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Yield and laboratory evaluations of five triticale cultivars, Arthur wheat and Balbo rye in East Tennessee

C. Wayne Smith

To the Graduate Council:

I am submitting herewith a dissertation written by C. Wayne Smith entitled "Yield and laboratory evaluations of five triticale cultivars, Arthur wheat and Balbo rye in East Tennessee." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Plant, Soil and Environmental Sciences.

Vernon H. Reich, Major Professor

We have read this dissertation and recommend its acceptance:

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(Original signatures are on file with official student records.)

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and recommend its acceptance:

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YIELD AND LABORATORY EVALUATIONS OF FIVE TRITICALE CULTIVARS, ARTHUR WHEAT AND BALBO RYE IN EAST TENNESSEE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee

C. Wayne Smith

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ABSTRACT

An experiment was conducted for two years on Decatur silt loam soil at Knoxville, Tennessee, to compare the yields of five triticale cultivars, Arthur wheat and Balbo rye. The study also compared clipping to two stubble heights and planting either early October or late October to early November. Several laboratory evaluations of forage and grain yields also were made.

The experimental design was a randomized complete block design, with forage evaluations analyzed as a split-split-plot arrangement and grain analyzed as a split-plot arrangement of treatments within each year. Regression analysis was used to determine the sums of squares for the analyses of variance since the statistical design was unbalanced due to winter kill.

Balbo rye yielded an average of almost 1000 kg/ha more forage than the next highest cultivar, Fas Gro 131 triticale, when harvested in the vegetative stage of growth for two years. Planting early and cutting to a stubble height of 5 cm resulted in significantly more oven-dry forage clipped in this stage of maturity. Percent fiber of most cultivars tested ranged from approximately 20 percent in early spring to about 32 percent by the last vegetative stage harvest. Balbo rye ranged from 26 to 40 percent over the vegetative stage harvests during the two years tested. Percent lignin ranged from about 2 percent to almost 5 percent, with Balbo rye again higher than most other cultivars. Percent crude

protein of the cultivars harvested in the vegetative stage ranged from approximately 23 percent in early spring to 15 percent by the last vegetative stage cuttings. Most cultivars were similar in percent crude protein.

Fas Gro 131 triticale averaged 8496 kg/ha over the two years tested compared to 4981 kg/ha for Balbo rye when cut in the late milk to early dough stage of maturity. Planting early and cutting to a stubble height of 5 cm resulted in the most oven-dry forage. Percent fiber of the cultivars ranged from 32 to 43 percent, while percent lignin ranged from 4 to 6.5 percent during the two years of this study. There was little variation among the cultivars with respect to percent crude protein or percent P, Mg and K. Arthur wheat and Balbo rye averaged 0.09 and 0.21 percent Ca, respectively, while all triticale cultivars were intermediate.

When harvested as grain, Fas Gro 131 triticale yielded as high as or higher than Arthur wheat and Balbo rye when planted early; however, Arthur and Balbo were much more stable with respect to date of planting. Percent crude protein ranged from 14 to 19 percent over the two years of this study. All cultivars were similar in percent P, Mg, K and Ca.

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CHAPTER I

INTRODUCTION

In 1971, an estimated total of 200,000 acres of Triticale were grown for harvest in several countries (67). Triticale is a man-made cereal species that is an attempt to combine the grain quality, productivity and disease resistance of wheat with the hardiness and vigor of rye. The name Triticale is derived by combining the generic names of wheat (Triticum) and rye (Secale).

Triticales have been developed that are octaploid (2n = 56) or hexaploid (2n = 42). Primary octaploid triticale results from crossing hexaploid wheat (Triticum aestivum L., group aestivum) with diploid rye (Secale cereale L.) and doubling the resulting chromosome number. Likewise, the primary hexaploid triticales are obtained by crossing tetraploid wheat (group durum) with diploid rye. The resulting fertile allopolyploids behave predominantly as amphidiploids.

In accordance with the terminology of Radford, Ahles and Bell (49), triticale is a cespitose annual with culms to 15 dm in length. The internode immediately below the spike is densely pubescent while nodes and lower internodes are glabrous. Leaf blades are 6-20 mm wide and up to 30 cm long with the upper surface and margins scaberulous and the lower surfaces glabrous. Ligules are scarious with margins erose to lacerate and 2-4 mm in length. Auricles, if present, may be up to 3 mm long. The spikes range from 9 to 15 cm in length, excluding awns. The spikelets

are alternate on opposite sides of the rachis with the wide side appressed to the rachis; spikelets are to 2.5 cm and 3-4 flowered with the terminal floret usually not developed. Disarticulation of the spikelets occurs by breakage of the rachis. The rachis is somewhat flattened with the edges hirsute. Glumes are nerved, acuminate to ovate, cuspidate, margins scarious, awn and keel scaberulous, and to 1.5 cm including the awn. The lemmas are awned with body up to 1.5 cm and awns to 10 cm in length. Margins of lemmas are scarious with awns and keel scabrous. Palea are awnless, margins scarious, veins may be scaberulous with length equaling the body length of the lemmas. The grain is 7-10 mm, yellowish, shrivelled, longitudinally grooved, ovate to oblong and the apex blunt with some pubescence.

Triticale grain has been heralded as the grain that will be the difference between plentiful food worldwide or mass starvation. It is proposed to be higher yielding than other grains, disease resistant and adapted to a wider range of environments than competing small grains (2).

Objectives of this study were:

1. To compare the forage yields of five triticale cultivars, Arthur wheat and Balbo rye under two clipping heights, two clipping regimes and two planting dates.
2. To compare the grain yields of three cultivars when planted in early October and late October to early November.
3. To compare the fiber and lignin content of the forage of these cultivars.

4. To compare the percent crude protein in forage and grain of these cultivars.
5. To compare the percent P, Mg, K and Ca of forage clipped in the late milk to early dough stage of maturity and in grain of the cultivars included in the study.

CHAPTER II

LITERATURE REVIEW

Historical

In 1875, Wilson presented to the Botanical Society of Edinburgh results of effecting a cross between wheat and rye. However, the F_1 hybrids were sterile and further generations were not obtained (27).

E. S. Carman, editor of the Rural New Yorker magazine from 1876 to 1899, published the first illustration of a wheat-rye hybrid in 1884. Carman recovered an open pollinated hybrid which produced a few grains and from which a wheat variety named Rural New Yorker No. 6 was selected and grown as late as 1916 (27).

The amphidiploid triticale was first discovered by Rimpau in 1888 and described by him in 1889. According to O'Mara (46), the original publication indicates that Rimpau did not discover a total amphidiploid individual, but a double sector on a single hybrid plant. From 15 seeds he obtained three plants which were undoubled backcross contaminations to wheat and 12 plants which were very uniform in appearance and very much like the hybrid from which they came. These 12 amphidiploids were probably the first new species to be observed in origin. The Rimpau triticale illustrated well the constancy found in all later allopolyploids, having been propagated by seed until 1953 with no detected deviation from its original behavior or variation in its original structure, intermediate between wheat and rye.

Several research workers (4,7,14,28,29,30,35,37,39,52) reported observing natural wheat-rye crosses and obtainning crosses between wheat and rye from 1915 to 1928.

In 1932, Muntzing (41) began an intensive octaploid triticale development program at Svalof, Sweden. From 1932 through 1946, he concentrated on the development of primary triticales and on studies of their properties. Muntzing recovered octaploid triticale types that outperformed their wheat parents on sandy soils, were winter hardy, were high in grain protein and of good baking quality. In the late 1940's, he began a program of crossing new primary rye-wheats produced by treatment of seedlings with colchicine with his best existing triticales. By 1960, he had increased the yields of his best octaploid triticales to within a few percentage points of winter wheat, and speculated that full equality with respect to yield could be obtained through further selection (40).

Sanchez-Monge (53) reported to the Ninth International Congress of Genetics in 1953 that he had obtained hybrids by crossing tetraploid wheats to inbred rye displaying a high amount of selfing. At the First International Wheat Genetics Symposium in 1958, he reported on his progress with hexaploid triticales. He stated that his hexaploid triticales involving T. durum Desf., T. dicoccum Schr. and T. dicoccoides Korn. in litt. in Schweinf. as seed parents, displayed a kind of intergenomic vegetative heterosis when grown in Spain, and that the major remaining obstacle was that of seed shrivelling. He proposed that hexaploid triticales may have their most use, agronomically, on marginal land as a replacement for rye (52).

Pissarev (47) reported on Russian progress in developing useful triticales at the Second International Wheat Genetics Symposium in 1963. He reported a triticale selection that was high in grain protein and that partially survived winter soil temperatures as low as -41°C. He also reported that his most fertile hexaploid lines were secondary triticales developed by crossing octaploid and hexaploid types and selecting for hexaploid types.

An intensive research program was intiated in 1954 at the University of Manitoba, Winnipeg, Canada, to study hexaploid triticales. In 1965, a major breakthrough occurred with the recovery of plants growing in a triticale population in their winter nursery at Sonora, Mexico, that were insensitive to daylength, earlier maturing and shorter in stature than the parental material. Recovery of these lines made it possible to test advanced lines of triticale comparatively with other standard cultivars of cereal crops (25).

In 1969, Larter et al. (26) released a hexaploid triticale, the first results of the Manitoba project. Rosner triticale (Triticale hexaploids Lart. proposed) was licensed in 1969 and became a new crop in Canada.

The Center for the Improvement of Maize and Wheat (CIMMYT) triticale program in Mexico is a direct result of the University of Manitoba's winter breeding nursery at Sonora, Mexico. A cooperative breeding program, under the initial direction of Borlaug, Quinones and Rodriguez, was established in 1964 between the University of Manitoba and CIMMYT. The objective of the CIMMYT triticale program was to develop types that

would yield as much or more grain than the best cultivars of wheat, oats and barley (66).

Agronomic

Muntzing (40) reported results of yield trials involving several strains of octaploid triticales. He found that his rye-wheat strains averaged approximately 14 percent less grain than standard wheat cultivars.

Larter et al. (25) reported to the Third International Wheat Genetics Symposium in 1968 that the expected yield potential of hexaploid triticales had not been obtained. However, they did report that the overall mean yield of their best hybrid was approximately the same as Canada's best bread wheat. They reported that the poor yield of most triticales could be attributable to sterility.

Zillinsky and Borlaug (66) reported that through 1968 the grain yields of triticale strains in Mexico were only slightly more than half the yield of the better wheat cultivars. However, with the recovery of Armadillo triticale in 1968, their best triticale lines outyielded the best wheat cultivar in three of seven locations by 1970. Increased fertility of the triticale strains with Armadillo in their ancestry was credited as the reason for the increased yields.

Rooney et al. (51) evaluated six triticales compared with spring wheat, barley and oats grown on the High Plains of Texas. They found that the triticales yielded significantly less grain than the other small grain cultivars, and were not significantly different from each other.

Briggle (7) reported that ten experimental spring type triticales were obtained from the Canadian program and grown by the Crops Research

Division and cooperating State Experiment Stations at five locations in 1967. These locations were Tifton, Georgia, Beltsville, Maryland, College Station, Texas, Mesa, Arizona and Aberdeen, Idaho. He reported that the performance was extremely poor due largely to the lack of adaptation to these locations. Considerable sterility was evident at Beltsville and at Aberdeen. Leaf rust and powdery mildew were very severe in some lines at Tifton, Georgia and College Station, Texas, and therefore no yield data were collected. None of the triticales produced as much grain as the better wheat cultivars in the Beltsville test or in the irrigated Aberdeen tests. Frost tolerance was no better than the more tolerant spring wheats at Beltsville.

When Rosner triticale was licensed in Canada in 1969, an increase in yield of 4 percent over Manitou wheat was reported. This was the mean yield obtained at 48 locations in Manitoba, Canada in 1968 (26).

Busch (8) conducted yield trials with spring seeded small grains in North Dakota from 1967 through 1970. He reported that the triticale strains included in his experiments yielded from 15 to 25 percent less than oats or barley.

Reich et al. (50) compared two triticale cultivars with wheat at three locations in Tennessee in 1971. The wheat standard outyielded the triticales at all three locations. That same year an experiment involving barley, oats, rye, wheat and triticale was conducted at three locations across the state. They found that, on the average, barley and wheat yielded more grain than the triticales, while rye and oats yielded less. Results of a forage comparison showed that triticale yielded

less oven-dry forage than wheat, rye, oats or barley when clipped in the boot stage of maturity.

According to information summarized by Andrews (1), triticale produced more grain than only one wheat cultivar at only one location in Arkansas when compared to four wheat cultivars at six locations in 1970-71. In Texas, the best triticale tested failed to produce as much grain as the best wheat in the tests during the period 1968 through 1970. He stated also that, according to information he had available, triticale compared favorably with other small grains in Texas grazing trials.

A Fas Gro triticale cultivar was included in the wheat performance test by Louisiana State University in 1969. The triticale outyielded 11 of 12 commercial wheats and was not significantly lower yielding than the highest yielding wheat (34).

Larter, Kaltsiks and McGinnis (24) found that date of seeding spring type Rosner triticale had more effect on yield than did seeding rate. In comparing Rosner triticale to a standard wheat cultivar, they studied four seeding dates (April-May) and eight seeding rates (25-200 kg/ha) and found that delayed seeding reduced triticale yield more than that of wheat. They reported also an optimum seeding rate of 100 kg/ha for triticale.

In comparing the stability of yield performance of Rosner triticale to aestivum and durum wheats, Kaltsiks (20) found that triticale was less stable than T. durum which was less stable than the three cultivars of aestivum wheat. The experiment included five locations over two years in Manitoba, Canada.

Watson et al. (64) reported in 1972 that triticales tested tended to produce higher yields in relation to wheat and other small grains when fall seeded on the High Plains of Texas. Spring triticales planted in the fall performed well but tended to winter kill. The most hardy triticales were those that had a prostrate fall growth habit. However, triticale cultivars included in grazing and clipping trials produced substantially less total forage from September to June than did winter wheat, barley, rye or oats.

Prato, Qualset and Gustafson (48) reported that triticales have only occasionally yielded as well as the better wheat cultivars in California. However, if yields were improved, they predicted that triticales could be used by the feed-grain industry.

Cowley et al. (11) found that in each of three years, from 1968 to 1971, triticales included in forage production experiments were consistently the lowest yielding in total forage production. However, they found that the triticales yielded comparably in the period September through December, but due to a lack of winter hardiness, failed to produce good winter or spring growth.

Busch and Wilkins (9) reported on the continuation of Busch's earlier work (8) in 1972. They reported that the performance of several triticales averaged yielding less grain than wheat, oats and barley in field trials over the period 1968 through 1970.

Sapra et al. (54) recently reported that short term data indicated that lack of day sensitivity, lack of winter hardiness and lodging were major problems in eight triticale cultivars tested in Alabama. They

reported also that high protein, palatable forage, large kernels and improved grain yield compared to rye were desirable features.

In Vitro Quality Analyses

Concern over population growth has stimulated interest in triticale development during the past few years. Triticales, both octaploid and hexaploid, have been evaluated for quality characteristics in the realm of both human consumption and as a feed grain and feed forage.

Muntzing (40) reported that the crude protein of his octaploid strains ranged in relative values from 100 to 122.6 compared to a wheat standard. The percent crude protein was higher in primary triticales and was found to be inversely related to grain shrivelling.

Unrau and Jenkins (62) compared 15 hexaploid and 2 octaploid triticales, 4 tetraploid wheats, 2 spring wheats, 2 durum wheats and 1 rye cultivar for bushel weights and crude protein as a percent of dry weight of grain. They found that the weight of a bushel of hexaploid triticale ranged between 48 and 53 pounds while that of octaploid triticale was around 57 pounds. All the wheat cultivars and the rye had acceptable bushel weights. The crude protein content of the hexaploid triticales ranged from 16.3 to 19.8 percent, while the two octaploids averaged about 18.5 percent crude protein. This compared to 15.0 to 18.3 for the wheats and 19.1 for the rye cultivars tested. They concluded that the high protein in triticales was a result of the rye genome.

Unrau and Jenkins (62) reported also flour yields of hexaploid triticales to be intermediate to rye and wheat as was that of the two

octaploids studied. Protein quality, with respect to baking potential, was low in the triticales evaluated.

Larter et al. (25) found that with hexaploid triticales, the percent protein averaged slightly higher than T. aestivum or T. vulgare Vill. They found the triticale flour was generally inferior to bread wheat flour since hexaploid triticale lacks the D genome which confers the high breadmaking quality to wheat. However, bread of acceptable quality could be produced from triticale flour. They also reported the testing of hexaploid triticale grain in breakfast foods, industrial distilling and brewing trials with favorable results. Lorenz (31) and Lorenz et al. (32,33) concluded that hexaploid triticales could be used for a variety of bread products.

Villegas et al. (63) determined protein content of 100 strains of triticale grown in 1969. Protein ranged from 12 to 21 percent while lysine content ranged from 3 percent of the protein percentage to 3.8 percent of protein. He reported also that the Protein Efficiency Ratio (PER), which is a measure of the efficiency with which the proteins increase body weight, of the triticales compared favorably with other cereals.

Knipfel (23) compared the PER's of triticale, wheat and rye. He found that the PER of the triticale was equal to that of rye and that the wheat PER was inferior to both. Examination of the amino acid concentration in the test diets and in the blood plasma of the test rats indicated that lysine was severely limiting in triticale and wheat and

less so in rye. Knipfel proposed that triticale would be suitable for human consumption.

Several others (5,9,21,22,33,47,51,60,63) have reached similar conclusions concerning the crude protein content and nutritive value of triticale. Bravo, Naranjo and Shimada (6), among others (5,22,23,63) have found lysine to be the first limiting amino acid followed by methionine in triticale.

Dinusson et al. (13) found Rosner triticale grain higher in percent protein than oats or barley. Barley grain was lower in phosphorus than oats or triticale, which were found to be the same.

Tingle and Dawley (61) studied the mineral composition of whole-plant cereal silage. They found that Rosner triticale was not significantly different in percent phosphorus than the oat, barley and spring wheat cultivars studied. All cultivars tested contained the minimum amount of phosphorus required in nonfinishing rations, while only one barley cultivar met the minimum requirement for high-energy finishing rations. All cultivars tested contained sufficient amounts of calcium and potassium for feed rations. The percent magnesium found in all cultivars was adequate for growing and finishing rations for steers and heifers. However, the triticale cultivar did not contain the minimum percent magnesium required for rations of lactating cows.

Cowley et al. (11) compared triticale forage to other small grain forage when fall seeded in Texas. They found that over a three-year period triticale forage was consistently in the higher range of forage protein content.

In Vivo Quality Analyses

Sell, Hodgson and Shebeski (55) conducted some of the first feed grain experiments involving triticale cultivars. In 1962, they reported that on a pound for pound basis, triticale was approximately equal to hard spring wheat in chick rations as judged by growth, efficiency of feed utilization and ration metabolizable energy.

Sell and Johnson (56) reported in 1969 that triticale was comparable to durum wheat for support of weight gain by young turkeys. They concluded that clean triticale, relatively free of ergot, was a satisfactory feedstuff for poultry and that it compared favorably with wheat in nutritional value.

However, Bixler, Schaible and Bandemler (5) found that chick starter diets consisting of corn or wheat were significantly better than triticale in a two-week weight gain study. The triticale diet was not better than a starter diet comprised of rye grain.

Experiments conducted in South Dakota by Guenthner and Carlson (17) indicated that triticale grain could not be used as the sole grain in laying hen rations. Not only did the triticale diets result in decreased egg production, but also resulted in a loss of body weight, as did one wheat diet, indicating amino acid imbalances in the diets. Cuca and Avila (12) reported similar results in 1973.

Stothers and Shebeski (59) tested hexaploid triticale in starter, grower and finisher rations with swine. Rations were formulated replacing barley as the sole grain of the ration with either 50 or 100 percent triticale. They found that the high protein content of triticale was

used satisfactorily by pigs started at an initial weight of 39 kg, but not by pigs placed on the 100 percent triticale ration at a weight of only 16 kg. With the smaller pigs, significantly lower average daily gains were recorded. Subsequent tests verified that triticale was equivalent to barley as an energy source when heavier pigs were used as test animals.

Serious palatability problems were encountered for two years when triticale was fed as a finishing ration, replacing barley when pigs reached a weight of 60 kg. However, a gradual introduction of the grain did permit triticale to be used as the sole grain during finishing (59).

Shimada, Martinze and Bravo (57) reported that the substitution of increasing levels of triticale for sorghum did affect performance of growing pigs. Supplementation with either lysine or methionine, or preferably both, resulted in better performance. They concluded that triticale could successfully replace sorghum and part of the soybean meal in diets of growing pigs.

Cornejo et al. (10) concluded that triticale had a higher energy content and could replace barley but not corn in swine finishing rations. Animals were hand fed at less than maximum voluntary intake so no palatability problems were encountered.

Harrold et al. (18) reported results which indicated that triticale was less acceptable than barley to growing and finishing swine. This unpalatability resulted in reduced feed consumption which resulted in less rapid growth. Similar conclusions were reported by Noland, Sharp and McGhee (44) at the University of Arkansas.

Wilson (65) found that pigs consumed more triticale per day than corn yet did not make as rapid gains as with corn. This resulted in an increased amount of feed per pound of gain with triticale as compared to all corn diets tested. Wilson concluded that triticale could make up approximately 25-30 percent of the grain mixture for growing and finishing swine in Ohio.

Ingalls, Derlin and McKirdy (19) found that complete calf rations containing 27.5 or 55 percent triticale resulted in a significant reduction in feed intake and weight gain compared to barley-urea or barley-soy rations. However, feed efficiency was similar for all rations tested. Ergot may have played a role in the results, but levels found in the triticale were considerably lower than standards used in grain trade.

McCloy et al. (36) obtained similar results when triticale rations were fed to steers. Feed utilization was significantly more efficient with triticale than the sorghum grain ration control.

Dinusson et al. (13) compared beef cattle rations and found that animals on triticale gained 17 percent less rapidly than cattle fed barley or oats and barley. They speculated that ergot contamination was the reason for the decreased performance rather than differences in grain quality.

Triticales have been developed that are superior to other small grains in certain environments. When these triticale cultivars are grown in various other environments, their performances, relative to standard small grain cultivars, are varied. In some instances, they yield as well as or better than control cultivars, but they often lack

adaptation to that specific environment and are therefore poorer yielding. From the standpoint of quality indicators, triticales appear to be competitive with other small grains.

CHAPTER III

MATERIALS AND METHODS

Field Evaluation

An experiment was conducted in two consecutive years at the University of Tennessee Small Grains Farm at Knoxville to compare several triticale cultivars with standard cultivars of wheat and rye. The cultivars were compared for forage yields when clipped to stubble heights of 5 and 10 cm throughout the spring in the vegetative stage of growth, when clipped to 5 and 10 cm stubble heights for hay or silage (hereafter referred to as hay) in the late milk to early dough (LM-ED) stage of maturity, and when harvested for grain.

Each cultivar was drill planted on October 8 and October 27, 1971, and on October 10 and November 6, 1972, on a Decatur silt loam soil. Cultivars and seeding rates are shown in Table 1. All plots received a 448 kg/ha rate of 6-12-12 fertilizer applied broadcast prior to planting and 37 kg/ha N applied broadcast in early March of each year.

Three main plots of each cultivar were planted in a randomized complete block design (RCB) with four replications. Plots were six meters in length with five rows, 18 cm apart. One main plot of each cultivar was used to compare grain yields while the remaining plots of each cultivar were split and harvested as vegetative stage forage clipped to stubble heights of 5 and 10 cm and as hay clipped to the same stubble heights. Forage was harvested with a rotary mower equipped with a catch

Table 1. Seeding Rates of Cultivars Evaluated at Knoxville, 1971-73

Cultivar	Seeding Rate kg/ha
Fas Gro 204 triticale	78
Fas Gro 131 triticale	78
Fas Gro 385 triticale	78
Graz Grain 70A triticale	78
Dot Pathfinder triticale	78
Balbo rye	125
Arthur wheat	134

basket and stubble heights were obtained by adjustment of mower blade height. Forage samples were dried in forced-air ovens at 70°C, with all comparisons made on the basis of oven-dry weight. There was a deviation of this harvest method in the second year of the experiment when the hay forage was clipped by use of electric shears to the correct stubble height.

Grain yields were determined by harvesting the entire plot with a plot combine. The grain was threshed only once, mechanically cleaned using an Allan Seed Cleaner, Model AB6C-1, and comparisons made on the basis of cleaned seed weights at field moisture. Grain yields were analyzed as a split-plot arrangement of treatments in a RCB design in each year. Planting dates comprised the main treatments, while cultivars made up the split treatments.

Vegetative stage forage yields were determined by harvesting the center three rows of each forage split-plot. Border rows were mowed at the time of harvest to the approximate stubble height of the harvested areas. In the first year of the experiment, there was sufficient winter growth to justify, and weather permitted, an early spring harvest of forage. This harvest was taken from the three center rows of each main forage plot. All subsequent vegetative stage harvests, as well as hay yields, were taken from only three meters of the main plots. In the second year, there was not sufficient forage growth during the winter months to justify an early spring clipping. All forage plots in 1972-73 were three rows, three meters long. Harvest dates within each year are shown in Table 2.

Table 2. Harvest Dates for Vegetative Stage Forage During 1972 and 1973

Year	Early Spring	Mid Spring	Late Spring
1971-72	March 16	April 20	May 16
1972-73	---	April 2	May 7

Vegetative stage forage and LM-ED stage forage yields were compared as a split-split-plot arrangement of treatments in a RCB design in each year. Planting dates made up the main treatments, while cultivars and stubble heights were the split treatments and the split-split treatments, respectively.

In the first year of the experiment, there was not enough seed of Fas Gro 385 triticale for the second planting. Because of this and the failure of some plots to survive the winters, the statistical design was unbalanced. The sums of squares for the analyses of variance were therefore obtained by fitting of least-squares constants. The statistical computations were performed on an IBM 360/65 computer at the University of Tennessee Computing Center, Knoxville, and followed standard methods described in statistical texts. A significance level of .05 was chosen for all comparisons unless otherwise stated in the results.

The experiment was not designed to compare individual harvest dates across both years. Hay yields and grain yields of each cultivar were compared within each year and across both years since all cultivars were harvested in a comparable state. Total forage yield, defined as the yearly yield of each cultivar when clipped in the vegetative stage of growth throughout the growing season, also was compared across years.

Laboratory Evaluation

All forage samples were dried in a forced-air oven immediately after harvest. Dried samples were ground through a 1 mm screen in a Wiley Mill, and stored in plastic bags. Laboratory determinations were made on grain without additional drying.

Percent acid detergent fiber and percent acid detergent lignin were determined for all forage samples according to the procedures outlined by Goering and Van Soest (16). Statistical analyses were the same as for forage yields, with the addition that the five triticale cultivars were

considered as representative of the triticale species in East Tennessee and that Balbo rye and Arthur wheat were representative of their respective species and comparisons also were made on this basis.

Percent ammonium nitrogen was determined by the phenol-hypochlorite colorimetric method on a Technicon Autoanalyzer for all forage and grain samples. Digestion of the forage and grain samples followed that outlined by Ashburn (3). Percent crude protein was then determined by multiplying the percent nitrogen in grain by 5.7 and the percent nitrogen in forage samples by 6.25 (23). Statistical analyses of the forage protein were the same as those for percent fiber, and analyses of grain protein were the same as outlined above for grain yields.

Phosphorus and magnesium percentages of the hay and grain were determined by colorimetric methods with the Autoanalyzer, while the percent potassium and percent calcium were determined by flame photometry on the Autoanalyzer. Digestion of the plant material followed a modification of the wet oxidation procedure of Gieseking, Snider and Getz (15). Percentages of these four minerals in the vegetative stage forage were not determined because the method of harvest resulted in some soil in the plant samples and it was decided that comparisons of hay and grain would be more suitable for detecting real differences in the cultivars tested. Statistical procedures followed those described above for percent crude protein.

CHAPTER IV

RESULTS AND DISCUSSION

Winter Survival

The daily maximum and minimum temperatures, obtained at 1.5 meters above sod at the Plant Science Farm in Knoxville, Tennessee, for December and January of 1971-72 and 1972-73 are shown in Table 3. In the 1971-72 season, reasonably good growing conditions were noted from the two planting dates until January 16, 1972. Extremely low winter temperatures were noted on that date, which resulted in severe winter kill of Fas Gro 204, Graz Grain 70A and Dot Pathfinder triticales planted October 8, 1971. Apparently more of the plants of Dot Pathfinder were in the early phase of the reproductive stages on January 16 when planted October 8 compared to October 27, as indicated by much better survival in the second planting. Fas Gro 204 and Graz Grain 70A triticales suffered severe winter kill in both plantings. All other cultivars tested survived the winter of 1971-72 well (Table 4).

Table 3 shows that freezing or below freezing temperatures were encountered for at least a 48-hour period between January 16 and 19 of 1973. Most cultivars in the November 6 planting were in the young seedling stage at this time and suffered severe winter kill, especially Fas Gro 204 and Graz Grain 70A triticales, as a result of heaving and not being adapted to abrupt, low winter temperatures. Cultivars planted

Table 3. Maximum and Minumum Daily Temperatures (°C) for December and January of 1971-72 and 1972-73

Day	1971-72				1972-73			
	December		January		December		January	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	08	-03	12	-03	05	01	20	-01
2	08	-05	09	-03	08	-03	13	02
3	07	-03	08	-02	16	-01	09	01
4	02	-02	08	-01	13	03	09	03
5	13	02	12	00	12	03	14	03
6	13	07	04	-06	19	11	07	01
7	16	09	04	-06	18	-01	04	-03
8	17	09	09	-07	08	-01	-02	-03
9	12	07	12	-05	14	03	01	-06
10	12	08	15	04	19	11	00	-10
11	23	04	19	09	17	03	01	-12
12	18	01	18	-02	08	03	03	-12
13	16	00	19	-02	14	06	-01	-14
14	18	04	21	01	12	07	03	-12
15	21	08	03	-08	11	07	07	-06
16	24	15	-03	-18	14	-07	08	-05
17	17	09	-06	-17	00	-12	12	-06
18	11	-07	06	-12	-01	-12	13	-04
19	09	-08	10	-10	09	-12	19	-02
20	09	-06	12	03	12	-03	14	-04
21	15	08	17	06	15	07	14	-01
22	17	02	18	07	12	07	16	05
23	12	03	03	08	10	07	16	06
24	09	01	01	09	12	08	12	-03
25	15	03	03	02	13	04	11	-05
26	21	03	08	-05	10	02	16	-05
27	26	12	12	-03	06	-02	08	01
28	22	12	12	01	04	-03	08	04
29	16	-02	12	02	15	01	09	-01
30	17	28	07	00	11	04	01	-10
31	19	-01	05	-08	19	06	05	-10

Table 4. Percent Winter Survival of Cultivars Planted October 8 and October 27, 1971 and October 10 and November 6, 1972

Planting Dates	Cultivar	Percent Survival[+] 1971-72	1972-73
Oct. 8 - Oct. 10	Fas Gro 204 triticale	12 e[++]	83 bcd
	Fas Gro 131 triticale	100 a	100 a
	Fas Gro 385 triticale	100 a	100 a
	Graz Grain 70A triticale	4 f	70 f
	Dot Pathfinder triticale	35 d	100 a
	Balbo rye	100 a	100 a
	Arthur wheat	100 a	95 ab
Oct. 27 - Nov. 6	Fas Gro 204 triticale	6 ef	50 g
	Fas Gro 131 triticale	99 b	88 bcd
	Fas Gro 385 triticale[+++]	---	71 e
	Graz Grain 70A triticale	10 ef	22 g
	Dot Pathfinder triticale	85 c	76 de
	Balbo rye	98 b	80 cde
	Arthur wheat	96 b	92 abc

[+]Average of four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

[+++]Fas Gro 385 triticale deleted from second planting in 1972 due to insufficient seed.

early survived the winter well, except for Graz Grain 70A, of which approximately a third of the plants winter killed (Table 4).

The two winters during this experiment were so different that a combined analysis did not appear appropriate. However, as a general observation, from the standpoint of winter survival, the earlier planting dates appear to be desirable. Fas Gro 204 and Graz Grain 70A triticales do not seem to be hardy enough for the winters in Knoxville, while Dot Pathfinder would, at best, have to be considered a risk in this environment.

Plant Height

Plant height was taken on all cultivars harvested for grain in 1973. Table 5 shows that Balbo rye was significantly taller than all other cultivars tested. Arthur wheat was significantly the shortest cultivar tested, with all triticales intermediate in height.

Planting date and the planting date x cultivar interaction variance components were significant. These significant F ratios appear to be the result of Fas Gro 131 and Fas Gro 385 triticales being taller when planted at the earlier date. All other cultivars were not significantly different in plant height when planted either date. There is no apparent explanation for this occurrence, and since plant heights were recorded in only one year of the experiment, there is no way of knowing if this is characteristic of these cultivars. It appears, since all other cultivars were not different, that this is genetically controlled and not totally environmental.

Table 5. Agronomic Characteristics of Cultivars Evaluated at Knoxville, Tennessee

Cultivar	Character[+]			
	Plant Ht.	Wt/100 Seed	Test Wt.	Percent Sterility
	cm	gm	kg/hl	
Fas Gro 204 triticale	124 c[++]	2.94 e	6.83 ef	15.68 ab
Fas Gro 131 triticale	157 b	4.31 a	6.97 e	15.79 ab
Fas Gro 385 triticale	138 b	3.32 c	7.12 d	20.08 a
Graz Grain 70A triticale	109 d	3.15 cd	6.75 f	19.32 a
Dot Pathfinder triticale	137 b	3.41 b	7.31 c	15.82 ab
Balbo rye	175 a	2.30 f	7.84 b	13.68 b
Arthur wheat	91 e	3.06 de	8.82 a	6.93 c

[+]Plant heights, weights per 100 seeds and test weights are the average of two planting dates and four replications. Sterility percentages are the average of two years, two planting dates, three spikes and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

One Hundred Seed Weight and Weight per Hectoliter

Balbo rye was significantly lower in weight per 100 seeds than all other cultivars tested in 1973. All triticale cultivars were either significantly higher or not significantly different from Arthur wheat (Table 5).

The shrivelling encountered in triticale grain causes an increase in the amount of air space in a given volume and therefore decreases the test weight. Arthur wheat and Balbo rye were higher in hectoliter weights than all triticale cultivars (Table 5). In 1973, Arthur wheat and Balbo rye test weights were below the highest grade test weights set by the U. S. Department of Agriculture (44). No official test weight standards have been set for triticale.

Percent Sterility

Percent sterile florets was determined for three randomly selected spikes of each cultivar in each planting date for two years. The percent sterility was significantly lower in 1971-72 than in 1972-73. This trend held for each cultivar tested. When years were combined, date of planting had no effect on percent sterility. Table 5 shows that all triticales were not significantly different from each other in percent sterility. Balbo rye was not lower in sterility percentage than three triticale cultivars, while Arthur wheat was significantly lower than any other cultivar tested. These data show that sterility continues to be a problem in triticale cultivars.

Forage Harvested in the Vegetative Stage During 1972

When harvested March 16, 1972, the average yield of the cultivars planted October 8, 1971, was significantly higher than when these cultivars were planted on October 27, 1971. There was not a significant difference between the average yields of the cultivars planted these two dates when harvested for the second time in this year; however, by the third harvest, the average yield of the cultivars planted on the later date was significantly higher than when planted October 8. Apparently, the older plants were more susceptible than the younger plants to damage by loss of the apical meristem as the harvest season progressed (Table 6).

The 5 cm stubble height treatment resulted in more oven-dry forage than the 10 cm treatment when the cultivars were harvested on March 16, 1971. When harvested on April 20, 1971, and with the exception of Fas Gro 204 and Graz Grain 70A triticales, each cultivar was higher yielding when cut to the 10 cm stubble height than when cut to the shorter stubble. Apparently, the plants cut to the shorter stubble on March 16 were at a competitive disadvantage due to the more complete removel of photosynthetic area. The 5 cm stubble treatment again resulted in more oven-dry forage at the third harvest in 1972, which indicates that the lower yields from the 5 cm stubble height treatment at the second harvest was not the result of meristem removal of plants cut to the lower stubble height on March 16, 1971 (Table 7).

Balbo rye yielded significantly more total forage cut in the vegetative stage of growth during the 1971-72 growing season than any other

Table 6. Yield of Oven-Dry Forage Harvested During 1972 When Planted October 8 or October 27, 1971

Planting Date	Cultivar	Yield[+] March 16	April 20	May 16	Total
		kg/ha			
October 8	Fas Gro 204 triticale	100 e[++]	317 f	178 cd	594 gh
	Fas Gro 131 triticale	1816 b	1803 a	550 b	4169 b
	Fas Gro 385 triticale	1196 c	1524 b	674 ab	3395 c
	Graz Grain 70A triticale	45 e	100 fg	46 d	192 h
	Dot Pathfinder triticale	148 e	362 ef	278 cd	787 g
	Balbo rye	3637 a	211 fg	898 a	4745 a
	Arthur wheat	1397 c	1301 bc	405 bc	3104 cd
October 27	Fas Gro 204 triticale	16 e	28 g	109 d	152 h
	Fas Gro 131 triticale	562 d	1326 bc	932 a	2820 d
	Fas Gro 385 triticale	---	---	---	---
	Graz Grain 70A triticale	28 e	30 g	184 cd	242 h
	Dot Pathfinder triticale	152 e	605 de	874 a	1631 f
	Balbo rye	1515 bc	795 d	664 ab	2975 cd
	Arthur wheat	150 e	1119 c	934 a	2204 e

[+]Average of four replications and two stubble heights.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 7. Yield of Oven-Dry Forage Harvested in the Vegetative Growth Stage to Two Stubble Heights During 1972

Cultivar[+]	Stubble Ht.	Yield[++]			
		March 16	April 20	May 16	Total
	cm	kg/ha			
Fas Gro 204 triticale	5	93 f[+++]	202 ef	199 de	494 f
	10	21 f	143 f	87 e	251 f
Fas Gro 131 triticale	5	1524 c	1459 ab	898 a	3883 ab
	10	853 d	1669 a	573 c	3106 c
Fas Gro 385 triticale	5	1449 c	1313 bc	916 ab	3678 b
	10	944 d	1736 a	431 cd	3111 c
Graz Grain 70A triticale	5	53 f	106 f	109 de	267 f
	10	20 f	25 f	121 de	166 f
Dot Pathfinder triticale	5	213 f	403 de	662 bc	1278 e
	10	86 f	562 d	491 c	1139 e
Balbo rye	5	2672 a	395 de	1027 a	4095 a
	10	2480 b	610 d	535 c	3627 b
Arthur wheat	5	941 d	1057 c	841 ab	2838 cd
	10	605 d	1363 b	500 c	2470 d

[+]Fas Gro 385 triticale included in the first planting date only. Therefore, its relative yield may be biased upward.

[++]Average of two planting dates and four replications.

[+++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

cultivar planted October 8, 1971. Fas Gro 131 triticale yielded significantly more than any other cultivar except Balbo rye, while Fas Gro 385 triticale and Arthur wheat yielded significantly less than Fas Gro 131 and not significantly different from each other. Graz Grain 70A triticale produced significantly less than any other cultivar in the first planting date, except Fas Gro 204 triticale (Table 6).

When planted the later planting date in 1971, Balbo rye again significantly outyielded all cultivars tested in that planting, except Fas Gro 131 triticale. Both Balbo and Fas Gro 131 yielded significantly more than Arthur wheat, which significantly outyielded Dot Pathfinder triticale. Graz Grain 70A and Fas Gro 204 triticales yielded significantly less than all other cultivars tested in the second planting date and harvested in the vegetative growth stage on three dates during 1972 (Table 6).

All cultivars tested yielded significantly more vegetative stage forage when planted October 8 than when planted October 27, 1971, except Graz Grain 70A and Fas Gro 204 triticales. These two cultivars were found to yield the same significant amount of forage when planted on either date (Table 6).

When planting dates were combined, Balbo rye yielded significantly more oven-dry forage during 1971-72 than any other cultivar tested. Fas Gro 131 triticale yielded significantly more than Arthur wheat, which significantly outyielded Dot Pathfinder triticale. Again, Fas Gro 204 and Graz Grain 70A triticales yielded significantly less than any other cultivar tested in both planting dates (Table 8).

Table 8. Yield of Oven-Dry Forage Harvested in the Vegetative Stage of Growth During 1972

Cultivar[+]	Yield[++]			
	March 16	April 20	May 16	Total
	kg/ha			
Fas Gro 204 triticale	57 d[+++]	172 d	143 c	373 e
Fas Gro 131 triticale	1189 b	1565 a	740 ab	3494 b
Graz Grain 70A triticale	37 d	65 d	115 c	217 e
Dot Pathfinder triticale	150 d	483 c	576 b	1210 d
Balbo rye	2576 a	503 c	782 a	3860 a
Arthur wheat	773 c	1211 b	670 ab	2654 c

[+]Fas Gro 385 deleted due to insufficient seed for the second planting date.

[++]Average of two planting dates, four replications and two stubble heights.

[+++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

The 5 cm stubble treatment resulted in significantly ($P < .01$) more vegetative stage forage clipped during 1972 than the 10 cm treatment. Planting date x stubble height was not significant, indicating that within each planting date the 5 cm stubble treatment produced more forage than the higher stubble treatment. Analysis of variance indicated that the cultivars tended to respond relatively the same to the stubble treatments throughout the harvest season. Table 7, page 31, shows that all cultivars tested yielded more actual forage when cut to the shorter stubble than when cut to 10 cm during the 1972 season. According to separation by Duncan's New Multiple-Range (DMR), Balbo rye and Fas Gro 131 triticale yielded significantly more when cut to 5 cm, while all other cultivars yielded significantly the same.

Forage Harvested in the Late Milk to Early Dough Maturity Stage in 1972

Date of planting had no significant effect on yield of forage harvested in the LM-ED stage of maturity in 1972. The interaction of planting date and cultivars was found to be significant ($P < .01$), indicating that each cultivar did not respond relatively the same to the effects of date of planting.

When planted October 8, 1971, Fas Gro 131 triticale yielded significantly more forage than any other cultivar tested in that planting date. Fas Gro 385 triticale yielded second to Fas Gro 131 and significantly more than the remaining cultivars. Arthur wheat yielded significantly more than Balbo rye, which yielded significantly more than Dot Pathfinder, Fas Gro 204 and Graz Grain 70A triticales (Table 9).

Table 9. Yield of Oven-Dry Hay Harvested in the Late Milk to Early Dough Stage of Maturity and Planted October 8 or October 27, 1971, and October 10 or November 6, 1972

Planting Date	Cultivar	Yield[+] 1972	Yield[+] 1973
		kg/ha	kg/ha
Oct. 8 - Oct. 10	Fas Gro 204 triticale	599 e[++]	5,513 e
	Fas Gro 131 triticale	7,556 a	11,696 a
	Fas Gro 385 triticale	5,384 b	10,157 b
	Graz Grain 70A triticale	64 e	2,871 f
	Dot Pathfinder triticale	960 e	9,462 bc
	Balbo rye	2,185 d	8,620 cd
	Arthur wheat	3,956 c	4,866 e
Oct. 27 - Nov. 6	Fas Gro 204 triticale	352 e	2,110 fg
	Fas Gro 131 triticale	6,917 a	7,815 d
	Fas Gro 385 triticale	---	3,389 f
	Graz Grain 70A triticale	458 e	1,326 g
	Dot Pathfinder triticale	3,797 c	4,884 e
	Balbo rye	3,922 c	5,195 e
	Arthur wheat	4,844 bc	2,831 f

[+]Average of four replications and two stubble heights. Fas Gro 385 triticale deleted from second planting date in 1971.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Fas Gro triticale again significantly outyielded all cultivars tested in the second planting when harvested in the LM-ED stage of maturity. Arthur wheat, Balbo rye and Dot Pathfinder triticale were found to be significantly higher yielding than Graz Grain 70A and Fas Gro 204 triticales, but not significantly different from each other (Table 9).

Balbo rye and Dot Pathfinder triticale were the only cultivars tested to show a significant difference in yield with respect to planting date. These two cultivars yielded significantly more hay when planted October 27 than when planted October 8, 1971. In the case of Dot Pathfinder, the difference in winter survival noted in Table 4, page 25, would explain this finding. However, with Balbo rye, there appears no apparent explanation (Table 9).

Fas Gro 131 triticale yielded significantly more hay than any other cultivar tested when planting dates were averaged. Arthur wheat yielded significantly more than any other cultivar except Fas Gro 131; while Balbo rye produced more, but not significantly more hay than Fas Gro 204 and Graz Grain 70A triticales, which were not significantly different from each other (Table 10).

In the 1971-72 season, there was a cutting of vegetative stage forage from the main plots before they were split to vegetative and LM-ED stage hay subplots. When cut in the LM-ED stage of maturity, significantly more forage was harvested from the 10 cm stubble treatment than the 5 cm stubble height treatment. The early depletion of photosynthetic area, down to a stubble of only 5 cm apparently inhibited regrowth such that the plants did not reach the vegetative growth attained

Table 10. Yield of Oven-Dry Hay Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar[+]	Yield[++]	
	1972	1973
	kg/ha	
Fas Gro 204 triticale	475 d[+++]	3811 c
Fas Gro 131 triticale	7236 a	9756 a
Fas Gro 385 triticale	---	6734 b
Graz Grain 70A triticale	261 d	2098 d
Dot Pathfinder triticale	2379 c	7170 b
Balbo rye	3053 c	6907 b
Arthur wheat	4400 b	3849 c

[+]Fas Gro 385 triticale deleted in second planting of 1971 due to insufficient seed.

[++]Average of two planting dates, four replications and two stubble heights.

[+++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

by the plants cut to only 10 cm in height. All cultivars, except Fas Gro 204 triticale, yielded more actual forage as LM-ED stage hay when cut to 10 cm than when cut to 5 cm. Arthur wheat was the only cultivar tested that yielded significantly more oven-dry hay when cut to the higher stubble height (Table 11).

Forage Harvested in the Vegetative Stage During 1973

When harvested for the first time in 1973, the average yield of the cultivars planted October 10, 1972, was significantly higher than the average yield of those cultivars planted November 6. The reverse was found when the cultivars were harvested for the second time in 1973, which substantiates the assumption that the older plants were generally the first plants damaged via removal of the apical meristem (Table 12). The same effect of stubble height treatments on yield was observed in this year as reported for 1972 (Table 13).

When the cultivars were planted on the earlier date in 1972, they averaged significantly more total vegetative forage than when they were planted later. Table 12 shows that when planted at the earlier planting date, Balbo rye yielded significantly more total forage during the growing season than any other cultivar. Fas Gro 131, Fas Gro 385 and Dot Pathfinder triticales yielded significantly more than any other cultivar, except Balbo rye. Arthur wheat and Fas Gro 204 triticale yielded significantly more than Graz Grain 70A triticale and were not significantly different from each other when planted October 10, 1972.

Table 11. Yield of Oven-Dry Hay Harvested in the Late Milk to Early Dough Stage of Maturity and Harvested to Two Stubble Heights in 1972 and 1973

Cultivar	Stubble Ht.	Yield[+]	
		1972	1973
	cm	kg/ha	
Fas Gro 204 triticale	5	533 g[++]	3689 d
	10	417 g	3944 d
Fas Gro 131 triticale	5	6929 a	9853 a
	10	7544 a	9679 a
Fas Gro 385 triticale	5	4928 bc	7571 b
	10	5840 b	5976 c
Graz Grain 70A triticale	5	249 g	2158 e
	10	273 g	2037 e
Dot Pathfinder triticale	5	2320 f	7034 bc
	10	2437 f	7307 bc
Balbo rye	5	2738 ef	7099 bc
	10	3370 de	6713 bc
Arthur wheat	5	3978 d	4128 d
	10	4823 c	3568 d

[+]Average of two planting dates and four replications. Fas Gro 385 triticale deleted from the second planting date in 1971.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 12. Yield of Oven-Dry Forage Harvested in the Vegetative Stage of Growth During 1973 and Planted October 10 or November 6, 1972

Planting Date	Cultivar	Yield[+] April 2	May 7	Total
		kg/ha		
October 10, 1972	Fas Gro 204 triticale	1567 c[++]	585 cd	2150 c
	Fas Gro 131 triticale	2467 b	665 c	3132 b
	Fas Gro 385 triticale	2279 b	754 bc	3033 b
	Graz Grain 70A triticale	716 d	292 e	1008 ef
	Dot Pathfinder triticale	2424 b	402 de	2826 b
	Balbo rye	4789 a	656 c	5445 a
	Arthur wheat	1640 c	627 cd	2268 c
November 6, 1972	Fas Gro 204 triticale	181 ef	754 bc	934 f
	Fas Gro 131 triticale	605 d	1207 a	1812 cd
	Fas Gro 385 triticale	171 ef	773 bc	744 f
	Graz Grain 70A triticale	40 f	235 e	276 g
	Dot Pathfinder triticale	504 de	983 ab	1488 de
	Balbo rye	1285 c	758 bc	2044 c
	Arthur wheat	556 d	815 bc	1372 def

[+]Average of four replications and two stubble heights.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 13. Yield of Oven-Dry Forage Harvested in the Vegetative Growth Stage to Two Stubble Heights During 1973

Cultivar	Stubble Ht.	Yield[+]		
		April 2	May 7	Total
	cm	kg/ha		
Fas Gro 204 triticale	5	1012 de[++]	690 b	1702 de
	10	737 e	646 b	1384 e
Fas Gro 131 triticale	5	1795 b	874 ab	2670 b
	10	1276 cd	998 a	2276 bc
Fas Gro 385 triticale	5	1378 c	829 ab	2206 bc
	10	1073 de	696 b	1768 de
Graz Grain 70A triticale	5	376 f	159 c	535 f
	10	379 f	367 c	746 f
Dot Pathfinder triticale	5	1599 bc	704 ab	2305 bc
	10	1328 cd	681 b	2009 cd
Balbo rye	5	3082 a	661 b	3743 a
	10	2990 a	755 ab	3746 a
Arthur wheat	5	1317 cd	711 ab	2027 cd
	10	880 e	732 ab	1613 de

[+]Average of two planting dates and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

In the second planting, Balbo rye was again higher yielding than any other cultivar tested, but not significantly higher than Fas Gro 131 triticale. Fas Gro 131 yielded more, but not significantly more total forage than Dot Pathfinder triticale and Arthur wheat. Graz Grain 70A triticale produced significantly less oven-dry forage during 1973 than any other cultivar planted on November 6, 1972 (Table 12).

When planting dates were combined, Balbo rye produced significantly more total forage in 1973 than any other cultivar tested. Fas Gro 131 triticale yielded the second highest amount of forage, but not significantly more than Dot Pathfinder triticale. Dot Pathfinder triticale was not significantly higher yielding than Fas Gro 385 or Arthur wheat. Graz Grain 70A triticale produced significantly less total forage during the 1972-73 growing season than any other cultivar tested (Table 14).

The cultivars tested yielded significantly more oven-dry forage during 1972-73 when clipped to a stubble height of 5 cm, than when cut to 10 cm. Each cultivar tended to respond relatively the same to the stubble height treatments as indicated by nonsignificance for that interaction. Table 13 shows that, according to separation by DMR, only Fas Gro 385 triticale yielded significantly more total forage when cut to the shorter stubble during 1973.

Forage Harvested in the Late Milk to Early Dough Maturity Stage in 1973

The earlier planting date tested in the second year of this experiment resulted in significantly more forage than the later planting date when cultivars were harvested in this stage of maturity in 1973. Each

Table 14. Yield of Oven-Dry Forage Harvested in the Vegetative Stage of Growth During 1973

Cultivar	Yield[+]		
	April 2	May 7	Total
	kg/ha		
Fas Gro 204 triticale	875 e[++]	669 b	1543 d
Fas Gro 131 triticale	1536 b	936 a	2472 b
Fas Gro 385 triticale	1225 cd	707 b	1938 c
Graz Grain 70A triticale	377 f	263 c	642 e
Dot Pathfinder triticale	1464 bc	693 b	2157 bc
Balbo rye	3037 a	708 b	3744 a
Arthur wheat	1098 de	721 b	1820 cd

[+]Average of two planting dates, four replications and two stubble heights.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

cultivar yielded significantly more oven-dry hay when planted October 10 than when planted November 6, 1972. During the 1972-73 winter, the plants in the late planting suffered considerable winter kill due to heaving which would account for the difference in the yields obtained in the two dates tested.

Table 9, page 35, shows that in the earlier planting Fas Gro 131 triticale yielded significantly more forage than any other cultivar tested. Fas Gro 385 triticale yielded more oven-dry forage than any other cultivar planted October 10, except Fas Gro 131, but not significantly more than Dot Pathfinder triticale, which was not significantly higher yielding than Balbo rye. Graz Grain 70A triticale was significantly lower yielding than all other cultivars planted October 10, 1972.

When planted November 6 and harvested in the LM-ED stage of maturity, Fas Gro 131 triticale was again significantly higher yielding than any other cultivar tested. Balbo rye and Dot Pathfinder triticale were not significantly different from each other and higher yielding than any other cultivar, except Fas Gro 131. Yield of Fas Gro 385 triticale, Arthur wheat and Fas Gro 204 triticale were not significantly different from each other at this harvest and significantly higher than Graz Grain 70A triticale (Table 9).

When planting dates were combined, Fas Gro 131 triticale produced significantly more forage than any other cultivar tested. Yields of Dot Pathfinder and Fas Gro 385 triticales and Balbo rye were not different and significantly higher than any other cultivar except Fas Gro 131. Graz Grain 70A triticale yielded the least amount of forage cut in the LM-ED maturity stage in 1973 (Table 10, page 37).

At thir harvest, there was not a significant difference between the two stubble heights tested. Planting date x stubble height and the stubble height x cultivar interactions were nonsignificant when cultivars were harvested in the late milk to early dough stage in 1973. All cultivars, except Fas Gro 204 and Dot Pathfinder triticales, yielded more forage when clipped to 5 cm than when cut to 10 cm. This could have been the result of human error, since these yields were obtained by use of shears, but was probably due to unequal split plot populations due to unequal winter kill. According to separation by Duncan's New Multiple Range test, there were no significant differences in the yields of any cultivar, with respect to stubble height treatments, except Fas Gro 385 triticale, which yielded significantly more forage when cut to the 5 cm stubble (Table 11, page 39).

Total Forage Harvested in the Vegetative Stage for Two Years

There was not a significant difference between the two years tested with respect to total vegetative stage forage yield of all cultivars tested. Analysis of variance indicated that the earlier planting date resulted in significantly more oven-dry forage than the late October and early November plantings. The early planting date in 1972 yielded significantly more forage than the early planting date in 1971; whereas, there was no difference between years of the later planting dates tested.

There was a significant interaction of year x cultivar, indicating that the cultivars did not yield relatively the same within each year.

Fas Gro 204, Graz Grain 70A and Dot Pathfinder triticales yielded significantly more forage in the second year of the experiment than in the first year, probably due to differences in winter survival. Fas Gro 131 and Arthur wheat yielded significantly more the first year, while Balbo rye was found to yield about the same in each year.

When years were combined, each cultivar tested yielded more actual vegetative stage forage when planted in early October than when planted the later dates. However, Graz Grain 70A and Dot Pathfinder triticale yielded the same significant amount of forage. When years and planting dates were combined, Balbo rye produced significantly more forage than any other cultivar, while Fas Gro 131 triticale yielded second to Balbo rye and produced significantly more than the remaining cultivars tested. This agrees with results obtained by several research workers in that triticale cultivars evaluated did not outyield all control small grain cultivars in total forage production (1,11,64). Fas Gro 385 triticale and Arthur wheat yielded significantly more oven-dry forage than Dot Pathfinder triticale, which significantly outyielded Fas Gro 204 and Graz Grain 70A triticales (Table 15).

The 5 cm stubble height treatment resulted in significantly ($P < .01$) more oven-dry forage harvested over the two years tested than the higher stubble treatment. The stubble height treatments resulted in the same trend within each year and within each of the planting times tested for two years, as indicated by nonsignificant interactions. The cultivar x stubble height interaction was nonsignificant, which indicates that when years and planting dates within years were averaged,

Table 15. Mean Yield of Oven-Dry Forage Harvested in the Vegetative Growth Stage During 1972 and 1973

Cultivar	Yield[+] kg/ha
Balbo rye	3802 a[++]
Fas Gro 131 triticale	2984 b
Fas Gro 385 triticale	2457 c
Arthur wheat	2237 c
Dot Pathfinder triticale	1683 d
Fas Gro 204 triticale	958 e
Graz Grain 70A triticale	429 f

[+]Average of two years, two planting dates, two stubble heights and four replications.

[++]Values followed by the same letter are not significantly different at the .05 level of probability.

each cultivar tended to yield more oven-dry forage when cut to the shorter stubble height.

Forage Harvested in the Late Milk to Early Dough Maturity Stage for Two Years

There was a significant ($P < .01$) difference in the yield of LM-ED stage hay between the two years tested. There was more hay produced in 1972-73 than in the first year of the experiment, probably as a result of differences in winter survival of some cultivars. When years were combined, analysis of variance indicated that the early planting dates resulted in significantly more oven-dry forage clipped at this stage of maturity, again attributable to the loss of more plots due to winter kill when planted at the later planting dates in 1972.

In the 1971-72 season, there was more actual hay harvested from plots planted the later planting date, whereas the opposite was true in the second year. In the first year, some cultivars in the first planting were affected more by low winter temperatures since the plants had made appreciable fall growth and severe kill back was noted. During the second year, cultivars in the second planting were most affected because low temperatures were encountered relatively early in the season and an appreciable amount of heaving was noted. In the second year of the experiment, there was almost twice as much hay cut from the first planting as was cut from the November 6 planting. This resulted in the earlier planting dates being significantly ($P < .01$) higher when years were combined.

Each cultivar tested yielded significantly more hay in the 1972-73 season compared to the first year of the experiment, except Arthur wheat. Arthur produced more actual forage in the first year, but not significantly more than in 1972-73. Each cultivar yielded more oven-dry hay when planted on the earlier dates, when years were combined. Fas Gro 204, Fas Gro 131 and Fas Gro 385 triticales yielded significantly more when planted early, while the other cultivars tested yielded the same significant amount of LM-ED stage forage regardless of planting date.

When years and planting dates within years were combined, Fas Gro 131 triticale was found to yield significantly more hay than any other cultivar tested. Fas Gro 385 triticale produced significantly more forage than any other cultivar except Fas Gro 131; however, since it was deleted from the second planting in 1971, its comparative yield may be biased upward. Balbo rye yielded more, but not significantly more, than Dot Pathfinder triticale; while both yielded significantly more than Arthur wheat, Fas Gro 204 and Graz Grain 70A triticales (Table 16).

Grain Yields

Analysis of variance indicated that there was not a significant difference between the average grain yields of the cultivars when planted either October 8 or October 27, 1971. When planted October 8, 1971, Fas Gro 131 triticale yielded significantly more grain than any other cultivar tested in that planting. Balbo rye, Fas Gro 385 triticale and Arthur wheat yielded significantly more than Dot Pathfinder, Fas Gro 204 and Graz Grain 70A triticales, and not significantly

Table 16. Mean Yield of Oven-Dry Forage Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar	Yield[+] kg/ha
Fas Gro 131 triticale	8496 a[++]
Fas Gro 385 triticale	6310 b
Balbo rye	4981 c
Dot Pathfinder triticale	4775 c
Arthur wheat	4125 d
Fas Gro 204 triticale	2143 e
Graz Grain 70A triticale	1184 f

[+]Average of two years, two plantings, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values followed by the same letter are not significantly different at the .05 level of probability.

different from each other. Graz Grain 70A yielded significantly less grain than any other cultivar in the first planting, except Fas Gro 204 triticale. When planted October 27, Arthur wheat, Balbo rye, Fas Gro 131 and Dot Pathfinder triticales all yielded significantly the same and significantly more than Fas Gro 204 and Graz Grain 70A triticales, which were not significantly different (Table 17).

Fas Gro 204 and Fas Gro 131 triticales and Balbo rye yielded more grain when planted October 8 than when planted October 27, 1971, but only Fas Gro 131 yielded significantly more. Dot Pathfinder and Graz Grain 70A triticales and Arthur wheat yielded more when planted the later planting date compared to October 8, with only Dot Pathfinder significantly higher yielding (Table 17).

When planting dates were combined, Fas Gro 131 triticale yielded more grain than any other cultivar tested, but not significantly more than Balbo rye and Arthur wheat. Dot Pathfinder triticale yielded significantly more grain than Fas Gro 204 and Graz Grain 70A triticales, which were not significantly different from each other (Table 18).

In the 1972-73 season, there was a significant ($P < .01$) difference in grain yield between the two planting dates tested, with the yield from the October 10 planting being greater than that from the November 6 planting date. When planted October 10, Fas Gro 131 triticale yielded significantly more grain than any other cultivar in that planting, except Fas Gro 385 triticale, Dot Pathfinder triticale and Balbo rye. Fas Gro 204 triticale and Arthur wheat were lower yielding, but not significantly lower yielding than Balbo rye. Graz Grain 70A triticale

Table 17. Grain Yield of Cultivars Planted on Two Dates in Each of Two Years

Planting Date	Cultivar	Yield[+] 1971-72	1972-73	Average
		kg/ha		
Oct. 8 - Oct. 10	Fas Gro 204 triticale	222 d[++]	1224 cde	724 fg
	Fas Gro 131 triticale	3415 a	2393 a	2904 a
	Fas Gro 385 triticale	2490 b	2246 ab	2368 b
	Graz Grain 70A triticale	37 d	472 ef	254 gh
	Dot Pathfinder triticale	930 c	2250 ab	1589 de
	Balbo rye	2642 b	1837 abc	2239 b
	Arthur wheat	2456 b	1254 cde	1856 bcd
Oct. 27 - Nov. 6	Fas Gro 204 triticale	144 d	797 def	470 gh
	Fas Gro 131 triticale	2493 b	1243 cde	1868 bcd
	Fas Gro 385 triticale	---	1152 cde	1152 ef
	Graz Grain 70A triticale	187 d	194 f	190 h
	Dot Pathfinder triticale	1969 b	1387 bcd	1679 cde
	Balbo rye	2531 b	1894 abc	2212 bc
	Arthur wheat	2573 b	1122 cde	1848 bcd

[+]Average of four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 18. Grain Yield of Cultivars Evaluated for Two Years

Cultivar	Yield[+] 1971-72	1972-73	Average
	kg/ha		
Fas Gro 204 triticale	183 c[++]	1010 c	596 d
Fas Gro 131 triticale	2955 a	1818 a	2386 a
Fas Gro 385 triticale	2490 a	1699 ab	1962 bc
Graz Grain 70A triticale	112 c	333 d	222 e
Dot Pathfinder triticale	1449 b	1819 a	1634 c
Balbo rye	2587 a	1865 a	2225 ab
Arthur wheat	2514 a	1121 bc	1852 c

[+]Average of two planting dates and four replications. Fas Gro 385 included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

yielded the lowest amount of grain of any cultivar planted October 10, 1972 (Table 17).

In the second planting, Balbo rye yielded the most grain, yet not significantly more than Dot Pathfinder, Fas Gro 131 and Fas Gro 385 triticales and Arthur wheat. Graz Grain 70A triticale again yielded the least grain when planted November 6, 1972. Each cultivar yielded less grain when planted November 6 than when planted the earlier date in 1972, with Fas Gro 131 and Fas Gro 385 triticales yielding significantly more according to separation by DMR (Table 17).

When planting dates were combined, Balbo rye was found to yield more grain than any other cultivar tested, yet not significantly more than Dot Pathfinder, Fas Gro 131, and Fas Gro 385 triticales. Graz Grain 70A triticale was the only cultivar to yield significantly less than Arthur wheat (Table 18). Yield of Arthur wheat was severely reduced due to bird damage in this year of the experiment.

Analysis of variance indicated that significantly more grain was produced during 1971-72 than in the second year tested, and that significantly more grain was harvested when cultivars were planted the earlier dates as compared to October 27 and November 6. The year x planting date interaction was not significant, indicating that the relative yields within planting dates tended to be the same within each year. The year x cultivar component of variance in the combined analysis was significant. Fas Gro 131 triticale, Fas Gro 385 triticale, Balbo rye and Arthur wheat yielded more in the first year of the experiment, while all other cultivars yielded less. The comparative yield of Fas Gro 385

triticale may be biased upward due to being included in only the first planting date in 1971.

When years were combined, Fas Gro 131 triticale yielded significantly more grain than any other cultivar tested in the early October plantings. Fas Gro 385 triticale yielded second to Fas Gro 131, but was not significantly higher yielding than Balbo rye and Arthur wheat. Dot Pathfinder triticale yielded significantly more than Fas Gro 204 and Graz Grain 70A triticales (Table 17).

When planted at the later planting dates and averaged for the two years tested, Balbo rye, Fas Gro 131 triticale and Arthur wheat yields were not significantly different from each other and significantly higher than the yields of the remaining cultivars. Again, Fas Gro 204 and Graz Grain 70A triticales yielded significantly less than any of the other cultivars tested (Table 17).

Fas Gro 131 triticale and Fas Gro 385 triticale yielded significantly more grain when planted the earlier dates compared to the October 27 and November 6 dates, when years were combined. All other cultivars were found to be similar in grain yields when planted either early October or late October to early November (Table 17).

In the overall analysis, Fas Gro 131 triticale yielded more grain, but not significantly more than Balbo rye. Fas Gro 385 triticale yielded significantly the same as Balbo rye, and was not significantly higher yielding than Arthur wheat and Dot Pathfinder triticale. Fas Gro 204 and Graz Grain 70A triticales were the lowest yielding cultivars tested (Table 18). Again, caution must be exercised in comparing the reported yield of Fas Gro 385 triticale.

Grain yields obtained in this study compare favorably with those obtained by several other research workers in that at least one triticale cultivar yielded as much as or more grain than one or more control small grain cultivars (26,34,50). Grain yields of Arthur wheat compared well with those obtained by Reich et al. (50) in East Tennessee in 1970, except that no bird damage was noted in that experiment.

Evaluation of Fiber and Lignin Percentages in 1972 Vegetative Stage Forage

Date of planting had no effect on percent fiber when forage was harvested in the vegetative growth stage on March 16, 1972. When planting dates were combined, there were no significant differences among the fiber percentages of the cultivars tested, according to the analysis of variance; however, according to DMR separation, Balbo rye was significantly higher in percent fiber than any other cultivar tested except Graz Grain 70A and Fas Gro 204 triticales. Fas Gro 204 was not different from the remaining cultivars (Table 19). Statistical procedures confirmed the appropriateness of the residual error variance estimate used to obtain the nonsignificant F value.

The 10 cm stubble height treatment resulted in a significantly lower percent fiber than the 5 cm stubble treatment. The planting date x stubble height and cultivar x stubble height interactions were nonsignificant at this harvest.

When the cultivars tested were combined to represent their respective species, analysis of variance indicated that the three species

Table 19. Percent Acid Detergent Fiber of Forage of Cultivars Harvested in 1972

Cultivar	Percent Fiber[+]			
	March 16	April 20	May 16	Hay
Fas Gro 204 triticale	23.39 ab[++]	21.65 a	31.63 a	34.29 a
Fas Gro 131 triticale	20.17 a	27.95 c	32.87 a	39.24 c
Fas Gro 385 triticale	19.82 a	26.43 bc	32.40 a	37.76 bc
Graz Grain 70A triticale	26.08 b	23.31 ab	32.55 a	32.69 a
Dot Pathfinder triticale	21.67 a	26.32 bc	32.83 a	35.10 ab
Balbo rye	26.13 b	26.36 bc	39.86 b	43.42 d
Arthur wheat	21.62 a	26.02 bc	32.21 a	32.70 a

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

tested were significantly different from one another. Wheat and triticale were found to be significantly lower in percent fiber than rye and not significantly different from each other (Table 20).

The lignin percentages of the cultivars tested were not significantly different when planted either October 8 or October 27, 1971, and harvested on March 16, 1972. When planting dates were combined, Fas Gro 131 triticale and Balbo rye were found to be the lowest in percent lignin, yet not significantly lower than any other cultivar, except Graz Grain 70A triticale (Table 21). When compared as species, there were no significant differences among the three species evaluated (Table 22).

The stubble height treatments were found to have no significant effect on the percent lignin of the cultivars tested. All interactions

Table 20. Percent Acid Detergent Fiber of Forage of Species Harvested in 1972

Species	Percent Fiber[+]			
	March 16	April 20	May 16	Hay
Triticale	22.05 a[++]	25.12 a	32.48 a	35.73 b
Rye	26.13 b	26.36 a	39.86 b	43.42 c
Wheat	21.62 a	26.02 a	32.21 a	32.70 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 21. Percent Acid Detergent Lignin of Forage of Cultivars Harvested in 1972

Cultivar	Percent Lignin[+]			
	March 16	April 20	May 16	Hay
Fas Gro 204 triticale	3.02 ab[++]	3.31 a	3.81 a	5.99 b
Fas Gro 131 triticale	2.55 a	3.15 a	3.75 a	5.99 b
Fas Gro 385 triticale	2.70 ab	3.24 a	3.82 a	5.63 ab
Graz Grain 70A triticale	3.40 b	3.10 a	3.80 a	4.04 a
Dot Pathfinder triticale	2.75 ab	3.56 a	3.47 a	5.36 ab
Balbo rye	2.58 a	2.78 a	4.97 b	6.52 b
Arthur wheat	2.72 ab	3.41 a	4.00 a	5.52 b

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 22. Percent Acid Detergent Lignin of Forage of Species Harvested in 1972

Species	Percent Lignin[+]			
	March 16	April 20	May 16	Hay
Triticale	2.84 a[++]	3.28 a	3.71 a	5.57 a
Rye	2.59 a	2.78 a	4.97 b	6.52 b
Wheat	2.72 a	3.41 a	4.00 a	5.52 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

involving stubble height treatments were also nonsignificant at this harvest.

When harvested April 20, 1972, the average percent fiber of the cultivars planted the first planting date was significantly higher than when the cultivars were planted October 27, 1971. However, the means of planting dates are separated by only 0.54 percentage points, and, therefore, planting either early or late October in the first year of this experiment had no real biological effect on the average percent fiber of the cultivars when harvested for the second time in 1972.

When planting dates were combined, Fas Gro 204 triticale was lower than any other cultivar harvested in the vegetative growth stage on April 20, but not significantly lower in percent fiber than Graz Grain 70A triticale. Fas Gro 131 triticale was the highest in fiber percentage, yet not significantly higher than Fas Gro 385 triticale,

Dot Pathfinder triticale, Balbo rye and Arthur wheat (Table 19, page 57). Evaluated on a species basis, there were no significant differences among the three species (Table 20, page 58).

There was not a significant difference between stubble height treatments when cultivars were harvested for the second time in 1972 and evaluated for percent fiber. All interactions involving stubble treatments were nonsignificant.

The two planting dates tested had no effect on the percent lignin of the cultivars harvested on April 20 of the first year. There were no significant differences in percent lignin among the cultivars or species tested at this harvest (Tables 21 and 22, respectively). The two stubble height treatments tested also had no effect on percent lignin.

Date of planting had no significant effect on the average fiber percentage of cultivars harvested for the third time in 1972. The cultivars tended to respond relatively the same to the planting dates tested, as indicated by nonsignificance of that interaction. When planting dates were combined, Fas Gro 204 triticale contained the lowest actual percent fiber at this harvest, but was not significantly lower than any other cultivar, except Balbo rye (Table 19, page 57).

There were no significant differences in the percent fiber of any of the cultivars with respect to the stubble height treatments. All interactions involving stubble heights were nonsignificant at this harvest.

When analyzed on a species basis, there was a significant difference in percent fiber of the three species tested. At this harvest, rye was significantly higher in percent fiber than triticale and wheat, which were not significantly different from one another (Table 20, page 58).

With respect to percent lignin, the difference between the two planting dates tested when the cultivars were harvested for the third time in 1972 was not significant. When planting dates were combined, DMR separation showed Balbo rye to be significantly higher in percent lignin than any of the other cultivars, which were not significantly different from each other (Table 21, page 59). Therefore, the rye species was significantly higher in percent lignin than triticale and wheat, which were not significantly different from each other (Table 22, page 60).

Cutting to a stubble of 10 cm resulted in a lower lignin percentage, but not significantly lower than the 5 cm stubble height treatment. All interactions involving stubble height treatments were nonsignificant.

Evaluation of Fiber and Lignin Percentages of Forage Harvested in the Late Milk to Early Dough Stage of Maturity in 1972

When harvested in the LM-ED maturity stage, the average percent fiber of the cultivars planted on October 8 was significantly lower than when the cultivars were planted October 27. However, as with the April 20 vegetative stage harvest, this appears to be statistical rather than biological, since the mean percent fiber from the October 8 planting was 36.36 percent compared to 36.58 percent for the October 27 planting.

There were significant differences in percent fiber among the cultivars tested when harvested in the LM-ED stage of maturity and planting dates combined. Graz Grain 70A triticale was the lowest in fiber percentage, but not significantly lower than Arthur wheat, Fas Gro 204 triticale and Dot Pathfinder triticale. Balbo rye was significantly higher in percent fiber than any other cultivar tested. Fas Gro 131 triticale was significantly higher than any other cultivar, except Balbo rye and Fas Gro 385 triticale (Table 19, page 57). As a species, wheat was significantly lower in percent fiber than triticale, which was significantly lower than rye (Table 20, page 58). The two stubble heights tested did not cause a significant difference in percent fiber of the cultivars when harvested in the LM-ED stage of maturity in 1972.

The differences between the two planting dates tested with respect to percent acid detergent lignin of the cultivars harvested in this stage of growth was not significant. When planting dates were combined, Graz Grain 70A triticale was lower in percent lignin than any other cultivar, but not significantly lower than Dot Pathfinder and Fas Gro 385 triticales. Balbo rye was higher in percent lignin than any other cultivar, but significantly higher than only Graz Grain 70A triticale (Table 21, page 59).

Stubble height treatments were not significantly different with respect to percent lignin of the cultivars harvested in the LM-ED stage. All interactions involving stubble treatments also were non-significant.

There was a significant difference in percent lignin of the three species evaluated. Wheat was lower in percent acid detergent lignin than the other two species, but not significantly lower than triticale (Table 22, page 60).

Evaluation of Fiber and Lignin Percentages in 1973 Vegetative Stage Forage

Analysis of variance indicated that date of planting had a significant effect on the percent fiber when cultivars were harvested for the first time in 1973. However, this difference again appears to be mathematical and not biologically important. The October 10 planting date resulted in an average of 27.91 percent fiber, while the November 6 planting date resulted in 29.53 percent. An increase of 6 percent of the fiber percentage probably should not be considered as an indication that planting November 6 would result in less acceptable forage than planting in early October.

There were no significant differences among the cultivars tested with respect to percent acid detergent fiber when planting dates were combined, at the first harvest in 1973. Fas Gro 131 triticale was lowest in actual percent fiber, while Balbo rye was highest (Table 23).

The 10 cm stubble height treatment resulted in a significantly ($P < .01$) lower percent fiber than the 5 cm treatment. The planting date x stubble height and the cultivar x stubble height interactions were nonsignificant indicating that the stubble height treatments

Table 23. Percent Acid Detergent Fiber of Forage of Cultivars Harvested in 1973

Cultivar	Percent Fiber[+]		
	April 2	May 7	Hay
Fas Gro 204 triticale	27.46 a[++]	33.06 ab	40.33 c
Fas Gro 131 triticale	27.06 a	30.60 a	36.94 b
Fas Gro 385 triticale	27.80 a	31.18 a	38.28 b
Graz Grain 70A triticale	29.16 a	30.22 a	38.22 b
Dot Pathfinder triticale	28.36 a	31.47 a	40.44 c
Balbo rye	30.80 a	35.13 b	40.29 c
Arthur wheat	29.15 a	31.27 a	32.19 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

resulted in the same relative effect within each planting date and that each cultivar responded similarly to stubble treatments.

When the cultivars were averaged to represent their respective species, there was a significant difference in the percent fiber of the three species tested when harvested April 2, 1973. Triticale was significantly lower in percent fiber than rye, while wheat was intermediate to these in numerical value (Table 24).

Statistical analysis indicated that date of planting in the second year of this experiment had no effect on percent acid detergent lignin of the forage at this harvest. When planting dates were combined, the cultivars tested were not significantly different from each other in percent acid detergent lignin. Fas Gro 204 triticale was lower in actual value, but not significantly lower than any other cultivar (Table 25).

Table 24. Percent Acid Detergent Fiber of Forage of Species Harvested in 1973

Species	Percent Fiber[+]		
	April 2	May 7	Hay
Triticale	27.86 a[++]	31.40 a	38.87 b
Rye	30.80 b	35.13 b	40.29 b
Wheat	29.15 ab	31.26 a	32.19 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 25. Percent Acid Detergent Lignin of Forage of Cultivars Harvested in 1973

Cultivar	Percent Lignin[+]		
	April 2	May 7	Hay
Fas Gro 204 triticale	2.06 a[++]	2.98 a	5.57 d
Fas Gro 131 triticale	2.62 a	3.00 a	4.63 b
Fas Gro 385 triticale	2.49 a	3.17 a	5.24 cd
Graz Grain 70A triticale	3.02 a	2.76 a	4.96 bc
Dot Pathfinder triticale	2.33 a	3.16 a	5.30 cd
Balbo rye	2.98 a	3.74 a	5.55 d
Arthur wheat	2.56 a	3.07 a	3.84 a

[+] Average of two planting dates, two stubble heights and four replications.

[++] Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Likewise, there was not a difference in the three species represented in this experiment when harvested on April 2, 1974 (Table 26).

At this harvest, analysis of variance indicated a significant difference in percent lignin due to the stubble height treatments. The 10 cm height resulted in a significantly lower percent lignin than the shorter stubble height treatment. All interactions involving stubble treatments were nonsignificant.

There was not a significant effect of date of planting on the percent fiber of forage harvested in the vegetative stage of growth on May 7, 1973. The planting date x cultivar interaction was significant at this harvest, indicating that cultivars did not respond relatively the same to the effect of planting date. Examination of the means of cultivars within planting dates, however, showed that each cultivar was higher in

Table 26. Percent Acid Detergent Lignin of Forage of Species Harvested in 1973

Species	Percent Lignin[+]		
	April 2	May 7	Hay
Triticale	2.48 a[++]	3.04 a	5.14 b
Rye	2.98 a	3.74 a	5.55 b
Wheat	2.56 a	3.07 a	3.84 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

actual percent fiber when planted November 6, 1972, but that only Balbo rye was significantly higher than when planted October 10, 1972.

When planting dates were combined, Graz Grain 70A triticale was lower in percent fiber than any other cultivar, but significantly lower than only Balbo rye (Table 23, page 65). At this harvest, the higher stubble height resulted in a significantly lower percent acid detergent fiber than when the cultivars were cut to 5 cm. All interactions involving stubble treatments were found to be nonsignificant.

As suggested in the cultivar discussion, there was a significant difference in the percent fiber of the three species tested when harvested for the second time in 1973. Triticale and wheat were not significantly different from each other but were significantly lower than rye (Table 24, page 66).

Planting October 10 or November 6, 1972, had no significant effect on the average percent lignin of cultivars harvested in the vegetative growth stage on May 7, 1973. There were no significant differences in the percent acid detergent lignin of the cultivars tested when planting dates were combined at this harvest. Graz Grain 70A triticale was lowest in actual value, while Balbo rye was highest (Table 25, page 67). Therefore, as species, there were no significant differences among the three species included in the experiment (Table 26).

Analysis of variance indicated that the higher stubble height treatment resulted in a significantly lower percentage of acid detergent lignin than the 5 cm treatment. Planting date x stubble height and cultivar x stubble height interactions were nonsignificant at this harvest.

Evaluation of Fiber and Lignin Percentages of Forage Harvested in the Late Milk to Early Dough Stage of Maturity in 1973

Analysis of variance indicated that the earlier planting date resulted in a significantly ($P < .01$) lower percent acid detergent fiber than when cultivars were planted November 6, 1972, and harvested in the LM-ED stage of maturity. However, the biological significance of the difference at this harvest is again questionable.

When planting dates were combined, Arthur wheat was significantly lower in percent fiber than any other cultivar tested. Dot Pathfinder and Fas Gro 204 triticales and Balbo rye were not significantly different from each other and significantly higher in percent fiber than any other cultivar (Table 23, page 65).

The stubble heights tested were not significantly different from each other when planting dates and cultivars were combined; however, the planting date x stubble height interaction was significant. Examination of the means revealed that the 10 cm stubble treatment resulted in a lower actual fiber percentage of cultivars when they were planted late as compared to cutting to the 5 cm height; whereas, the reverse was true for the earlier planting date. The cultivar x stubble height interaction was nonsignificant, indicating that each cultivar tended to respond relatively the same to the stubble height treatments when planting dates were combined.

When the triticale cultivars were averaged to represent the triticale species, it was found not to differ from rye with respect to percent fiber

when harvested in the LM-ED stage of maturity. Both of these species were significantly higher in fiber percentage than wheat (Table 24, page 66).

The two dates of planting tested had no effect on the average percent acid detergent lignin of cultivars were cut in this stage of maturity. When planting dates were combined, Arthur wheat was significantly lower in percent lignin than any other cultivar tested. Fas Gro 131 triticale was found to be lower than any other cultivar, except Arthur wheat, yet not significantly lower than Graz Grain 70A triticale. Fas Gro 204 triticale was higher in percent lignin, but not significantly higher than Balbo rye, Dot Pathfinder triticale and Fas Gro 385 triticale (Table 25, page 67).

Stubble height treatment had no effect on lignin percentages of cultivars harvested in the LM-ED stage of maturity. All interactions involving stubble heights were nonsignificant.

On a species basis, wheat was found to be significantly lower in percent lignin than either triticale or rye. Triticale and rye were not significantly different from each other (Table 26, page 68).

Evaluation of Fiber and Lignin Percentage of Forage Harvested for Two Years

Since fiber and lignin are structural components of plants, the physical size of the plants should be highly associated with these two indicators of quality, especially with reference to small grain vegetative stage forage. Since time of each harvest was a subjective decision

based on weather and the size of the plants, the April 20 and April 2 harvest dates, and May 16 and May 7 harvest dates in 1972 and 1973, respectively, were considered comparable across years with regard to percent fiber and lignin. Examination of the cultivar means in the April and May harvests substantiate the appropriateness of these comparisons.

There was a significant difference between the two years in overall percent fiber when cultivars were harvested in the vegetative growth stage in April. The average fiber percentage of the cultivars was significantly ($P < .01$) lower when harvested April 20 of the first year than when harvested April 2, 1973. When years were combined, date of planting had no effect on the average percent fiber of forage harvested in April of both years.

When years and planting dates were combined, Fas Gro 204 triticale was significantly lower in percent fiber than any other cultivar tested, except Graz Grain 70A triticale. Balbo rye was higher in percent fiber than any other cultivar, but significantly higher than only Fas Gro 204 and Graz Grain 70A triticales (Table 27).

The 10 cm stubble height treatment resulted in a significantly lower fiber percentage when cultivars were cut in April of both years and planting dates combined, than when harvested to a stubble height of 5 cm. The cultivar x stubble height interaction was not significant indicating that each cultivar tended to respond in this same relative manner to the two stubble heights.

When years and planting dates were combined, significant differences were observed in the percent fiber of the three species tested at the

Table 27. Percent Acid Detergent Fiber of Forage of Cultivars Harvested for Two Years

Cultivar	Percent Fiber[+]		
	April	May	Hay
Fas Gro 204 triticale	24.45 a[++]	32.40 a	37.31 c
Fas Gro 131 triticale	27.49 bc	31.73 a	38.13 c
Fas Gro 385 triticale	27.22 bc	31.61 a	38.11 c
Graz Grain 70A triticale	25.70 ab	31.44 a	35.74 b
Dot Pathfinder triticale	27.28 bc	32.17 a	37.77 c
Balbo rye	28.65 c	37.41 b	41.85 d
Arthur wheat	27.64 bc	31.75 a	32.44 a

[+]Average of two years, two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

April harvest. Triticale was lower in fiber percentage, yet not significantly lower than wheat. Rye was significantly higher in percent fiber than triticale, but not significantly different from wheat (Table 28).

The average percent lignin of the cultivars tested was significantly ($P < .01$) lower in the 1973 April cutting than when cut in April of 1972. When years were combined, date of planting, early October versus late October to early November, had no significant effect on the percent lignin of the cultivars evaluated.

When years and planting dates were combined, there were no significant differences in the percent lignin among the cultivars tested when harvested in April of both years. Fas Gro 204 triticale was numerically

Table 28. Percent Acid Detergent Fiber of Forage of Species Harvested for Two Years

Species	Percent Fiber[+]		
	April	May	Hay
Triticale	26.46 a[++]	31.91 a	37.40 b
Rye	28.65 b	37.42 b	41.85 c
Wheat	27.64 ab	31.75 a	32.44 a

[+]Average of two years, two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971.

[++]Values within a column are not significantly different at the .05 level of probability.

lowest in percent lignin, while Graz Grain 70A triticale was highest (Table 29). Likewise, the three species represented were not significantly different from each other (Table 30).

Analysis of variance indicated that the 10 cm stubble height treatment resulted in a significantly lower percent lignin than cutting to the shorter stubble when the cultivars were harvested in April of both years. All interactions involving stubble heights were nonsignificant.

There was a significant difference between the May harvests of the two years in the average percent fiber of the cultivars tested. However, the yearly means differ by only 1.65 percentage points, which represents only 5 percent of the smaller mean, and the significance of this difference may not be biologically important. This statistical significance occurred also for planting dates, in which the earlier dates averaged 32.44 percent fiber compared to 33.14 percent for the later dates. A difference between planting dates of this magnitude would not seriously affect the decision of which of the dates tested would provide better forage the following May.

There were significant differences among the cultivars tested in percent fiber when years and planting dates were combined. Balbo rye was significantly higher in fiber percentage than any other cultivar tested, with all other cultivars being not significantly different from one another (Table 27, page 73). This was true also when compared as species, with rye significantly higher in percent acid detergent fiber than wheat and triticale, which were not significantly different (Table 28, page 74).

Table 29. Percent Acid Detergent Lignin of Forage of Cultivars Harvested for Two Years

Cultivar	Percent Lignin[+]		
	April	May	Hay
Fas Gro 204 triticale	2.73 a[++]	3.38 a	5.78 b
Fas Gro 131 triticale	2.89 a	3.37 a	5.31 ab
Fas Gro 385 triticale	2.80 a	3.39 a	5.37 ab
Graz Grain 70A triticale	3.06 a	3.36 a	4.82 a
Dot Pathfinder triticale	2.99 a	3.31 a	5.33 ab
Balbo rye	2.89 a	4.33 b	6.04 b
Arthur wheat	2.98 a	3.55 a	4.68 a

[+]Average of two years, two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 30. Percent Acid Detergent Lignin of Forage of Species Harvested for Two Years

Species	Percent Lignin[+]		
	April	May	Hay
Triticale	2.90 a[++]	3.36 a	5.33 b
Rye	2.89 a	4.33 b	6.04 c
Wheat	2.98 a	3.55 a	4.68 a

[+]Average of two years, two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Analysis indicated that the higher stubble treatment resulted in a significantly lower percent fiber than the 5 cm height. The stubble height treatment means were different by only 1.58 percentage points, and the biological importance of this difference is again questionable. All interactions involving stubble heights were nonsignificant at this harvest.

When harvested in May of both years, analysis of variance indicated a significant difference between years with respect to the mean percent lignin of the cultivars included in the experiment. The percent lignin in 1971-72 was 3.95 percent compared to a mean of 3.15 percent in the second year tested. This apparently small difference could be considered biologically important in comparing the quality of forage of the two years tested since it represents a 25 percent increase in the smaller

mean. However, since the experiment was conducted the same within each year, this represents an uncontrollable variation in percent lignin. When years were combined, there was not a significant difference in the average percent lignin of cultivars harvested in May with respect to date of planting.

When years and planting dates were combined, DMR separation indicated that Balbo rye was significantly higher in percent lignin than any other cultivar harvested in May of both years. All other cultivars were not different from each other (Table 29, page 76). Likewise, rye was significantly higher in percent lignin than the triticale and wheat species, which were not significantly different (Table 30).

The two stubble heights tested were not different when years and planting dates were combined and cultivars, harvested in May, were evaluated for percent acid detergent lignin. However, the 10 cm stubble treatment was lower in actual percent lignin than the shorter stubble treatment.

When harvested in the LM-ED stage of maturity, there was a significant difference in the mean percent fiber of the cultivars between the two years tested and in the two planting times tested when years were combined. However, the means are different by 1.36 percent and 1.37 percent, respectively, and, biologically, may not be important differences since these represent only 5 and 4 percent, respectively, of the smaller mean in each case.

With years and planting dates combined, Arthur wheat was significantly lower in percent acid detergent fiber than any other cultivar

tested. Graz Grain 70A triticale was significantly lower than all remaining cultivars, while Balbo rye was significantly higher than any other cultivar evaluated. Fas Gro 204, Fas Gro 313, Fas Gro 385 and Dot Pathfinder triticales were intermediate between Graz Grain 70A and Balbo and not significantly different from each other (Table 27, page 73).

When harvested in the LM-ED maturity stage, there were no significant differences in the mean percent fiber of the cultivars cut to either 10 or 5 cm over the two years. All interactions involving stubble heights were nonsignificant.

When planting dates were combined, the three species included in the experiment were significantly different in percent fiber when harvested in the LM-ED stage for two years. Wheat was significantly lower than triticale, which was significantly lower than rye (Table 28, page 74).

The mean percent acid detergent lignin of the cultivars tested in 1972-73 was significantly lower than in 1971-72. The difference represented an increase of 14.2 percent of the smaller mean, and, therefore, its importance, biologically, may be significant. When years were combined, date of planting had no effect on the mean percent lignin when the cultivars were harvested in the LM-ED stage of maturity.

When years and planting dates were combined, Arthur wheat was significantly lower in percent lignin than Fas Gro 204 triticale and Balbo rye but not significantly different from the remaining cultivars.

Balbo rye was significantly higher in percent lignin at this harvest than Arthur wheat and Graz Grain 70A triticale but not significantly different from the remaining cultivars (Table 29, page 76).

The stubble height treatments had no effect on the percent lignin of cultivars harvested in the LM-ED stage of maturity for two years. All interactions involving stubble height treatments also were nonsignificant.

The three species represented in this test were significantly different when years and planting dates were combined. Wheat was significantly lower in percent lignin than triticale, which was significantly lower than rye (Table 30, page 77).

Evaluation of Fiber and Lignin Percentages During the Growing Season

Averaged across cultivars, the percent acid detergent fiber and lignin of forage harvested on three dates in the vegetative stage and in the LM-ED stage of maturity increased progressively from March 16 through the hay harvest during 1972. Each successive cutting was significantly higher than the preceding harvest.

With planting dates combined, each cultivar tested was higher in percent fiber when harvested in the LM-ED stage than at any vegetative stage harvest. However, Fas Gro 204 triticale, Graz Grain 70A triticale, Dot Pathfinder triticale and Arthur wheat were not significantly higher than when harvested on May 16, 1972. The percent fiber of each cultivar significantly increased successively across the three vegetative harvests, except Balbo rye, Fas Gro 204 and Graz Grain 70A triticales, which were significantly the same in percent fiber when cut on March 16 and April 20, 1972 (Table 19, page 57).

The percent lignin of each triticale cultivar tested was not significantly different at each of the three vegetative stage harvests in 1972. With Balbo rye and Arthur wheat, the percent lignin at the March 16 and April 20 harvests were not significantly different and significantly lower than the May 16 cutting. Each cultivar, except Graz Grain 70A triticale, was significantly higher in percent lignin when harvested in the LM-ED stage of maturity than at any vegetative stage harvest (Table 21, page 59).

Statistical analysis showed that the mean percent fiber and lignin of the cultivars harvested in the LM-ED stage of maturity were significantly higher than when the cultivars were harvested in the vegetative stage on May 7, 1973. The May 7 cutting was significantly higher in percent fiber and lignin than the April 2 harvest, when planting dates and cultivars were combined.

Each cultivar tested contained a significantly higher percent fiber when cut as hay than when cut in the vegetative stage of growth on May 7, 1973, except Arthur wheat, which was found not to differ with respect to stage of harvest. Each cultivar tested was significantly higher in percent fiber when cut May 7 than when harvested on April 2, except Graz Grain 70A triticale, which was not significantly different in percent fiber at the two vegetative stage harvest dates (Table 23, page 65).

Each cultivar tested contained a significantly higher percent acid detergent lignin when cut in the LM-ED stage of maturity than when harvested in the vegetative stage of growth on May 7, 1973. There was

not a significant difference in the percent lignin of Arthur wheat and Fas Gro 131, Fas Gro 385 and Graz Grain 70A triticales when harvested either May 7 or April 2, 1973. Fas Gro 204 and Dot Pathfinder triticales and Balbo rye contained a significantly higher percent lignin when harvested the second time in 1973 than when cut April 2 (Table 25, page 67).

When years were combined, there were significant differences in the mean percent fiber and lignin among the three harvests evaluated. When the cultivars were cut in the LM-ED stage of maturity, they averaged significantly higher in percent fiber and lignin than when harvested in the vegetative growth stage in May. The May harvest was significantly higher than the April cutting.

When years and planting dates were combined, each cultivar tested was significantly higher in percent fiber when harvested in the LM-ED stage of maturity, except Arthur wheat, which was only numerically higher, than when harvested in the vegetative stage in May of both years. Each cultivar was significantly higher in percent fiber when harvested in May than when cut in April of both years according to separation by DMR (Table 27, page 73).

When years and planting dates were combined, each cultivar contained a higher percent lignin when cut in the LM-ED stage of maturity than when cut in the vegetative stage in May or April. Each cultivar was higher in actual percent lignin when cut in May than when harvested in April of both years, but only Balbo rye was significantly higher (Table 29, page 76).

Crude Protein Evaluation of 1972 Vegetative Stage Forage

When cut on March 16, 1972, the cultivars planted October 27 were significantly lower in the average percent crude protein than when planted October 8, 1971. As was often the case with fiber and lignin percentages, the biological significance is open to doubt. The average crude protein percentages of the cultivars in the two planting dates tested were different by only 0.89 percent, which represents only 5 percent of the smaller value. The planting dates tested would probably not seriously affect protein quality of vegetative forage harvested at this time. Planting date x cultivar was nonsignificant for the March 16 harvest, indicating that each cultivar responded in this same relative manner to the effect of planting dates.

When planting dates were combined, Graz Grain 70A triticale was numerically the lowest in percent crude protein, but not significantly lower than Balbo rye, Dot Pathfinder triticale and Fas Gro 204 triticale. Fas Gro 385 triticale contained the highest percentage of crude protein, yet not significantly higher than Fas Gro 131 triticale, Fas Gro 204 triticale, Balbo rye and Arthur wheat (Table 31).

Analysis of variance indicated that the 10 cm stubble treatment resulted in a significantly ($P < .01$) higher percent crude protein than the 5 cm cutting height. The average percent crude protein of the cultivars cut to the higher stubble was 1.92 percent greater than when cut to 5 cm, which represents an 11 percent increase in the crude protein percentage of the smaller mean. An increase in protein percentage of this magnitude could be biologically important. All

Table 31. Percent Crude Protein of Forage of Cultivars Harvested During 1972

Cultivar	Percent Crude Protein[+]			
	March 16	April 20	May 16	Hay
Fas Gro 204 triticale	20.03 abc[++]	21.97 ab	17.52 a	15.37 a
Fas Gro 131 triticale	21.92 ab	20.02 bc	15.76 a	10.68 c
Fas Gro 385 triticale	23.18 a	19.31 bc	14.41 a	10.11 c
Graz Grain 70A triticale	18.63 c	22.17 ab	17.00 a	14.96 a
Dot Pathfinder triticale	20.01 bc	19.05 c	15.32 a	12.04 b
Balbo rye	20.68 abc	22.89 a	15.44 a	12.61 b
Arthur wheat	21.50 ab	18.50 c	15.19 a	10.72 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

interactions involving stubble heights were not significant when forage was harvested on March 16, 1972.

There were no significant differences among the three species represented in this experiment when they were harvested on March 16. Wheat was numerically higher in percent crude protein, but not significantly higher than rye and triticale (Table 32).

The date of planting did not have a significant effect on the average crude protein percentage of the cultivars tested when harvested for the second time in 1972. The planting date x cultivar interaction was significant ($P < .01$). Each cultivar, except Balbo rye, was numerically higher in percent crude protein when planted October 27 than when planted October 8, 1971. Balbo rye was significantly higher in percent protein when planted the earlier date in 1971.

Table 32. Percent Crude Protein of Forage of Species Harvested in 1972

Species	Percent Crude Protein[+]			
	March 16	April 20	May 16	Hay
Triticale	20.70 a[++]	20.40 b	16.05 a	12.83 a
Rye	20.68 a	22.89 a	15.44 a	12.61 a
Wheat	21.50 a	18.50 c	15.19 a	10.72 b

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

When planting dates were combined, Balbo rye contained the highest percent crude protein, but not significantly higher than Fas Gro 204 and Graz Grain 70A triticales. All other cultivars tested were not significantly different from each other, with Arthur wheat being numerically the lowest (Table 31, page 84).

The average percent crude protein of the cultivars tested was not significantly different when clipped to either 5 or 10 cm. All interactions involving stubble height treatments were nonsignificant when forage was harvested on April 20.

The three species evaluated were significantly different from each other with respect to percent crude protein when they were harvested in the vegetative stage of growth for the second time in 1972. Rye contained a significantly higher percentage of crude protein than triticale, which was significantly higher than wheat (Table 32).

Again, there were no significant differences in average crude protein percentage among the cultivars tested when planted October 8 or October 27, 1971 and harvested on May 16, 1972. The planting date x cultivar interaction was nonsignificant indicating that the cultivars tended to respond relatively the same to planting dates.

The cultivars evaluated were not significantly different in percent protein when harvested in the vegetative stage of growth on May 16, 1972. When planting dates were combined, Fas Gro 204 triticale contained the highest numerical percent crude protein but was not significantly different from Fas Gro 385 triticale, which was numerically the lowest in percent crude protein (Table 31). Likewise, there were no

significant differences among the three species represented at this harvest (Table 32, page 85).

The 10 cm stubble treatment resulted in a significantly higher average percent crude protein than the 5 cm treatment. All interactions involving stubble height treatments were nonsignificant.

Crude Protein Evaluation of Forage Harvested in the Late Milk to Early Dough Stage of Maturity in 1972

There was a significant difference in the mean crude protein percentage of the cultivars when planted October 8 compared to October 27, 1971 and harvested in the LM-ED stage of maturity in 1972. The average percent crude protein of cultivars planted October 27 was 1.28 percentage points higher than when they were planted the earlier date in 1971, which represents a 12 percent increase in the smaller value. Fas Gro 204 and Graz Grain 70A triticales were significantly higher when planted the later planting date, while all other cultivars were not significantly different in percent crude protein when planted either October 8 or October 27, 1971.

When planting dates were combined, Fas Gro 204 triticale was significantly higher in percent crude protein than any other cultivar when harvested as hay, except Graz Grain 70A triticale. Balbo rye ranked third in percent crude protein but was not significantly higher than Dot Pathfinder triticale. Fas Gro 385 triticale was numerically the lowest in percent crude protein, but not significantly lower than Fas Gro 131 triticale and Arthur wheat (Table 31, page 84).

The two stubble height treatments had no effect on percent crude protein of cultivars harvested in the LM-ED stage of maturity. All interactions involving stubble heights were nonsignificant.

As a species, triticale was higher in percent crude protein when harvested in the LM-ED stage, but not significantly higher than rye. Wheat was significantly lower in percent crude protein than triticale and rye (Table 32, page 85).

Crude Protein Evaluation of 1973 Vegetative Stage Forage

The average percent crude protein of the cultivars tested was significantly ($P < .01$) higher when planted October 10 than when planted November 6, 1972, and harvested in the vegetative growth stage on April 2, 1973. The earlier planting date was 2.31 percentage points higher than when the cultivars were planted November 6, 1972, which is a 16 percent increase in the smaller value and is probably biologically important. However, the average percent protein of either planting date would be considered acceptable with regards to quality standards. All cultivars except Fas Gro 204 and Graz Grain 70A triticales contained a numerically higher percentage of crude protein when planted October 10 than when planted November 6 and harvested April 2, 1973.

When planting dates were combined, Graz Grain 70A triticale was numerically highest in percent crude protein, but not significantly higher than all other cultivars at this harvest (Table 33). Likewise, the three species represented in the experiment were not significantly different (Table 34).

Table 33. Percent Crude Protein of Forage of Cultivars Harvested in 1973

Cultivar	Percent Crude Protein[+]		
	April 2	May 7	Hay
Fas Gro 204 triticale	17.93 a[++]	16.51 a	10.54 b
Fas Gro 131 triticale	17.87 a	17.08 a	9.46 cd
Fas Gro 385 triticale	18.78 a	16.95 a	10.02 bc
Graz Grain 70A triticale	19.69 a	17.50 a	11.61 a
Dot Pathfinder triticale	16.34 a	17.46 a	9.12 d
Balbo rye	16.85 a	17.17 a	10.69 b
Arthur wheat	17.05 a	15.38 a	10.77 b

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 34. Percent Crude Protein of Forage of Species Harvested in 1973

Species	Percent Crude Protein[+]		
	April 2	May 7	Hay
Triticale	17.96 a[++]	17.05 a	10.18 a
Rye	16.85 a	17.17 a	10.69 a
Wheat	17.05 a	15.38 a	10.77 a

[+]Average of two planting dates, two stubble heights and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

The average percent crude protein of the cultivars tested was significantly ($P < .01$) higher when they were cut to a stubble height of 10 cm than when harvested to 5 cm. The planting date x stubble height and cultivar x stubble height interactions were not significant, indicating that the stubble treatments had the same relative effect within each planting date and that the cultivars tended to respond in the same relative manner to the two stubble height treatments.

When the cultivars were harvested in the vegetative growth stage for the second time in 1973, there was not a significant effect of date of planting. Planting date x cultivar also was nonsignificant. When planting dates were combined, there were no significant differences among the cultivars evaluated for percent crude protein when harvested for vegetative stage forage on this date (Table 33). Likewise, the

three species represented in the experiment were not significantly different (Table 34).

Again, the 10 cm stubble height treatment resulted in a significantly higher percent crude protein than cutting the cultivars to a stubble of 5 cm. All cultivars tended to respond in this manner to the two stubble heights tested with regard to percent crude protein, as indicated by nonsignificance for that interaction.

Crude Protein Evaluation of Forage Harvested in the Late Milk to Early Dough Stage of Maturity in 1973

According to the analysis of variance, when harvested in the LM-ED stage of maturity, the average percent crude protein of the cultivars planted November 6, 1972 was significantly higher than when they were planted October 10. There was only 0.68 percent difference in the protein percentage values obtained, and this represents only an 8 percent increase in the smaller value. Here again, the biological significance may be questionable. A difference of this magnitude would not be a deciding factor in consideration of the two planting dates tested. The planting date x cultivar interaction was significant indicating that the cultivars did not respond relatively the same to date of planting. Fas Gro 131 triticale, Balbo rye and Arthur wheat were higher in percent crude protein when planted the earlier date, but not significantly higher. All other cultivars were significantly higher in percent crude protein when planted the later planting date.

When planting dates were combined, there were significant differences among the cultivars when harvested in the LM-ED stage of maturity. Graz Grain 70A triticale was significantly higher in percent crude protein than any other cultivar evaluated. Dot Pathfinder triticale was significantly lower than any other cultivar except Fas Gro 131 triticale. All remaining cultivars were intermediate to these and not significantly different from each other (Table 33, page 89).

There was not a significant difference in the two stubble height treatments tested. All interactions involving stubble heights were nonsignificant.

When the cultivars were evaluated on a species basis, there were no significant differences among the three species tested. Triticale was numerically lowest in percent crude protein, while wheat was highest in numerical value (Table 34, page 90).

Crude Protein Evaluation of Forage During the Growing Season

Generally, as the vegetative harvests progressed through the season, the percent crude protein progressively decreased. At the March 16 harvest, the average percent crude protein of the cultivars tested was significantly ($P < .01$) higher than at any other harvest except the April 20 harvest. The average percent crude protein of the cultivars harvested in the hay stage was significantly lower than at any other harvest date.

Fas Gro 131 triticale, Fas Gro 204 triticale, Dot Pathfinder triticale and Balbo rye contained the same significant crude protein

percentage when they were cut in the vegetative stage on March 16 or April 20, 1972. With these cultivars, the May 16 protein percentage was significantly lower than the first two vegetative stage cuttings, and the hay harvest was significantly lower than the May 16 harvest. Fas Gro 385 triticale and Arthur wheat significantly decreased in percent crude protein at each successive harvest throughout the year. Graz Grain 70A triticale contained a significantly higher percent crude protein on April 20 than at the first harvest date in 1972. The percent crude protein of forage of Graz Grain 70A triticale was significantly the same when it was harvested March 16, May 16 or as hay (Table 31, page 84).

Each cultivar tested was high enough in percent crude protein at any vegetative stage harvest during 1972 to serve as the sole source of crude protein in any beef cattle ration and in most dairy cattle rations, with only minor protein supplementation of rations of high producing dairy cows fed forage harvested in late spring. When cut in the LM-ED stage of maturity, all cultivars either met or were only slightly below crude protein requirements for any beef cattle ration, but all cultivars tested would require protein supplementation if fed to lactating cows, according to the National Research Council-National Academy of Sciences (NRC) (42,43).

The cultivars tested were significantly higher, as a whole, in percent crude protein when harvested on April 2 than when cut in the vegetative stage of growth on May 7, 1973. Both vegetative harvests were significantly higher than the LM-ED stage cutting. Analysis of variance indicated that this trend held for each cultivar tested during 1972-73.

When harvested in the vegetative stage of growth, on a dry weight basis, each cultivar tested could serve as the only source of crude protein in beef cattle rations, and only Arthur wheat would require minor supplementation when included in most lactating dairy cattle rations. According to the NRC (42,43), no cultivar tested could serve as the sole source of crude protein for lactating dairy cattle rations if it were harvested in the LM-ED stage of maturity. Some beef cattle rations could contain this forage as LM-ED stage hay as the sole source of crude protein if low average daily gains were acceptable.

The percent crude protein of triticale vegetative stage forage compared well with average values obtained by several workers in Texas (11,51,64). This was true within each year tested.

Crude Protein Evaluation of Forage Harvested in the Late Milk to Early Dough Stage of Maturity for Two Years

Since crude protein percentage fluctuates from year to year and is less associated with factors that led to the decision as to when to harvest the vegetative stage forage throughout the year, the only valid forage comparison across years was when cultivars were harvested in the LM-ED stage of maturity. This is the only forage harvest that can be considered physiologically the same in both years of the experiment.

The average percent crude protein was significantly ($P < .01$) higher in 1972 than in 1973 when cultivars were harvested in the LM-ED stage of maturity. All cultivars were significantly higher in percent crude protein in 1972, except Fas Gro 385 triticale and Arthur wheat, which were not different with respect to the two years tested.

When years were combined, the later plantings resulted in a significantly higher average protein percentage. However, the difference between planting dates was only 1.93 percentage points and probably would not affect the decision to plant either in early October or late October to early November. When planting dates were combined, Graz Grain 70A triticale contained a higher percentage of crude protein, but not significantly higher than Fas Gro 204 triticale. Fas Gro 385 triticale was lowest in percent crude protein of any cultivar, but not significantly lower than Arthur wheat, Fas Gro 131 triticale and Dot Pathfinder triticale (Table 35).

The stubble heights tested had no effect on the mean percent crude protein of cultivars harvested in the LM-ED stage of maturity for two years. All interactions involving stubble heights were nonsignificant.

With respect to percent protein there was a significant difference in the three species represented in this experiment when years and planting dates were combined and forage harvested in the LM-ED stage of maturity. The percent protein in rye was significantly higher than in wheat, but not significantly different from triticale (Table 36).

Crude Protein Evaluation of Grain

The average percent crude protein of grain of cultivars planted October 27 was significantly higher than when the cultivars were planted October 8, 1971. However, there was only 1.06 percentage points difference in the percent crude protein, which represents only 7 percent of the smaller mean. In this case, the biological significance is again

Table 35. Mean Percent Crude Protein of Cultivars Harvested in the Late Milk to Early Dough Stage of Maturity for Two Years

Cultivar	Percent Crude Protein[+]
Fas Gro 204 triticale	13.04 a[++]
Fas Gro 131 triticale	10.09 c
Fas Gro 385 triticale	10.06 c
Graz Grain 70A triticale	13.06 a
Dot Pathfinder triticale	10.58 c
Balbo rye	11.62 b
Arthur wheat	10.74 c

[+]Average of two years, two planting dates, two stubble heights and four replications.

[++]Values followed by the same letter are not significantly different at the .05 level of probability.

Table 36. Mean Percent Crude Protein of Species Harvested in the Late Milk to Early Dough Stage of Maturity for Two Years

Species	Percent Crude Protein[+]
Triticale	11.41 a[++]
Rye	11.62 a
Wheat	10.74 b

[+]Average of two years, two planting dates, two stubble heights and four replications.

[++]Values followed by the same letter are not significantly different at the .05 level of probability.

questionable, especially since neither planting date had any great effect on the percent crude protein. Planting date x cultivar was not significant with regards to percent crude protein of the grain harvested in 1972.

When planting dates were combined, Graz Grain 70A triticale was numerically higher in percent crude protein than any other cultivar, yet not significantly higher than Fas Gro 204 triticale. Fas Gro 385 triticale was significantly lower in percent crude protein than any other cultivar except Arthur wheat and Dot Pathfinder triticale (Table 37). When evaluated on a species basis, rye grain was higher in percent crude protein than triticale or wheat, but not significantly higher (Table 38).

Table 37. Percent Crude Protein of Grain of Cultivars Harvested for Two Years

Cultivar	Percent Crude Protein[+]		
	1971-72	1972-73	Average
Fas Gro 204 triticale	17.79 ab[++]	16.91 b	17.35 b
Fas Gro 131 triticale	16.54 bcd	18.26 a	17.40 b
Fas Gro 385 triticale	13.97 e	16.31 b	15.53 c
Graz Grain 70A triticale	18.96 a	18.75 a	18.86 a
Dot Pathfinder triticale	14.85 de	15.08 c	14.96 c
Balbo rye	16.79 bc	18.20 a	17.44 b
Arthur wheat	15.39 cde	15.38 c	15.38 c

[+]Average of two planting dates and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 38. Percent Crude Protein of Grain of Species Harvested for Two Years

Species	Percent Crude Protein[+]		
	1971-72	1972-73	Average
Triticale	16.73 a[++]	17.12 b	16.93 a
Rye	16.79 a	18.20 a	17.44 a
Wheat	15.39 a	15.38 c	15.38 b

[+]Average of two planting dates and four replications.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Grain of cultivars harvested in 1973 was significantly ($P < .01$) higher in percent crude protein when planted November 6, 1972 than when planted October 10. Grain harvested from the later planting date was 1.72 percentage points higher than the average of the cultivars when planted October 10, which represents a 10 percent increase in the October 10 value. Delaying planting in order to increase a protein percentage of 15.35 percent by 10 percent of that value would probably not be practical since it would entail a decrease in yields. All cultivars were significantly higher in percent crude protein when planted the later date, except Arthur wheat, Balbo rye and Fas Gro 385 triticale which were not different with respect to date of planting.

When planting dates were combined, Graz Grain 70A triticale was higher in percent crude protein than any other cultivar, but not significantly higher than Fas Gro 131 triticale and Balbo rye. Dot Pathfinder

triticale was the lowest in percent crude protein, but not significantly lower than Arthur wheat (Table 37). As species, rye was significantly higher in percent crude protein than triticale, which was significantly higher than wheat (Table 38).

Analysis of variance indicated that there was not a significant difference between the two years tested in the average percent crude protein of the cultivars. There was a significant difference in planting dates tested, with the later planting dates resulting in a significantly higher average percent crude protein when years were combined. Over the two years tested, delaying planting by approximately one month increased the percent crude protein by 9 percent of the earlier planting date percentage. However, a small increase in an acceptable protein percentage would not be a serious consideration in determining date of planting.

When years and planting dates were combined, Graz Grain 70A triticale was significantly higher in percent crude protein than any other cultivar tested. Balbo rye was higher than any other cultivar, except Graz Grain 70A, but not significantly higher than Fas Gro 131 and Fas Gro 204 triticales. Dot Pathfinder triticale was lower in percent crude protein than any cultivar tested, but not significantly lower than Arthur wheat and Fas Gro 385 triticale (Table 37). As species, rye and triticale were not significantly different from each other in percent crude protein and were significantly higher than wheat (Table 38). These relative values compare favorably with those reported by Unrau and Jenkins (52) in 1964.

Fas Gro 385 triticale, Dot Pathfinder triticale and Arthur wheat harvested in 1972 were the only cultivars tested that averaged lower in percent crude protein than that required for any ration for lactating dairy cattle. In 1973, only Dot Pathfinder triticale and Arthur wheat were too low in percent crude protein to serve as the sole source of crude protein in any ration for lactating dairy cattle. When averaged across years, Dot Pathfinder triticale and Arthur wheat would require minor supplementation to serve as the only source of crude protein in any ration for lactating dairy cattle and in any beef cattle ration, according to the NRC (42,43).

Percent Phosphorus of Late Milk to Early Dough Stage Forage

There was a significant difference in the average percent P of the cultivars harvested in the LM-ED stage of maturity in 1972 when they were planted October 8 and October 27, 1971. The cultivars planted on the earlier planting date averaged 0.02 percentage points higher in percent P than when planted October 27, 1971, which represents an increase of 11 percent of the smaller value. Each cultivar tested in both plantings in 1971 contained a higher percent P when planted the earlier date, except Fas Gro 204 triticale, which was not different in percent P at either planting.

When planting dates were combined, Graz Grain 70A triticale was significantly higher in percent P than any other cultivar tested, except Fas Gro 204 triticale. Fas Gro 131 triticale was lower than any other cultivar, but not significantly lower than Dot Pathfinder triticale and Arthur wheat (Table 39). As species, there were no significant

Table 39. Percent P of Forage of Cultivars Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar	Percent Phosphorus[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.22 ab[++]	0.19 c	0.21 b
Fas Gro 131 triticale	0.16 d	0.16 d	0.16 c
Fas Gro 385 triticale	0.20 bc	0.19 c	0.19 bc
Graz Grain 70A triticale	0.23 a	0.24 a	0.24 a
Dot Pathfinder triticale	0.17 cd	0.16 d	0.17 c
Balbo rye	0.19 c	0.18 cd	0.18 c
Arthur wheat	0.18 cd	0.22 b	0.20 b

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

differences among the three species represented in this evaluation (Table 40).

The 10 cm stubble height treatment resulted in a slightly higher percent P when all cultivars were combined, but not significantly higher. All interactions involving stubble heights were nonsignificant.

In 1973, the effect of date of planting on the average percent P of the cultivars tested was opposite that found in 1972. When forage was harvested in the LM-ED stage of maturity, the average percent P of the cultivars planted November 6, 1972 was significantly higher than when the cultivars were planted October 10. The difference represented 17 percent of the smaller value, which could be considered biologically important. Each cultivar did not respond relatively the same to the

Table 40. Percent P of Forage of Species Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Species	Percent Phosphorus[+]		
	1972	1973	Average
Triticale	0.19 a[++]	0.19 b	0.19 a
Rye	0.19 a	0.18 b	0.18 a
Wheat	0.18 a	0.22 a	0.20 a

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in one one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

planting dates tested, as indicated by a significant interaction of planting date x cultivar. All triticale cultivars contained a higher percent P when planted November 6, 1972; whereas, Balbo rye and Arthur wheat were numerically higher in percent P when planted the earlier date.

When planting dates were combined, Graz Grain 70A triticale again contained a significantly higher percentage of P than any other cultivar tested. Fas Gro 131 triticale was again the lowest in percent P, yet not significantly lower than Dot Pathfinder triticale and Balbo rye (Table 39, page 102). When compared on a species basis, the percent P of wheat was significantly higher than triticale and rye, which were not different from each other (Table 40).

Again, the stubble height treatments had no significant effect on the percent P of the cultivars tested. All interactions involving stubble heights were nonsignificant.

The two years tested were not significantly different with respect to the average percent P of the cultivars included in this experiment. When averaged across years, the two planting dates, early October versus late October to early November, did not affect percent P of forage harvested in the LM-ED stage of maturity.

When years and planting dates were combined, Graz Grain 70A triticale was significantly higher in percent P than any other cultivar tested. Fas Gro 131 triticale was lower than any other cultivar, but not significantly lower than Dot Pathfinder triticale, Balbo rye and Fas Gro 385 triticale (Table 39, page 102). Compared as species, there were no

significant differences among the three species evaluated for percent P (Table 40). The percent P reported in Table 40 for triticale was the same as that reported for Rosner triticale by Tingle and Dawley (61).

Graz Grain 70A triticale was the only cultivar that could serve as the only source of P in any finishing ration for beef cattle, which is probably a reflection of its poor yield. Averaged over the two years of this experiment, all cultivars except Fas Gro 131 triticale and Dot Pathfinder triticale met the minimum requirements for at least some grower rations of beef cattle. No cultivar tested met minimum requirements for any rations for lactating cows as set forth by the NRC (42,43).

Percent Phosphorus of Grain

Date of planting had a significant effect on the average percent P of the cultivars evaluated in 1971-72. Cultivars planted the earlier planting date averaged significantly higher in grain percent P than when planted October 27. The difference was small and probably not biologically important. All cultivars planted in both plantings were numerically higher when planted October 8 than when planted October 27, except Fas Gro 204 triticale which was significantly higher when planted the later date.

When planting dates were combined, grain of Graz Grain 70A triticale was significantly higher in percent P than any other cultivar tested in 1971-72. Arthur wheat was the lowest numerically, but not significantly lower than Dot Pathfinder triticale (Table 41). As a species, triticale

Table 41. Percent P of Grain of Cultivars Harvested in 1972 and 1973

Cultivar	Percent Phosphorus[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.37 b[++]	0.42 c	0.39 c
Fas Gro 131 triticale	0.37 b	0.47 b	0.42 b
Fas Gro 385 triticale	0.36 bc	0.47 b	0.43 b
Graz Grain 70A triticale	0.46 a	0.52 a	0.49 a
Dot Pathfinder triticale	0.33 cd	0.38 d	0.36 d
Balbo rye	0.36 b	0.44 c	0.40 c
Arthur wheat	0.33 d	0.36 d	0.35 d

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

was significantly higher in percent P than rye, which was significantly higher than wheat (Table 42).

In 1972-73, planting on the second planting date resulted in an increase in percent P of grain of 12 percent of the smaller value. This difference is not important when dealing with phosphorus percentages as high as those obtained in this experiment. Grain of each cultivar was numerically higher in percent P when planted the later date, except Balbo rye, which was essentially the same at either planting.

When planting dates were combined, Graz Grain 70A triticale was significantly higher in percent P than any other cultivar evaluated in 1973. Arthur wheat was again the lowest, but not significantly lower than Dot Pathfinder triticale (Table 41). Triticale and rye were

Table 42. Percent P of Grain of Species Harvested in 1972 and 1973

Species	Percent Phosphorus[+]		
	1972	1973	Average
Triticale	0.38 a[++]	0.46 a	0.42 a
Rye	0.36 b	0.44 a	0.40 b
Wheat	0.33 c	0.36 b	0.35 c

[+]Average of two planting dates, two stubble heights and four replications. Pas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

significantly higher in percent P than wheat, but not significantly different from each other (Table 42).

The average percent P of the cultivars tested in 1973 was significantly higher than when harvested in 1972. When years were combined, the later planting dates resulted in a significantly higher percent P than the earlier dates. However, the effect of planting dates was opposite in the two years, resulting in a significant interaction for that variance term. The differences between years and planting dates are small and probably not important in the evaluation of the acceptability of the cultivars tested.

When years and planting dates were combined, Graz Grain 70A triticale was significantly higher in percent P than any other cultivar tested. Arthur wheat was lower than all other cultivars, but not significantly lower than Dot Pathfinder triticale (Table 41, page 106). As species, triticale was significantly higher in percent P than rye, which was significantly higher than wheat (Table 42). The value reported for triticale compares well with the percentage reported by Dinusson et al. (13).

All cultivars and species evaluated for grain percent P could be used as the sole source of P in almost any ration for beef cattle and lactating dairy cattle. This was true within and across the two years tested.

Percent Magnesium of Late Milk to Early Dough Stage Forage

The average percent Mg of the cultivars harvested in the LM-ED stage of maturity in 1972 and planted October 27, 1971 was significantly

higher than when those cultivars were planted October 8. Delaying planting in 1971 resulted in a 0.02 percent increase in the percent Mg, which is a 10 percent increase in the smaller value. This difference is not important when dealing with Mg percentages as high as those obtained in this experiment.

When planting dates were combined, Balbo rye was higher in percent Mg than any other cultivar, but significantly higher than only Dot Pathfinder and Fas Gro 131 triticales. Dot Pathfinder triticale was numerically the lowest in percent Mg when harvested in the LM-ED stage of maturity in 1972 (Table 43). Evaluated as species, rye and wheat were not significantly different from each other and significantly higher in percent Mg than triticale (Table 44).

There was not a significant effect of stubble height on the average percent Mg of the cultivars in 1971-72. Each cultivar tested was significantly the same with respect to Mg percentage when cut to either 5 or 10 cm.

In 1973, there was not a significant effect of date of planting on the average percent Mg when cultivars were harvested in the LM-ED stage of maturity. Percent Mg of each cultivar tested was significantly the same when planted either October 10 or November 6, 1972, except Graz Grain 70A triticale, which was significantly higher when planted late, and Balbo rye, which was significantly higher when planted the earlier date.

When planting dates were combined, Balbo rye and Arthur wheat were significantly higher in percent Mg than any other cultivar except Graz

Table 43. Percent Mg of Forage of Cultivars Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar	Percent Magnesium[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.23 ab[++]	0.18 bc	0.21 abc
Fas Gro 131 triticale	0.19 bc	0.18 c	0.19 cd
Fas Gro 385 triticale	0.22 abc	0.19 bc	0.20 bcd
Graz Grain 70A triticale	0.24 ab	0.21 ab	0.22 ab
Dot Pathfinder triticale	0.19 c	0.17 c	0.18 d
Balbo rye	0.24 a	0.22 a	0.23 a
Arthur wheat	0.23 ab	0.22 a	0.23 ab

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 44. Percent Mg of Forage of Species Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Species	Percent Magnesium[+]		
	1972	1973	Average
Triticale	0.21 b[++]	0.19 b	0.20 b
Rye	0.24 a	0.22 a	0.23 a
Wheat	0.23 a	0.22 a	0.23 a

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Grain 70A triticale. All other cultivars were found not to be different from each other, with Dot Pathfinder triticale being numerically the lowest (Table 43). Triticale, represented by the average of the five triticale cultivars tested, was significantly lower in percent Mg than rye and wheat, which were not different from each other (Table 44).

Again, there was not a significant effect of stubble height on the average percent Mg of forage of cultivars harvested in the LM-ED stage of maturity. All interactions involving stubble heights were nonsignificant.

Analysis of variance indicated a significant difference between the two years of this experiment in average percent Mg of the cultivars tested. However, this difference is not likely to be important in view of the Mg percentages observed. When years were combined, the late

planting was significantly higher in percent Mg of the cultivars tested than when the cultivars were planted in early October. Again this difference is considered unimportant in light of the adequate Mg percentages found in this experiment.

Table 43, page 110, shows that when years and planting dates were combined Balbo rye contained the highest percent Mg, but not significantly higher than Arthur wheat, Graz Grain 70A triticale and Fas Gro 204 triticale. Dot Pathfinder triticale was significantly lower in percent Mg than any other cultivar except Fas Gro 131 and Fas Gro 385 triticales. As species, rye and wheat were significantly higher in percent Mg than triticale and not significantly different from each other (Table 44). The value reported in Table 44 for triticale is slightly higher than that reported by Tingle and Dawley (61) in 1972.

Stubble height treatments had no effect on percent Mg when years and planting dates were combined. All interactions involving stubble heights were nonsignificant.

Each cultivar, when harvested in the LM-ED stage of maturity, contained a high enough percentage of Mg to serve as the sole source of ration Mg in all beef and dairy cattle rations, according to the NRC (42,43). This was true within and across years tested in this experiment.

Percent Magnesium of Grain

The dates of planting tested in 1971-72 had no significant effect on the average percent Mg of the cultivars evaluated. Grain of Graz

Grain 70A triticale, Balbo rye and Arthur wheat was higher when planted early, but not significantly higher, while all other cultivars included in both planting dates were numerically higher in percent Mg when planted October 27, 1971.

When planting dates were combined, Graz Grain 70A triticale was significantly higher than any other cultivar. Arthur wheat was numerically the lowest, but not significantly lower than Fas Gro 204, Dot Pathfinder and Fas Gro 385 triticales (Table 45). When the triticale cultivars were combined to represent that species, it was significantly higher in percent Mg than rye, which was significantly higher than wheat (Table 46).

In 1973, the later planting date resulted in a significantly higher percent Mg in the grain of the cultivars tested than the October 10 planting date. Delaying planting from October 10 to November 6, on the average, increased percent Mg by 0.05 percent, which represents a 20.8 percent increase of the earlier planting date mean. Although this is probably an important biological difference both planting date means were well above the values reported by the NRC as requirements for percent Mg required in any beef and dairy cattle ration (42,43). Each cultivar tested was numerically higher in percent Mg when planted November 6 than when planted October 10, except Balbo rye, which was found to be numerically higher when planted the earlier date.

When planting dates were combined, Graz Grain 70A triticale was again higher in percent Mg than any other cultivar, but not significantly higher than Fas Gro 131 triticale. Arthur wheat was numerically the

Table 45. Percent Mg of Grain of Cultivars Harvested in 1972 and 1973

Cultivar	Percent Magnesium[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.16 d[++]	0.25 c	0.19 cd
Fas Gro 131 triticale	0.21 b	0.30 ab	0.25 b
Fas Gro 385 triticale	0.18 cd	0.28 bc	0.25 b
Graz Grain 70A triticale	0.28 a	0.33 a	0.31 a
Dot Pathfinder triticale	0.17 cd	0.20 d	0.18 cd
Balbo rye	0.18 c	0.27 bc	0.22 bc
Arthur wheat	0.16 d	0.20 d	0.18 d

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 46. Percent Mg of Grain of Species Harvested in 1972 and 1973

Species	Percent Magnesium[+]		
	1972	1973	Average
Triticale	0.20 a[++]	0.27 a	0.24 a
Rye	0.18 b	0.27 a	0.22 b
Wheat	0.16 c	0.20 b	0.18 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

lowest cultivar tested in percent Mg, but not significantly lower than Dot Pathfinder triticale (Table 45). When compared as species, triticale was significantly higher in percent Mg than wheat and not different from rye at the .05 probability level (Table 46).

The two years evaluated in this experiment were significantly ($P < .01$) different in the average percent Mg of the cultivars tested. When years were combined, the later planting dates resulted in a significantly higher average percent Mg than the early October plantings. Again, these differences were not important in view of the levels of observed Mg percentages of grain of cultivars tested in this experiment.

When years and planting dates were combined, Graz Grain 70A triticale was significantly higher in percent Mg than any other cultivar tested. Arthur wheat was the lowest in percent Mg, but not significantly lower

than Dot Pathfinder and Fas Gro 204 triticales (Table 45, page 114). When considered on a species basis, triticale was significantly higher than rye, which was significantly higher than wheat (Table 46).

All cultivars and species tested met minimum requirements for ration Mg for any beef and dairy cattle ration according to those reported by the NRC (42,43). This was true in each year and when years were combined.

Percent Potassium of Late Milk to Early Dough Stage Forage

In 1972, the date of planting had no effect on the average percent K of the cultivars tested when harvested in the LM-ED stage of maturity. When planting dates were combined, Graz Grain 70A triticale was significantly higher in percent K than any other cultivar tested. Balbo rye, Fas Gro 204 triticale, Fas Gro 131 triticale and Fas Gro 385 triticale were found not to be significantly different from each other, while Arthur wheat was significantly lower than any other cultivar (Table 47). As a species, triticale was not different from rye in percent K while both were significantly higher than wheat (Table 48).

The two stubble height treatments had no effect on percent K at this harvest in 1972. All interactions involving stubble heights were nonsignificant.

When the cultivars were harvested in 1973, the earlier planting date resulted in a significantly ($P < .01$) higher average percent K than when the cultivars were planted November 6. The average percent K of the cultivars planted October 10 was 0.07 percentage points higher than when planted later, which is only a 5 percent increase in the

Table 47. Percent K of Forage of Cultivars Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar	Percent Potassium[+]		
	1972	1973	Average
Fas Gro 204 triticale	1.91 b[++]	1.43 ab	1.67 a
Fas Gro 131 triticale	1.82 b	1.31 c	1.56 b
Fas Gro 385 triticale	1.73 bc	1.41 ab	1.52 b
Graz Grain 70A triticale	2.13 a	1.47 a	1.77 a
Dot Pathfinder triticale	1.58 c	1.36 bc	1.47 b
Balbo rye	1.88 b	1.51 a	1.69 a
Arthur wheat	1.40 d	1.29 c	1.34 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 48. Percent K of Forage of Species Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Species	Percent Potassium[+]		
	1972	1973	Average
Triticale	1.83 a[++]	1.39 b	1.60 b
Rye	1.88 a	1.51 a	1.69 a
Wheat	1.40 b	1.29 c	1.34 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

smaller value and is probably not biologically important. Balbo rye and Arthur wheat were significantly higher in percent K at the LM-ED stage harvest when planted in early October, while Graz Grain 70A triticale was significantly higher when planted the later planting date. Each of the remaining cultivars tested were not significantly different with respect to date of planting.

When planting dates were combined, Balbo rye was higher in percent K than any other cultivar in 1973 when harvested in the LM-ED stage of maturity, but not significantly higher than Graz Grain 70A, Fas Gro 204 and Fas Gro 385 triticales. Arthur wheat was significantly lower in percent K than any other cultivar except Fas Gro 131 and Dot Pathfinder triticales (Table 47). As a species, rye was significantly higher in percent K than triticale, which was significantly higher than wheat (Table 48).

Again, stubble height treatments did not affect percent K in the LM-ED stage forage. All interactions involving the two stubble heights tested were nonsignificant.

The average percent K of the cultivars tested in 1972 was significantly higher than in 1973 when they were harvested in the LM-ED stage of maturity. When years were combined, date of planting did not affect average percent K.

When years and planting dates were combined, Graz Grain 70A triticale was higher in percent K than any other cultivar tested, but not significantly higher than Balbo rye and Fas Gro 204 triticale. Arthur wheat was significantly lower than any other cultivar tested (Table 47, page 117). On a species basis, rye was significantly higher in percent K than triticale, which was significantly higher than wheat (Table 48). Again, the value obtained for triticale percent K is higher than that reported for triticale silage in Central British Columbia (61).

All cultivars evaluated in the LM-ED stage of maturity could serve as the only source of K in any beef and dairy cattle rations, as described by the NRC (42,43). This was true in each year and when years were combined.

Percent Potassium of Grain

Date of planting had no effect on the average percent K found in the cultivars evaluated in 1971-72. When planting dates were combined, grain of Graz Grain 70A triticale was significantly higher in percent K than grain of any other cultivar. Arthur wheat was significantly

lower than any other cultivar harvested as grain in 1972 (Table 49). The triticale species was significantly higher than rye and wheat (Table 50).

In the second year of the experiment, delaying planting from October 10 until November 6 resulted in a significantly higher percent K. However, the increase was only 10 percent of the October 10 mean and probably not important since both were well above minimum requirements for beef and dairy cattle rations. Each cultivar tested tended to respond relatively in this manner as indicated by nonsignificance for the planting date x cultivar interaction.

When planting dates were combined, grain of Graz Grain 70A triticale was again significantly higher in percent K than any other cultivar, while Arthur wheat was significantly lower than any other cultivar evaluated. All remaining cultivars were intermediate to these and not significantly different from each other (Table 49). The triticale species, represented by the five triticale cultivars included in the experiment, was not significantly higher in percent K than rye, and both were significantly higher than wheat (Table 50).

The average percent K of the cultivars tested was significantly higher in the second year of the experiment than in the first year. When years were combined, delaying planting resulted in a significant increase in percent K, according to the analysis of variance. However, the increase was slight and probably not important, since both means were above minimum requirements for beef and dairy cattle rations.

When years and planting dates were combined, grain of Graz Grain 70A triticale was significantly higher in percent K than grain of any

Table 49. Percent K of Grain of Cultivars Harvested in 1972 and 1973

Cultivar	Percent Potassium[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.67 b[++]	0.88 b	0.77 b
Fas Gro 131 triticale	0.65 bc	0.87 b	0.76 b
Fas Gro 385 triticale	0.59 d	0.89 b	0.79 b
Graz Grain 70A triticale	0.78 a	1.03 a	0.91 a
Dot Pathfinder triticale	0.62 cd	0.81 b	0.71 c
Balbo rye	0.59 d	0.83 b	0.70 c
Arthur wheat	0.48 e	0.62 c	0.55 d

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 50. Percent K of Grain of Species Harvested in 1972 and 1973

Species	Percent Potassium[+]		
	1972	1973	Average
Triticale	0.67 a[++]	0.90 a	0.79 a
Rye	0.59 b	0.83 a	0.70 b
Wheat	0.48 c	0.62 b	0.55 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

other cultivar tested. Arthur wheat was significantly the lowest cultivar tested (Table 49). As a species, triticale was significantly higher in percent K than rye, which was significantly higher than wheat (Table 50).

Each cultivar evaluated for two years, met or exceeded the minimum requirements for percent K in rations for lactating dairy and beef cattle, except Arthur wheat. Arthur wheat was slightly below minimum requirements for beef rations and well below those suggested by the NRC (42,43) for dairy cattle rations.

Percent Calcium of Late Milk to Early Dough Stage Forage

The two planting dates tested in 1971-72 were significantly different with respect to the average percent Ca of the cultivars tested. The later planting date was 0.02 percentage points higher than when cultivars were planted October 8, 1971, which represents a 14 percent

increase in the smaller mean. This difference would not be a determining factor in determining the best of the two planting dates tested, since both means were below minimum requirements for beef and dairy cattle rations. Each cultivar tended to respond in this manner to the effects of date of planting.

When planting dates were combined, Balbo rye was significantly higher in percent Ca than any other cultivar, except Fas Gro 204 triticale. Arthur wheat was significantly lower than any other cultivar tested in 1971-72 (Table 51). As a species, rye was significantly higher in percent Ca than triticale, which was significantly higher than wheat (Table 52).

There was not a significant difference in average percent Ca of forage of cultivars harvested in the LM-ED stage of maturity in 1972 when clipped to either 5 or 10 cm. All interactions involving stubble height treatments were nonsignificant.

Each cultivar tested in this year was below the minimum requirement for percent Ca of dairy cattle rations. Fas Gro 204 triticale, Graz Grain 70A triticale and Balbo rye were high enough to serve as the sole source of ration Ca for some grower rations of beef cattle where low average daily gains are acceptable. However, Fas Gro 204 and Graz Grain 70A triticales are probably high in Ca due to poor yields and are, therefore, not validly comparable to Balbo rye.

When harvested in the LM-ED stage of maturity in 1973, the two planting dates tested had no significant effect on average percent Ca of the cultivars evaluated. When planting dates were combined, Balbo

Table 51. Percent Ca of Forage of Cultivars Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Cultivar	Percent Calcium[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.18 ab[++]	0.14 b	0.16 b
Fas Gro 131 triticale	0.14 c	0.10 c	0.12 b
Fas Gro 385 triticale	0.13 c	0.09 c	0.11 bc
Graz Grain 70A triticale	0.16 bc	0.10 c	0.13 b
Dot Pathfinder triticale	0.13 c	0.12 bc	0.12 b
Balbo rye	0.20 a	0.22 a	0.21 a
Arthur wheat	0.08 d	0.10 c	0.09 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 52. Percent Ca of Forage of Species Harvested in the Late Milk to Early Dough Stage of Maturity in 1972 and 1973

Species	Percent Calcium[+]		
	1972	1973	Average
Triticale	0.15 b[++]	0.11 b	0.13 b
Rye	0.20 a	0.22 a	0.21 a
Wheat	0.08 c	0.10 c	0.09 c

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

rye was significantly higher in percent Ca at LM-ED stage hay than any other cultivar tested. Fas Gro 385 triticale was numerically the lowest in percent Ca, but not significantly lower than any of the other cultivars except Balbo rye and Fas Gro 204 triticale (Table 51). When compared as species, rye was significantly higher in percent Ca than triticale, which was significantly higher than wheat (Table 52).

Again, stubble height treatments had no effect on percent Ca at this stage of growth. All interactions involving stubble height treatments were nonsignificant.

Balbo rye was the only cultivar tested in 1972-73 that could serve as the only Ca source in some grower rations for beef cattle. When harvested in the LM-ED stage of maturity, no cultivar contained the minimum percent Ca specified for dairy cattle rations by the NRC (42,43).

As indicated in Table 51, page 124, the forage harvested in the LM-ED stage in 1972 averaged significantly higher in percent Ca than that harvested in 1973. When years were combined, the average percent Ca was significantly ($P < .01$) higher when the cultivars were planted the later planting dates.

When years and planting dates were combined, Balbo rye was significantly higher in percent Ca than any other cultivar tested. Arthur wheat was the lowest, but not significantly lower than Fas Gro 385 triticale (Table 51). Means of the three species tested remained the same in relation to each other as in each individual year (Table 52). The percent Ca of triticale was lower than that reported by Tingle and Dawley (61) in 1972 for Rosner triticale.

Only Balbo rye and Fas Gro 204 triticale could provide the minimum percent Ca requirement for growing beef cattle. No cultivar met standards set out by the NRC for minimum requirements of ration Ca for any dairy cattle rations (42,43).

Percent Calcium of Grain

Date of planting in 1971 had no effect on the overall percent Ca of grain harvested in 1972. Fas Gro 204 and Graz Grain 70A triticales were the only cultivars found to show a significant difference with respect to date of planting. Fas Gro 204 was significantly higher in percent Ca when planted the later date, while Graz Grain 70A was significantly higher when planted October 8, 1971.

When planting dates were combined, Fas Gro 204 and Graz Grain 70A triticales were significantly higher in percent Ca than any other

cultivar tested. The remaining cultivars were not significantly different from each other (Table 53). As a species, triticale was significantly higher in percent Ca than rye and wheat, which were not significantly different from each other (Table 54).

All variance components were found to be nonsignificant with respect to percent Ca of cultivars harvested for grain in 1973. All cultivars and species were not significantly different from each other (Tables 53 and 54).

As can be seen from Table 53, the 1972 grain contained a significantly higher percentage of Ca than grain harvested in 1973. When years were combined, there was not a significant difference between the planting dates tested. However, Fas Gro 204, Graz Grain 70A and Dot Pathfinder triticales were significantly higher in percent Ca in 1972 than in 1973. All cultivars were the same at the indicated level of probability when planted either early October or late October to early November.

When years and planting dates were averaged, Graz Grain 70A and Fas Gro 204 triticales were not significantly different from each other and significantly higher in percent Ca than any other cultivar tested. All other cultivars were not significantly different from each other, with Fas Gro 385 triticale being numerically the lowest (Table 53). When considered on a species basis, there were no significant differences among the three species represented in this experiment when years and planting dates were combined (Table 54).

Table 53. Percent Ca of Grain of Cultivars Harvested in 1972 and 1973

Cultivar	Percent Calcium[+]		
	1972	1973	Average
Fas Gro 204 triticale	0.07 a	0.02 a	0.05 a
Fas Gro 131 triticale	0.03 b	0.02 a	0.03 b
Fas Gro 385 triticale	0.03 b	0.02 a	0.02 b
Graz Grain 70A triticale	0.07 a	0.02 a	0.04 a
Dot Pathfinder triticale	0.04 b	0.01 a	0.03 b
Balbo rye	0.03 b	0.02 a	0.03 b
Arthur wheat	0.03 b	0.03 a	0.03 b

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

Table 54. Percent Ca of Grain of Species Harvested in 1972 and 1973

Species	Percent Calcium[+]		
	1972	1973	Average
Triticale	0.05 a[++]	0.02 a	0.03 a
Rye	0.03 b	0.02 a	0.03 a
Wheat	0.03 b	0.03 a	0.03 a

[+]Average of two planting dates, two stubble heights and four replications. Fas Gro 385 triticale included in only one planting date in 1971-72.

[++]Values within a column followed by the same letter are not significantly different at the .05 level of probability.

The percent Ca of grain of all cultivars tested was well below minimum requirements recommended by the NRC (42,43) for any beef or dairy cattle ration. This was true within each year and when years were combined.

CHAPTER V

SUMMARY AND CONCLUSIONS

The study herein reported was conducted at the Small Grains Farm at Knoxville, Tennessee, to determine if any triticale cultivar available to East Tennessee farmers could adequately replace Balbo rye or Arthur wheat in three management systems. Five triticale cultivars were obtained that were commercially available in this area. Also included in this study were the evaluation of two planting dates, early October versus late October to early November, clipping to two stubble heights, 5 and 10 cm, and two years, 1971-72 and 1972-73.

The cultivars were evaluated for vegetative stage forage, LM-ED stage forage and grain yield. In addition, all forage samples were evaluated for percent fiber, percent lignin, and percent crude protein. The LM-ED stage forage was evaluated also for percent P, Mg, K and Ca. The grain of each cultivar was analyzed for percent crude protein, P, Mg, K and Ca.

Fas Gro 204 and Graz Grain 70A triticales are not suited for the winters of East Tennessee. Fas Gro 385 and Fas Gro 131 triticales appear to be winter hardy enough for this environment.

The five triticales were intermediate between Arthur wheat and Balbo rye in height of plants in 1973. In that year, weights per 100 seeds of Fas Gro 131, Fas Gro 385 and Dot Pathfinder triticales were higher than that for Arthur wheat, while Balbo rye was lowest. This

did not result in a heavier test weight for these triticale cultivars due to the shrivelling noted in seed of the triticale species. Both Arthur and Balbo were higher in weight per hectoliter than any triticale cultivar in 1973.

The triticale cultivars tested had more sterile florets than Arthur wheat, but Fas Gro 131, Fas Gro 204 and Dot Pathfinder triticale were not significantly different in percent sterility from Balbo rye. Although grain yields of triticales and Balbo rye would have been higher if the percent sterile florets had been lower, it appears not to have been a primary factor in determining the relative grain yields since Fas Gro 131 and Fas Gro 385 triticales compared favorably with Arthur wheat and Balbo rye.

From the standpoint of yield alone, Balbo rye was the highest yielding cultivar tested when cut as vegetative stage forage throughout the spring. Fas Gro 131 and Fas Gro 385 triticales outyielded Arthur wheat over the two years evaluated in this experiment. Planting in early October resulted in more oven-dry forage than planting approximately a month later. Also, cutting to a 5 cm stubble during the harvest season resulted in higher yields compared to the 10 cm stubble height.

If the management practice is to take one cutting of LM-ED stage forage in the spring, then date of planting is again an important consideration. Yield of LM-ED stage forage of Balbo rye and Arthur wheat were extremely stable in relation to date of planting, while the triticale cultivars were more variable. Fas Gro 131, Fas Gro 385, and Dot Pathfinder triticales yielded as much or more than Balbo rye and

Arthur wheat in this experiment. When planted early, over the two years tested, Fas Gro 131 triticale yielded approximately twice as much oven-dry LM-ED stage forage as Balbo rye and Arthur wheat. Fas Gro 385 triticale yielded well above Balbo rye and Arthur wheat under this management practice. Clipping to either 5 or 10 cm did not have a considerable effect on relative yields when cultivars were cut in the LM-ED stage. However, from the standpoint of yield, cutting to 5 cm was the better treatment.

When harvested for grain, Fas Gro 131 and Fas Gro 385 triticale consistently yielded as much as or more grain than Balbo rye and Arthur wheat when planted the earlier dates over the two years evaluated. When planted later, Balbo rye was the highest yielding cultivar in this experiment. Dot Pathfinder triticale yielded comparatively well in 1972-73, but due to its susceptibility to low temperatures, should not be planted in lieu of Fas Gro 131 or 385 triticales.

Although when harvested as vegetative stage forage, Balbo rye was consistently as high as or higher in percent fiber and lignin than all other cultivars tested, there was not a difference large enough to justify replacing Balbo rye as the best cultivar tested to plant under this management system. Neither are there sufficient differences in percent fiber and lignin to justify cutting forage to the higher stubble at a cost of decreased yields. No cultivar was consistently low enough in fiber and lignin percentages to say that it would be a better quality forage than any other cultivar throughout the year.

When the cultivars were harvested as LM-ED stage hay or silage, there was no evidence in this experiment that Fas Gro 131 or Fas Gro 385 triticales, because of percent fiber and lignin, should be replaced as the recommended choice. Only Arthur wheat was consistently low enough in percent fiber and lignin to suggest that it would be a higher quality forage when cut in the LM-ED stage of maturity.

The percent crude protein was fairly consistent among the cultivars tested in this experiment. No cultivar was high enough in percent crude protein to say that it would be a higher quality feed than any other cultivar when harvested in any of the three management situations considered. The dates of planting studied generally had no real effect on percent crude protein. The higher stubble treatment usually resulted in a higher percent crude protein, probably due to more leafy forage, but not enough higher to justify the sacrifice in yield that would accompany clipping to only 10 cm.

No extreme differences in the cultivars included in this experiment were found with respect to percent P, Mg and K. The percent of these minerals was consistent enough so that they would not dictate choosing one cultivar over any of the others as being of higher quality LM-ED stage hay or grain. Generally, these minerals were high enough to be adequate, or require only minor supplementation, for beef and dairy cattle rations. However, with percent Ca, Balbo rye was definitely the highest of all cultivars harvested in the LM-ED stage in both years. With respect to grain, Balbo rye was no better than any other cultivar

in percent Ca. The Ca percentages obtained in this experiment were well below requirements for rations of beef and dairy cattle.

Therefore, specific conclusions and recommendations of this study are:

1. Fas Gro 204 and Graz Grain 70A triticales are not adapted to East Tennessee.
2. Balbo rye should be planted as a forage for continuous clipping or grazing during the growing season.
3. Fas Gro 131 and Fas Gro 385 triticales are recommended for LM-ED stage hay or silage. Dot Pathfinder triticale yields well under this management system, but appears to be a risk in East Tennessee because of susceptibility to low temperatures.
4. When harvested as grain, Fas Gro 131 was the highest yielding cultivar tested when planted in early October. When planting is delayed, Balbo rye and Arthur wheat would be recommended over the triticale cultivars tested. Fas Gro 131, Fas Gro 385 and Dot Pathfinder triticales would be the recommended triticales when planted either time, with caution advised for Dot Pathfinder triticale.
5. No quality evaluation made would indicate that one cultivar is of higher quality than any other cultivar. However, Balbo rye was consistently higher in percent fiber and lignin; while Arthur wheat was lower in these two indicators when cut in the LM-ED stage of maturity. The differences observed would not be of overriding consideration in the choice of cultivar,

unless a highly acceptable silage was desirable in a ration such as that for lactating dairy cows.

6. When cultivars were evaluated as species for quality characteristics, no unusual results were reported. In many cases, but not all, triticale was intermediate to wheat and rye.
7. As the harvest season progressed, the percent fiber and lignin of the cultivars evaluated progressively increased, and the percent crude protein progressively decreased. Therefore, the early harvest of vegetative stage forage was of higher quality than later cuttings.
8. Fas Gro 131, Fas Gro 385 and Dot Pathfinder triticales should be tested in other locations across the state of Tennessee. Furthermore, results reported in the literature and results of this study indicate that at least these three cultivars of triticale should be included in animal performance tests to determine digestibility and acceptability of triticale grain and forage.

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