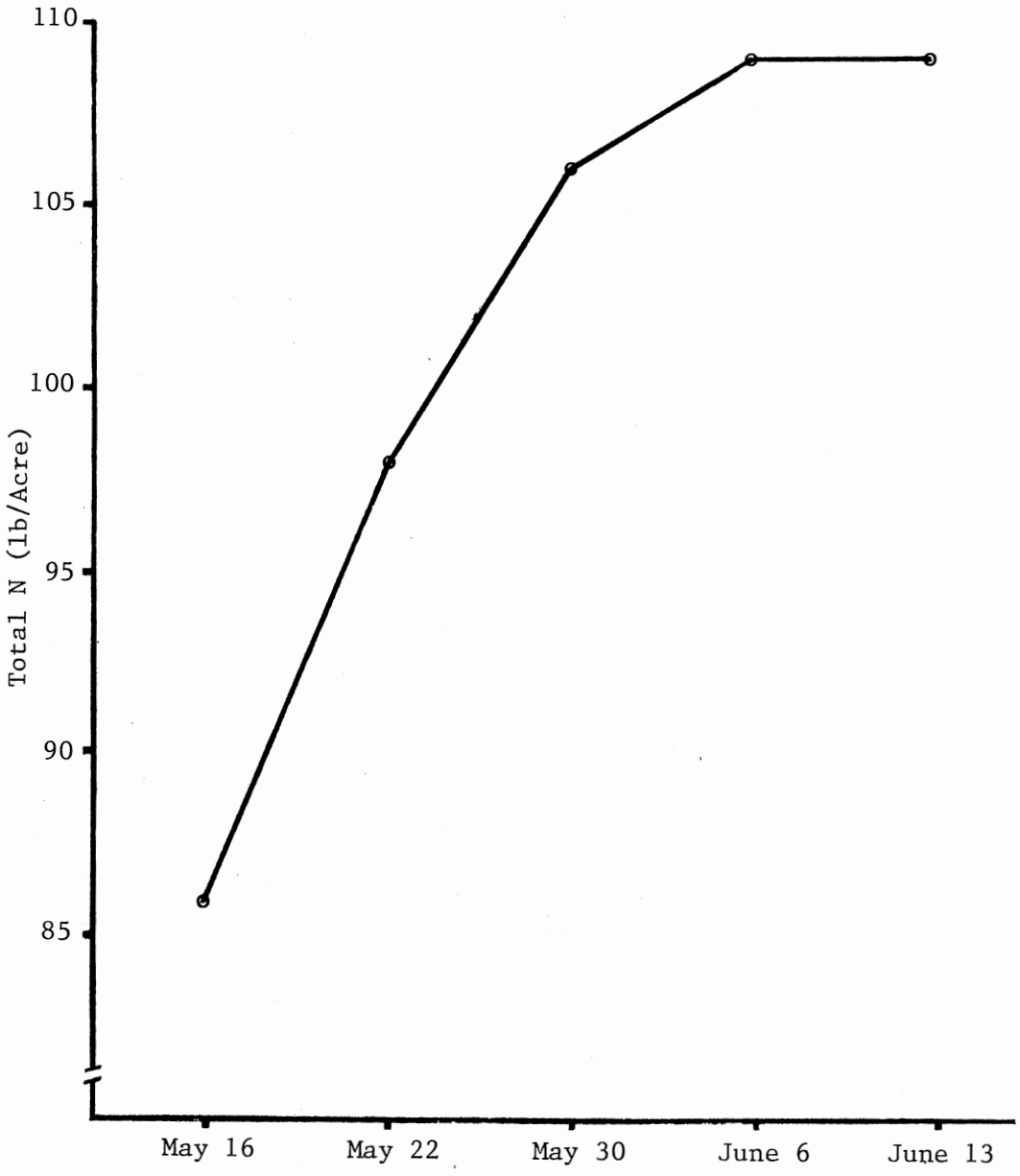

Figure 3. Total N in the Forage (Means of 10 Entries) at Five Different Harvest Dates

Table 6. Mean percent IVDMD of oat and triticale varieties of different harvest dates.

Variety	Date of Harvesting and Stage of Maturity[1]									
	May 16	Stage	May 22	Stage	May 30	Stage	June 6	Stage	June 13	Stage
Triticale										
T 208	72.24	B	68.46	EH	61.07	EH	65.15	FH	55.94	FH
Graze Grain 70	72.02	B	69.44	EH	63.74	EH	62.61	FH	55.71	FH
T 209	68.49	LB	68.87	EH	61.41	EH	64.92	FH	55.57	FH
T 204	69.24	LB	66.83	EH	59.95	EH	58.15	FH	56.19	FH
CL 72	72.14	B	69.14	LB	63.68	EH	60.29	FH	56.30	FH
Rosner	69.58	LB	66.25	EH	61.58	EH	60.11	FH	52.64	FH
T 418	70.58	LB	69.46	EH	61.37	EH	64.82	FH	53.44	FH
Oats										
Cimarron	75.39	LB	64.94	EH	60.96	FH	59.39	FH	53.41	FH
Chilocco	74.82	LB	66.30	EH	59.92	EH	57.02	FH	53.58	FH
Walken	75.68	PB	73.38	B	67.45	LB	65.14	EH	57.16	FH
Means	72.02		68.31		62.11		61.76		54.98	

LSD (P = 0.05) harvest date within variety = 2.19%

LSD (P = 0.05) variety within harvest date = 2.35%

LSD (P = 0.05) seasonal IVDMD = 0.69%

[1]Stages of maturity are: PB = Preboot succulent, B = Boot succulent, LB = Late boot succulent, EH = Early heading succulent, FH = Full heading succulent.

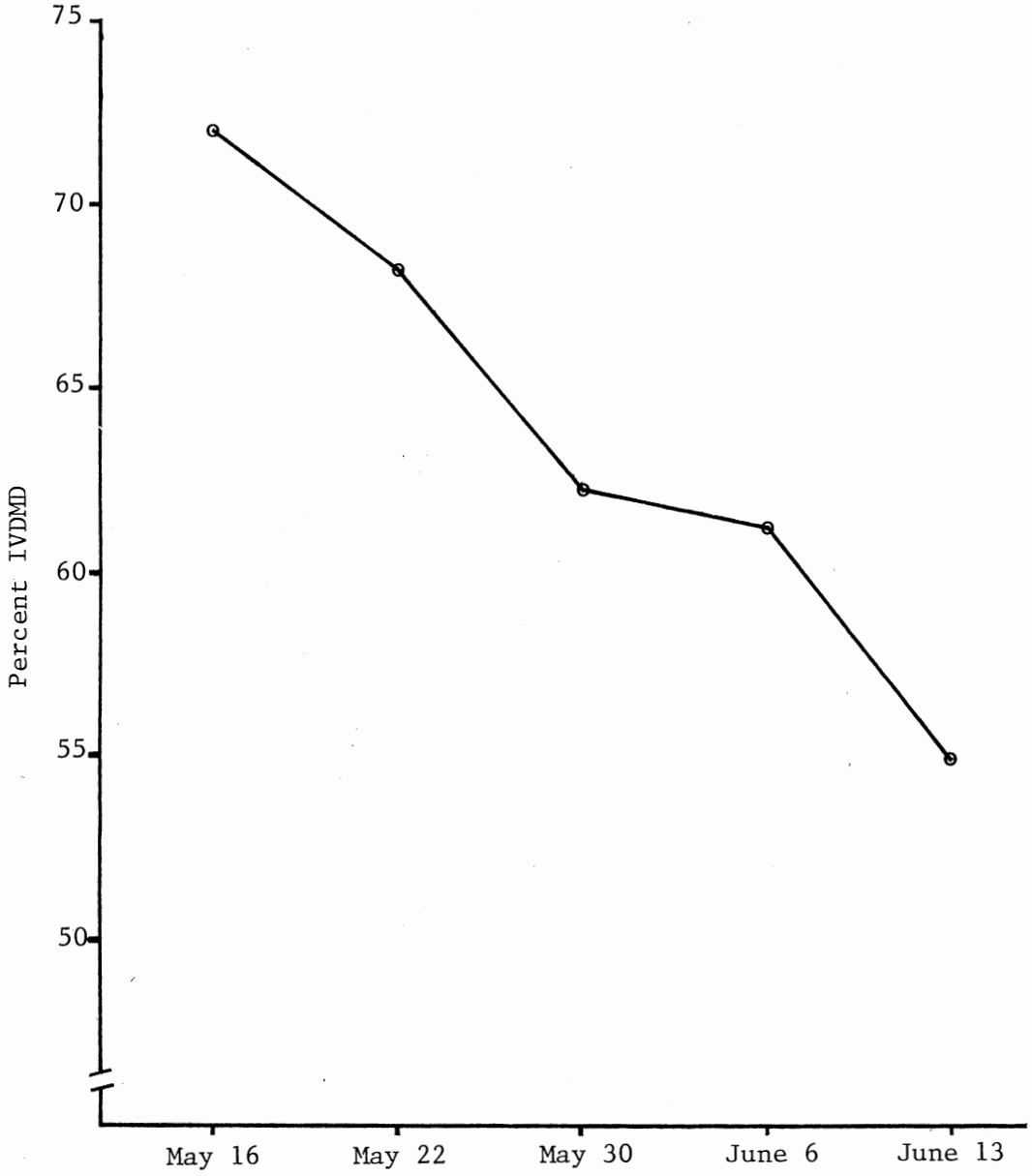

Figure 4. Percent IVDMD (Means of 10 Entries) at Five Different Harvest Dates

Between oat and triticale varieties there were significant varietal differences in IVDMD. On May 16, all oat varieties were greater in IVDMD than all triticale varieties. On May 22 and May 30, Walken oat was higher in IVDMD than the other oat and triticale varieties.

Among the oats, Walken had a greater IVDMD percentage than Cimarron and Chilocco on May 22, May 30, June 6, and June 13.

Within the triticales there were significant varietal differences in IVDMD. On May 16, T 208, Graze Grain 70, and CL 72 were significantly higher in IVDMD than T 209, T 204, and Rosner. T 204 and Rosner had lower IVDMD percentages than Graze Grain 70 and T 418 on May 22. On May 30, the third harvest date, Graze Grain 70 and CL 72 were greater in IVDMD than T 204. Also, on June 6, T 208, T 209, and T 418 had greater IVDMD percentages than T 204, CL 72, and Rosner. Furthermore, on June 13, the last harvest date Rosner was lowest in IVDMD of the triticale varieties.

A significant variety X harvest date interaction was also observed for IVDMD.

Generally, as the stage of maturity advanced the percent of IVDMD of forage crops decreased, however, on June 6, the IVDMD percentages of T 208, T 209, and T 418 were higher than for the third harvest date, May 30.

CHAPTER V

SUMMARY AND CONCLUSIONS

A field experiment to study the influence of stage of maturity on the forage production, percent crude protein content, total N in forage, and IVDMD of oat and triticale varieties was conducted in the 1975 (January-June) spring season at the Agronomy Research Station, Perkins, Oklahoma.

The different varieties tested had highly significant differences in date of emergence. Triticales emerged before all of those oats which produced a good stand. The last triticale to emerge was Rosner, and the Arl/Wtk//Cmr oat emerged on the same date. This oat failed to survive a late freeze. This would indicate that oats generally required a warmer temperature to germinate, or, were slower to germinate at these cool temperatures.

The forage yield of oats and triticale significantly increased with the advance in stage of maturity. Most of them produced the highest yield on June 13 except Walken and T 418 which produced most on June 6. Thus, a significant variety X harvest date interaction was observed for forage production. In all harvest dates the triticales produced significantly greater forage yield than oats. Walken oat was latest in maturity and produced the lowest yield at each harvest date as compared to the other varieties.

The percent crude protein content of all varieties was significantly reduced by later harvest dates. In the first harvest date, May 16 all of them contained the highest level of crude protein while the lowest level was obtained in the last harvest date, June 13. A highly significant crude protein difference was observed among varieties. Walken oat consistently had a greater percent crude protein content at each harvest date. Generally, oats had a higher percent crude protein content than triticale varieties. However, no significant variety X harvest date interaction was found for percent crude protein content.

The total N in the forage of most varieties significantly increased after May 16. Only Rosner triticale showed no significant increase. However, some entries produced the maximum total N prior to the last harvest date. Varieties, harvest date, and variety X harvest date interaction effects were significant.

A significant reduction in IVDMD was observed as the forage matured. A significant varietal difference between oats and triticale were observed on May 16, May 22, and May 30. There were significant varietal differences in IVDMD within the triticales for all harvest dates. Walken oat had significantly greater IVDMD among the oats for all harvest dates except on May 16.

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APPENDIXES

Table 7. Analysis of variance for date of emergence.

Source	df	MS	F Value
Total	63		
Reps	3	7.0573	1.1239
Varieties	15	335.1406	53.3705**
Error	45	6.2795	

CV = 4.70%

LSD (0.05) 4 observations = 4 days

**Denotes highly significant difference (P = 0.01)

Table 8. Analysis of variance for forage production harvested on May 16, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	735.0333	3.5963*
Varieties	9	1214.2667	5.9411**
Error	27	204.3852	

CV = 13.87% Data were (gm/2 x 2 ft plot)

LSD (0.05) 4 observations = 21 gm/plot

**Denotes highly significant difference (P = 0.01)
*Denotes significant difference (P = 0.05)

Table 9. Analysis of variance for forage production harvested on May 22, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	1287.5333	
Varieties	9	1131.1556	3.8682**
Error	27	292.4222	

CV = 12.46% Data were (gm/2 x 2 ft plot)

LSD (0.05) 4 observations = 25 gm/plot

**Denotes highly significant difference (P = 0.01)

Table 10. Analysis of variance for forage production harvested on May 30, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	694.0916	
Varieties	9	1217.0138	2.5539*
Error	27	476.5175	

CV = 11.95% Data were (gm/2 x 2 ft plot)

LSD (0.05) 4 observations = 32 gm/plot

*Denotes significant difference (P = 0.05)

Table 11. Analysis of variance for forage production harvested on June 6, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	276.4666	
Varieties	9	4266.9333	3.6624**
Error	27	1165.0592	

CV = 15.36% Data were (gm/2 x 2 ft plot)

LSD (0.05) 4 observations = 50 gm/plot

**Denotes highly significant difference (P = 0.01)

Table 12. Analysis of variance for forage production harvested on June 13, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	1463.6250	
Varieties	9	9153.3472	7.3509**
Error	27	1245.1990	

CV = 13.75% Data were (gm/2 x 2 ft plot)

LSD (0.05) 4 observations = 51 gm/plot

**Denotes highly significant difference (P = 0.01)

Table 13. Analysis of variance for a seasonal forage production.

Source	df	MS	F Value
Total	199		
Reps	3	2401.2133	3.1360*
Var	9	11510.8644	15.0334**
R x V	27	765.6837	
Date	4	154116.8575	240.6512**
V x D	36	1367.9631	2.1361**
Error	120	640.4158	

CV = 14.03% Data were (gm/2 x 2 ft plot)

LSD (0.05) seasonal forage production = 11.20 gm/plot

**Denotes highly significant difference (P = 0.01)
*Denotes significant difference (P = 0.05)

Table 14. Analysis of variance for percent N harvested on May 16, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	0.2178	1.7757
Varieties	9	0.3264	2.6607*
Error	27	0.1227	

CV = 9.87%

LSD (0.05) 4 observations = 0.51% N

**Denotes significant difference (P = 0.05)

Table 15. Analysis of variance for percent N harvested on May 22, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	0.4577	6.9231**
Varieties	9	0.4745	7.1776**
Error	27	0.0661	

CV = 8.50%

LSD (0.05) 4 observations = 0.37% N

**Denotes highly significant difference (P = 0.01)

Table 16. Analysis of variance for percent N harvested on May 30, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	0.0611	1.3791
Varieties	9	0.3040	6.8613**
Error	27	0.0443	

CV = 8.58%

LSD (0.05) 4 observations = 0.31% N

**Denotes highly significant difference (P = 0.01)

Table 17. Analysis of variance for percent N harvested on June 6, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	0.0132	0.2720
Varieties	9	0.2333	4.8206**
Error	27	0.0484	

CV = 10.60%

LSD (0.05) 4 observations = 0.32% N

**Denotes highly significant difference (P = 0.01)

Table 18. Analysis of variance for percent N harvested on June 13, 1975.

Source	df	MS	F Value
Total	39		
Reps	3	0.0420	1.1873
Varieties	9	0.5447	15.3849**
Error	27	0.0354	

CV = 10.26%

LSD (0.05) 4 observations = 0.27% N

**Denotes highly significant difference (P = 0.01)

Table 19. Analysis of variance for a seasonal percent N in the forage.

Source	df	MS	F Value
Total	199		
Reps	3	0.4535	5.0277**
Var	9	1.6387	18.1674**
R x V	27	0.0902	
Date	4	19.6710	331.1616**
V x D	36	0.0611	1.0286
Error	120	0.0594	

CV = 9.42%

LSD (0.05) variety within a date = 0.44% N

LSD (0.05) date means = 0.11% N

**Denotes highly significant difference (P = 0.01)

Table 20. Analysis of variance for total N (gm/plot) in the forage.

Source	df	MS	F Value
Total	199		
Reps	3	2.6743	5.4433**
Var	9	0.7752	1.5779
R x V	27	0.4913	
Date	4	6.6165	19.1008**
V x D	36	0.6298	1.8181**
Error	120	0.3464	

CV = 13.86%

LSD (0.05) harvest date within variety = 0.82 gm/plot

LSD (0.05) variety within harvest date = 0.87 gm/plot

LSD (0.05 seasonal N production = 0.26 gm/plot

**Denotes highly significant difference (P = 0.01)

Table 21. Analysis of variance for a seasonal IVDMD.

Source	df	MS	F Value
Total	199		
Reps	3	7.4288	1.8612
Var	9	59.2906	14.8549**
R x V	27	3.9913	
Date	4	1725.6842	704.8499**
V x D	36	15.1388	6.1834**
Error	120	2.4483	

CV = 2.45%

LSD (P = 0.05) harvest date within variety = 2.19%

LSD (P = 0.05) variety within harvest date = 2.35%

LSD (P = 0.05) seasonal IVDMD = 0.69%

**Denotes highly significant difference (P = 0.01)

VITA

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