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I am submitting herewith a thesis written by Joseph Jackson Slade entitled "Plant Growth Regulator Effects on the Forage Quality of Tall Fescue and Bermudagrass." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

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PLANT GROWTH REGULATOR EFFECTS ON THE FORAGE QUALITY OF TALL FESCUE AND BERMUDAGRASS

A Thesis

Presented For The

Master of Science

Degree

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ABSTRACT

Field experiments were conducted in 1981 and 1982 at Knoxville, Tennessee to determine the effectiveness of plant growth regulators on improving the forage quality of tall fescue (*Festuca arundinacea* Schreb.) and common bermudagrass (*Cynodon dactylon* (L.) Pers. var. *dactylon*) through late spring and summer. On May 13, 1981, a tall fescue experiment and a bermudagrass experiment were treated with chlormequat (2-chloroethyl trimethyl ammonium chloride), glyphosine (N, N-bis (phosphonomethyl) glycine), mefluidide (N-2, 4-dimethyl-5-(trifluoromethyl)-sulfonyl-aminophenylacetamide), and ethephon (2-chloroethyl phosphonic acid). On June 29, 1981, tall fescue and bermudagrass experiments were treated with chlormequat, glyphosine, mefluidide, ethephon, and endothall (7-oxabicyclo-(2,2,1)-heptane-2,3,-dicarboxylic acid, disodium salt). On April 15, 1982, a tall fescue experiment was treated with chlormequat, glyphosine, mefluidide, and ethephon. Dry matter production, neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, water soluble carbohydrates (WSC), and crude protein were determined from samples taken approximately every three weeks.

Bermudagrass showed a few small responses to treatment, and in some cases declined in quality. Tall fescue treated on April 15, 1982, while in the preboot stage, had the greatest increases in quality. Glyphosine reduced NDF by 10.1 and 12.7 percent in the first two sampling dates, and it reduced ADF by 5.6 and 6.8 percent in the first two sampling dates. Structural carbohydrate reductions were

also noted in 1981 with glyphosine, and with mefluidide and ethephon in 1981 and 1982. Increases in WSC of 10.7 and 12.3 percent were caused by glyphosine in the first two sampling dates of 1982. Some WSC increases, although not as large, were observed in 1981 from chlormequat, glyphosine, mefluidide, ethephon, and endothall treatments. Crude protein was increased in the first tall fescue experiment of 1981 by mefluidide and ethephon, and in 1982 by glyphosine, mefluidide, and ethephon. There were no differences in lignin or total yield, but yield reductions were observed in several harvests from glyphosine, mefluidide, and ethephon. Results indicate tall fescue quality was improved most by glyphosine applied in the preboot stage, with reductions in cellulose and hemicellulose and increases in WSC the most prominent changes. Further research should be conducted to determine the most effective chemical, rate, date of application for improving forage quality, and the effects of application on stand longevity.

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I. INTRODUCTION

It is a well established fact that forages are very important to the world's food resources. Forage crops support our huge livestock industry but have little direct value to humans until they are transformed by animals into meat, milk, or wool.

With the continual conversion of prime productive land to urban and industrial uses, rising energy costs, and rising demands for food, the importance of increasing quality and productivity of forage crops is becoming more apparent. The benefits from increasing forage quality could be realized in higher weaning weights, shorter backgrounding periods, less time to the feedlot, and a reduced need for supplements.

This experiment was initiated to determine if the application of growth regulators to Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.) and common bermudagrass (*Cynodon dactylon* (L.) Pers. var. *dactylon*) could improve forage quality by reducing cell wall constituents and increasing soluble carbohydrates and crude protein during late spring and summer when quality is lowest. Tall fescue is one of the most important forage species because of its ability to grow in a wide range of soil and climatic conditions (8). It will generally support a long grazing season and high stocking rate (8). Tall fescue is used on over 1.2 million hectares of pasture and hay in Tennessee. Common bermudagrass is widespread in Tennessee, mainly in the western and southern parts of the state (22). It is the dominant grass on about 200,000 hectares in Tennessee (22). Common bermudagrass is used for pasture rather than hay, because its short, dense growth does not lend itself to mechanical harvesting.

II. LITERATURE REVIEW

Forage Quality as Affected by Maturation

The environment influences the stage of physiological maturity of forages and results in differences in growth and chemical composition (6,14,34,56,62,66). Changes in temperature and photoperiod are primary factors responsible for advancing maturity (56,62). Increased levels of structural components have been noted from increased temperatures (2,14,34). The plant cell wall has been demonstrated experimentally to be the primary restriction on intake (62).

Allinson (2) reported a combination of long days (16-hour photoperiod) and high temperatures (27/16° C day/night) resulted in significantly lower percentages of _in vitro_ dry matter digestibility and _in vitro_ cellulose digestibility of tall fescue. Tall fescue grown in a cool environment (20/10° C day/night) was reported by Smith (56) to produce 20 percent more foliar dry matter, contain approximately 65 percent more soluble carbohydrates, and exhibit a 7 percent higher _in vitro_ dry matter digestibility than tall fescue grown in a warm environment (30/20° C day/night).

Minson (42) studied the digestibility of orchardgrass (_Dactylis glomerata_ L.) and ryegrass (_Lolium_ sp.) by sheep and noticed a rapid fall in digestibility when the heads emerged. Reductions in crude protein (5), ether extract, and acid-soluble ash have been reported to accompany advancing stages of growth (53). Mott (44) noted zero gains in steers grazing tall fescue pastures during summer and suggested a reduction in digestible energy intake alone was a critical factor limiting animal performance.

Nutritional value of structural and soluble carbohydrates

Ruminants utilize carbohydrates as their major source of energy for maintenance and productive purposes (4). Carbohydrates present in their diet consist of soluble sugars, oligosaccharides, fructans, starch, pectic substances, cellulose, and hemicellulose (31). Complex structures are hydrolyzed by rumen microbes to simple sugars, which are then fermented (31). Fermentation in the rumen can convert a large portion of the plant's structural components to forms which are directly useable by animal issues (38). Digestion of crude fiber yields about the same amount of energy per gram as digested starch or sugar (39).

The principal end products of all carbohydrate digestion are volatile fatty acids; mainly acetic, propionic, and butyric acids (39, 62). Considerable quantities of CO_2 and CH_4 are also produced as by-products of digestion (39). The relative amounts of volatile fatty acids (VFA) and byproducts produced vary with the diet.

Lignin and its effect on forage utilization

Lignin is an indigestible (12), noncarbohydrate phenylpropanoid polymer deriving subunits from the shikimic acid pathway that gives structural support to plant cell walls (62). Nutritionists view lignin as a negative index of forage quality because it is the main factor limiting digestion of structural carbohydrates (43,61,62). Lignin's effect on digestibility of structural carbohydrates quantitatively accounts for the influence of lignin on digestibility of forage dry matter (62).

It has been suggested (12,61) the acid detergent fiber (ADF) fraction is the most highly lignified and least digestible portion of the cell wall, and a close relationship exists between the effect of lignin and the lignin content of the ADF fraction. Evidence reported by Crampton and Maynard (12), from Schmidt-Ott, Iwata, and Williams and Olmstead, suggests hemicellulose may be somewhat more completely utilized by the ruminant than cellulose.

Advancing maturity of a forage produces changes in dry matter digestibility and voluntary intake which were closely correlated with cellulose digestibility and inversely related to lignin content (3). The increase in lignin noticed in certain grasses during the growing season reflects the change in proportion of stem tissue, which not only contains more lignin than leaves but undergoes greater lignification during maturation (32,33).

The mechanism by which lignin exerts its effect on cell wall digestiblity is the topic of several theories. The earliest theory was lignin imparts a physical barrier to microbial digestion by "incrusting" the cell wall (36,61,62). In support of this theory Kamstra (36) found that isolated cellulose was much more readily digested than cellulose in intact plant material.

An alternative theory is the presence of ligno-cellulose linkages resistant to cellulolytic enzymes (62). This theory is partially supported by the large increases in digestibility after alkali treatment of graminaceous straws, without altering the lignin content (62). Ester linkages between lignin and carbohydrates are characteristic of grasses and easily cleaved by alkali treatment (62). Rate of digestion studies where lignin does not appear to be associated with digestion rate of available cellulose also support this theory (62).

Crampton (12) suggested phenolic compounds derived from lignin precursors may influence forage digestion. Akin (1) tested p-coumaric, ferulic, and sinapic acids for their effect on rumen microbes and found p-coumaric, at certain concentrations, increased time required for cellulose digestion by two or three times, and inhibited the *in vitro* digestion of mesophyll and epidermal cells in leaf blades of orchardgrass. Mesophyll and epidermal cells were found by Hanna (32) to be rapidly digested tissues. Akin (1) reported there may be two or three times more p-coumaric acid in certain warm season grasses compared to cool season species.

Management Employed to Keep Forages in a More Nutritious State

Laude et al. (37) reviewed the literature on seasonal trends in tiller production and reported a decline in tiller production near the onset of flowering in several perennial grasses with an increase in tillering soon after. The growth of tillers provides most of the forage regrowth by herbage grasses (37). Reduced tillering during the reproductive stage was found to be offset, to a certain degree, by grazing or clipping the flowering stalks (37). Peterson (52) noted increased shoot numbers from plants heavily grazed.

Grazing heavily at this stage can also eliminate subsequent coarse and stemmy growth and appears to be a sound practice when seedhead production is not desired (37). Increased forage quality through heavy grazing has also been noted by Duvall (15), and Duvall and Whitaker (16). Burris, in Glenn et al. (28), reported harvesting forage at 14-day intervals prevented the onset of reproductive growth, and resulted in higher quality forage. Total dry matter yields were reduced by frequent cuttings (28,45).

Chemical Control of Grass Height

Height reductions in turf

The feasability of using chemical growth retardants to reduce mowing frequency and management costs of turf and roadside areas has become a topic of increasing interest (47). Growth retarding chemicals have been applied to turf grasses since 1949, when maleic hydrazide (1,2-dihydro-3, 6-pyridazindeione) was introduced (64).

Wu et al. (67) reported split applications and combinations of mefluidide, maleic hydrazide, chlorflurenol (methyl 2-chloro-9-hydroxyfluorene-9-carboxylate), and ethephon, at low rates, reduced growth and seedhead development of common bermudagrass. In the same experiment Wu et al. (67) noted chlormequat to be the least effective retardant tested, which does not agree with results of Cabler and Horn (9) who found chlormequat to perform better than maleic hydrazide. Reports from Gates (24) and Hield and Hemstreet (35) indicate mefluidide was effective in suppressing growth and seedhead formation in annual roadside grasses and cool and warm season turfgrasses. Suppression of growth and seedhead formation in tall fescue have been noted with applications of mefluidide (10,63,64) and other chemicals (17,18). Similar results have also been observed from mefluidide (21,30) and ethephon (21,41) applied to Kentucky bluegrass (Poa pratensis L.). Elkins (17) reported treatments should be applied for maximum effectiveness on tall fescue before the terminal growing point begins to elongate, and chemical effectiveness may be reduced by clipping prior to treatment due to a decrease in leaf surface area and absorptive capacity.

Adverse effects have been noted from use of retarding chemicals on grasses. Poovaiah and Leopold (54) reported a strong suppression of leaf elongation and a simultaneous stimulation of stem elongation in bluegrass 'Sydsport' treated with ethephon. Elkins et al. (19) suggested phytotoxic sensitivity to retarding chemicals is greater for Kentucky bluegrass and other intensively managed turfgrasses than for tall fescue. Reduced tiller numbers in tall fescue and bermudagrass, and reduction in rhizome numbers and length in Kentucky bluegrass have been reported from application of growth retardants (20,21,41). Slight retardation of bermudagrass root growth after treatment with chlormequat was reported by Younger and Nudge (68). Elkins et al. (20) suggested most chemical retardants which cause aerial growth reductions may also restrict root spread, root volume, and root dry weight.

Height reduction in cereal crops

Research has been conducted on the application of plant growth regulators to cereal crops to increase harvestable yields by reducing lodging. Lodging, caused by heavy winds or rain, can result in serious yield losses in tall cereals, such as barley (Hordeum vulgare L.), which currently cannot be reduced in height with semi-dwarf genes (13). Experiments with chlormequat and ethephon have proven effective in reducing lodging in certain cereal crops (7,13,46,58). Tolbert (58) reported shorter and thicker stems, earlier and stronger tillering and more uniform growth of wheat (Triticum vulgare cv. 'Thatcher') treated with chlormequat. Dahnous (13) found ethephon virtually eliminated lodging in barley and triticale (Triticale hexaploid L.) treated in the late boot stage. Lodging in wheat has also been reduced by ethephon treatement (7). Brown and Earley (7) noted no benefit from ethephon applied to spring oats (Avena sativa L.) due to yield reductions which accompanied height reductions.

Chemical Enhancement of Sucrose in Sugarcane

The first concerted effort to control the ripening of sugarcane (Saccharum spp. hybrids) by the use of plant growth regulators was started in Hawaii in the early 1960's. Osgood (48) described ripening as the induction of sucrose storage in preference to vegetative growth. Partitioning dry matter in favor of sucrose storage is apparently a function of reduced plant growth in an environment still conducive to photosynthesis (51). Reduced sugarcane growth and induction of sucrose storage can be brought about by lower winter temperatures and withdrawal of irrigation (51). These effects can also be induced by treatment with glyphosine and glyphosate (N-phosphonomethyl glycine) (46,47,48,49,50,51). Glyphosine was the first sugarcane ripener to be registered in the United States (40,47). Glyphosate was also registered in 1980 (47). Ethephon is used commercially on sugarcane in South Africa and Rhodesia (46,47). Chlormequat, mefluidide, and endothall have been registered for experimental use in the United States and several other countries (47).

Glyphosine has been extensively field-tested in Hawaii and Louisiana since 1969 and 1975, respectively. In Louisiana, although its performance was inconsistent, 20 percent of the tested locations had significant increases in sugar per acre (40). Some of the inconsistencies were explained by the presence of ratoon stunting disease (40). Infected cane was found by Martin et al. (40) to have a higher level of sucrose than noninfected and occisionally responded negatively to treatment. Also found were varietal differences in treatment response (40).

From 1970 to 1978 glyphosate was found to consistently enhance the ripening of Hawaiian sugarcane (48). As compared to glyphosine, glyphosate improved sucrose content over a wider range of climatic conditions, was less cultivar specific, and the ripening response was more constant and rapid (48). Glyphosate also increased sucrose as percent of stalk weight and sucrose purity more than glyphosine, and was considerably more effective when applied at approximately one-tenth the rate of glyphosine (50).

Experimenting with glyphosate, glyphosine, ethephon, and mefluidide Osgood and Teshima (51) suggested two models for chemical enhancement of sucrose in sugarcane. Glyphosate and glyphosine apparently increased sucrose per stalk by increasing the partitioning of dry matter toward sucrose storage and away from fiber production (51). Mefluidide, and to a lesser extent ethephon, apparently increased sucrose per stalk by increasing the total amount of dry matter produced, with a greater portion incorporated as fiber and a lesser amount as sucrose (51). Nickell (47) reported sugar yields can be increased as much as 20 percent depending on variety, weather and soil conditions.

Use of Plant Growth Regulators for Improving Forage Quality

Brown and Blazer (6) reported the application of maleic hydrazide on orchardgrass resulted in retarded maturity and increased water soluble carbohydrates, but many plants became chlorotic and necrotic with reduced dry matter yields. Glenn et al. (28) initiated a series of experiments to determine the effect of mefluidide on tall fescue quality, dry matter production, effective rates and dates of application, and animal response to treated forage. Mefluidide was applied at 0.28 and 0.56 kg/ha on April 29. Within 14 days after treatment a decrease in percent cellulose and increases in percent sugar and crude protein were noticed (28). Dry matter yields were reduced 21 days after treatment with both rates in one year and the highest rate in the second year (27). Yield reductions from mefluidide treatment have also been noted by Gerrish and Dougherty (25). Glenn et al. (27) found *in vitro* cellulose digestibility increased after mefluidide treatment. Glenn et al. (28) suggested reduced seedhead production after treatment was responsible for the increased quality of treated forage. Later application dates and split applications were found to lengthen the quality response (unpublished data). Gerrish and Dougherty (25) reported higher legume seedling populations in renovated pastures when mefluidide was used to suppress growth of tall fescue. The productivity per hectare of yearling beef steers and heifers grazing mefluidide-treated tall fescue pastures has been found by Robb et al. (55) to be increased as much as 27 percent.

Glenn (26) found increased incorporation of ^{14}C-leucine into protein of corn coleoptile sections treated with mefluidide, increased ^{14}C-UTP incorporation into RNA, and increased ^{3}H-TTP incorporation into DNA. Truelove et al. (59) noted the same results with ^{14}C-leucine incorporation and suggested mefluidide affected DNA-directed RNA synthesis which in turn affects the rate of protein synthesis. Glenn (26) also found mefluidide enhanced corn coleoptile elongation approximately equal to increases with IAA, and suggested the auxin activity of mefluidide may be responsible for the stimulation of protein and nucleic acid synthesis.

Wilkinson (65) found the conversion of kaurene to kaurenol was inhibited by mefluidide with a concomitant inhibition of the conversion of geranylgeranyl pyrophosphate to kaurene. Wilkinson (65) suggested the inhibitions lead to a major decrease in gibberellin (GA) biosynthesis and plant growth. In contrast, Truelove (59) reported applications of GA_3 did not reverse the growth retarding effects of mefluidide.

In view of the past research with plant growth regulators, a research project was designed to determine if the application of chlormequat, glyphosine, mefluidide, ethephon, and endothall to tall fescue and bermudagrass would improve forage quality during the late spring and summer. The desired improvements in quality would include reducing fiber constituents and increasing soluble carbohydrates and crude protein.

III. MATERIALS AND METHODS

Established areas of Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.) and Common bermudagrass (*Cynodon dactylon* (L.) Pers. var. *dactylon*) were treated with plant growth regulators in 1981 and 1982. There were two experiments of each grass species in 1981. One experiment of each species received treatments of mefluidide, glyphosine, chlormequat, and ethephon on May 13, 1981, and will be referred to as first application plots (refer to Table 1 for rates). The remaining two experiments received treatments of mefluidide, glyphosine, chlormequat, ethephon, and endothall on June 29, 1981. Forages treated in 1981 were in a stage of leafy regrowth. In 1982 the first application area of tall fescue was treated in the preboot stage with mefluidide, glyphosine, chlormequat, and ethephon on April 15. This was the only experiment in 1982. Growth regulators were applied with a CO_2 pressurized backpack sprayer operating under 2.07 bars pressure and delivering 262 liters per hectare. The first application fescue and bermudagrass plots were 1.83 m x 7.32 m in a randomized complete block design with three replications. The second application plots were 1.22 m x 4.57 m in a randomized complete block design with three replications. Experiments were located on the University of Tennessee Plant and Soil Science Field Laboratory near Knoxville. Soils of all treated areas were Etowah silt loam (fine-loamy, siliceous, thermic Typic Paleudults).

In 1981 soil tests indicated a pH range of 5.9 to 6.9 and medium to high levels of P and K for the areas. Nitrogen as NH_4NO_3 was applied

Table 1. Chemicals used in experiments and rates at which they were applied.

Common name	Trade name	Chemical Name	Rate of active ingredient 1981	1982
			kg/ha	
Mefluidide	Embark	N-[2,4-dimethyl-5-[[(trifluoromethyl) sulfonyl]amino]phenyl]acetamide	0.42	0.28
Glyphosine	Polaris	N,N-bis(phosphonomethyl)glycine	3.81	3.81
Chlormequat	Cycocel	2-chloroethyltrimethyl ammonium chloride	2.13	2.13
Endothall	Endothal	7-oxabicyclo-(2,2,1)-heptane-2,3-dicarboxylic acid, disodium salt	1.12	1.12
Ethephon	Ethrel	2-chloroethylphosphonic acid	1.9	1.9

after mowing to the first and second application fescue experiments on April 27, 1981, at 68.5 kg N/ha. Nitrogen was applied after mowing to the first application bermudagrass area on May 8, 1981, and to the second application bermudagrass area June 19, 1981 at 68.5 kg/ha. Both bermudagrass areas were treated with a 2,4-D bar after fertilization. The first application fescue area was again fertilized with N at 68.5 kg/ha on March 23, 1982.

First application samples in 1981 were harvested from a 0.46 m x 7.32 m strip through the middle of each plot on June 5, June 24, July 24, August 10, and September 2. A rotary mower was used to harvest and to remove borders at a 5-cm stubble height on each date. Second application samples in 1981 were harvested from a 0.46 m x 4.57 m area through the middle of each plot on July 20, August 12, September 1, and October 20. In 1982 grab samples were taken from the fescue experiment on April 29. Harvests were made from a 0.46 m x 7.32 m area through the middle of each plot on May 5 and May 27. Samples from 1981 and 1982 were dried in a forced air oven at 60° C for approximately 48 hours. Grab samples and grab samples taken from harvest collection bags were ground to pass through a 2 mm screen, and used for laboratory analysis. Height of sward in first application 1981 plots was measured 23 days after treatment, regrowth was also measured 19 days after the first harvest. Height of sward and seedhead density were measured 13 days after treatment in 1982. Observations were made on May 5, May 21, and June 9 in 1982 to detect visual differences in plant response.

Five forage quality indicators (water soluble carbohydrates (WSC), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignin) were determined on a dry matter basis for each grab sample taken. Water soluble carbohydrates include monosaccharides, sucrose, starch, and fructosans. Crude protein includes true proteins and nitrogen containing compounds which can be converted to microbial protein. Neutral detergent fiber is composed primarily of cellulose, hemicellulose, and lignin. Acid detergent fiber is composed primarily of cellulose and lignin. The water soluble carbohydrates were analyzed with the Scientific Analyzer 200, which employs the colorimetric potassium ferricyanide-potassium ferrocyanide oxidation-reduction reaction (23). Total N was determined with a Technicon Auto-analyzer on extracts obtained after digestion in concentrated H_2SO_4 and 35 percent H_2O_2 (57). Crude protein was calculated by multiplying percent N by 6.25. Neutral and acid detergent fiber were extracted according to Goering and Van Soest (29) and Van Soest (60), with slight modifications on a Fibertec System. Lignin was determined by treating the ADF fraction with 72 percent H_2SO_4 and ashing, according to the procedure of Cherney and Marten (11).

Data were analyzed by analysis of variance procedures. Significant differences ($\alpha \doteq 0.05$) among means were determined by the Duncan's Multiple Range Test. Climatic data were recorded approximately 180 m from the experiment.

IV. RESULTS AND DISCUSSION

1981 Experiments

Tall fescue treated on May 13, 1981

Forage produced during both fescue experiments was all leafy material because spring flowering heads were removed before treatments were applied. Dry matter production was reduced by glyphosine and melfuidide in the early June harvest (Table 2). Height measurements made prior to first harvest indicated glyphosine and mefluidide reduced height of fescue plants. Mefluidide and ethephon reduced yields in the late June harvest with mefluidide having the greatest effect. The yield suppressing effects of glyphosine appeared to be short-lived, and yield increases were noticed in the July harvest as well as with mefluidide. There were no differences in the August or September harvests. Total yields for the experiment were not different. However, glyphosine and melfuidide did have noticeable yield reductions. Reduced dry matter production from mefluidide (28) and glyphosine (18) has been noted by earlier researchers.

Neutral detergent fiber (NDF) was reduced by glyphosine, mefluidide, and ethephon in the early and late June harvests (Table 3). Ethephon and mefluidide also caused reductions in NDF in the July harvest. Ethephon-treated fescue had the lowest NDF values at the late June and July harvests.

Reductions in acid detergent fiber (ADF) were observed in the early June harvest from mefluidide (Table 3). The ADF was reduced at the second harvest by glyphosine, mefluidide, and ethephon, with

Table 2. Forage dry matter production of tall fescue treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sep. 2	Total Yield
	kg/ha					
Chlormequat	1571 a[1]	276 bc	211 b	81 b	154 a	2293 a
Glyphosine	915 b	389 a	305 a	80 b	158 a	1847 a
Mefluidide	923 b	159 d	341 a	127 a	184 a	1734 a
Ethephon	1643 a	248 c	237 b	97 ab	155 a	2380 a
Check	1619 a	345 ab	230 b	93 ab	167 a	2454 a

[1]Means with the same letter within a column do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 3. Selected cell wall constituents (as percent of dry matter) in forage of tall fescue treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sep. 2
	%NDF				
Chlormequat	62.0 ab[1]	53.3 ab	55.5 bc	50.7 a	56.0 b
Glyphosine	59.6 b	52.1 bc	57.7 a	52.4 a	56.7 ab
Mefluidide	57.5 b	49.8 c	54.5 cd	52.8 a	57.9 a
Ethephon	60.6 b	47.3 d	53.3 d	50.1 a	55.3 b
Check	66.6 a	54.6 a	56.6 ab	51.7 a	56.9 ab
	%ADF				
Chlormequat	34.6 a[1]	31.6 ab	32.1 a	28.5 a	30.3 bc
Glyphosine	34.1 a	30.4 b	32.1 a	29.4 a	30.1 bc
Mefluidide	32.3 b	27.7 c	30.2 b	29.3 a	31.0 ab
Ethephon	35.1 a	28.2 c	29.6 b	27.5 a	29.5 c
Check	35.0 a	32.1 a	32.8 a	29.1 a	31.6 a
	%Lignin				
Chlormequat	5.7 a[1]	5.4 a	7.0 a	5.9 a	6.5 a
Glyphosine	6.8 a	5.8 a	6.8 a	6.7 a	6.6 a
Mefluidide	8.1 a	5.2 a	7.1 a	6.6 a	5.8 a
Ethephon	7.7 a	6.2 a	6.3 a	6.2 a	6.4 a
Check	7.7 a	5.8 a	7.0 a	6.5 a	5.1 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

mefluidide and ethephon causing the most suppression. Forage at the July harvest had ADF reduced with mefluidide and ethephon. The ADF was affected similarly to NDF, which suggests that the structural carbohydrates were collectively affected. There were no differences in lignin at any harvest date (Table 3).

There were no differences in water soluble carbohydrates (WSC) in forage regrowth after the first harvest (Table 4). Mefluidide increased WSC in the early June harvest. Increased sugar values from mefluidide application have also been found by Glenn et al. (28).

Increases in crude protein (CP) were noted in the late June and July harvests for mefluidide and ethephon treated plants (Table 4). Glenn et al. (28) also reported increases in crude protein with mefluidide application.

Tall fescue treated on June 29, 1981

Mefluidide-treated plants had yields reduced in the first harvest and in two successive regrowths (Table 5). Ethephon also reduced yields in the third harvest. There were no differences in total yield, however, glyphosine and mefluidide caused noticeable reductions.

Ethephon reduced NDF in the first three harvests (Table 6), while melfuidide reduced NDF only in the September forage. The ADF was also reduced by ethephon in the first three harvests (Table 6). The reductions in NDF and ADF by ethephon suggest both cellulose and hemicellulose are being reduced. Lignin was increased in the August harvest by mefluidide (Table 6).

Table 4. Selected cellular contents (as percent of dry matter) in forage of tall fescue treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sept. 2
	%WSC				
Chlormequat	3.9 ab[1]	8.7 a	6.7 a	9.4 a	6.8 a
Glyphosine	3.5 ab	7.6 a	5.4 a	8.3 a	6.6 a
Mefluidide	4.7 a	10.4 a	6.0 a	10.0 a	7.0 a
Ethephon	3.6 ab	8.3 a	6.8 a	9.7 a	6.7 a
Check	3.3 b	8.7 a	6.3 a	9.1 a	6.5 a
	%CP				
Chlormequat	13.7 b[1]	15.9 c	14.7 b	14.7 a	13.9 a
Glyphosine	16.1 a	16.6 bc	15.0 b	14.4 a	13.5 a
Mefluidide	16.2 a	18.9 a	17.0 a	15.2 a	14.2 a
Ethephon	16.0 a	17.8 ab	16.1 a	15.7 a	14.2 a
Check	14.8 ab	15.3 c	14.5 b	14.4 b	13.4 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 5. Forage dry matter production of tall fescue treated on June 29, 1981.

Treatment	Harvest Date July 20	Aug. 12	Sep. 2	Oct. 20	Total Yield
	----------kg/ha----------				
Chlormequat	934 a[1]	172 a	217 ab	415 a	1739 a
Glyphosine	623 ab	120 ab	198 abc	390 a	1330 a
Mefluidide	528 b	48 b	164 c	401 a	1142 a
Ethephon	891 a	193 a	185 bc	463 a	1732 a
Endothall	910 a	195 a	200 abc	378 a	1680 a
Check	968 a	204 a	243 a	461 a	1876 a

[1]Means with the same letter within a column do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 6. Selected cell wall constituents (as percent of dry matter) in forage of tall fescue treated on June 29, 1981.

Treatment	Harvest Date July 20	Aug. 12	Sep. 2	Oct. 20
	%NDF			
Chlormequat	57.9 a[1]	57.7 ab	58.7 a	49.4 ab
Glyphosine	58.2 a	58.7 a	58.0 a	49.6 a
Mefluidide	57.7 a	55.9 b	56.0 c	48.3 ab
Ethephon	55.5 b	53.1 c	56.4 bc	48.8 ab
Endothall	57.4 a	55.8 b	57.7 ab	48.6 ab
Check	57.7 a	56.5 ab	58.1 a	48.1 b
	%ADF			
Chlormequat	31.4 ab[1]	29.8 a	32.2 a	25.7 ab
Glyphosine	31.8 ab	29.6 a	31.2 abc	25.8 a
Mefluidide	32.0 a	29.5 a	31.0 bc	25.3 abc
Ethephon	30.7 b	27.1 b	30.3 c	25.1 bc
Endothall	31.1 ab	29.2 a	31.5 ab	25.0 c
Check	32.0 a	29.5 a	31.9 ab	25.1 bc
	%Lignin			
Chlormequat	5.2 a[1]	5.4 b	6.5 ab	4.1 a
Glyphosine	5.6 a	5.1 b	6.0 abc	4.0 a
Mefluidide	6.5 a	6.4 a	5.4 c	3.6 a
Ethephon	5.7 a	5.1 b	6.6 a	4.0 a
Endothall	4.0 a	4.8 b	5.6 bc	3.9 a
Check	5.7 a	5.4 b	5.9 abc	4.1 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

There were no differences in WSC of the first or third harvests (Table 7). Small increases were noted in the August forage with chlormequat, glyphosine, ethephon, and endothall. Much larger increases in WSC occurred in all treatments from early September to late October. Seasonal WSC fluctuations occur commonly in tall fescue, and high levels are typically accumulated in the fall. Chemical applications did not affect crude protein at any harvest (Table 7).

Bermudagrass treated on May 13, 1981

There was no differences in yield at any harvest date (Table 8). However, height reductions were observed prior to first harvest from mefluidide and ethephon (Appendix A). There were no differences in total yield. The NDF was not affected by chemical treatements at any harvest (Table 9). Reductions in ADF occurred at the early and late June harvests from glyphosine, mefluidide, and ethephon (Table 9). Lignin and WSC were not affected at any harvest (Table 9 and 10). Crude protein was increased in the first harvest by ethephon (Table 10), but was not affected in later harvests.

Bermudagrass treated on June 29, 1981

Yield reductions were noted in the first harvest from glyphosine, mefluidide, and ethephon, with glyphosine causing the most severe yield suppression (Table 11). After the first harvest no differences in yield were observed. Glyphosine forage had the lowest value in total yield, but was not significantly different from the check. No visible differences in reproductive growth were observed in either bermudagrass experiment.

Table 7. Selected cellular contents (as percent of dry matter) in forage of tall fescue treated on June 29, 1981.

Treatment	Harvest Date July 20	Aug. 12	Sep. 2	Oct. 20
	%WSC			
Chlormequat	8.5 a[1]	9.8 a	6.7 a	24.8 ab
Glyphosine	8.6 a	9.3 a	6.7 a	25.0 ab
Mefluidide	8.2 a	8.0 b	6.7 a	24.6 b
Ethephon	8.4 a	9.9 a	6.7 a	25.7 a
Endothall	7.7 a	9.8 a	7.0 a	25.0 ab
Check	8.1 a	8.5 b	7.2 a	25.6 a
	%CP			
Chlormequat	14.1 ab[1]	14.3 b	13.5 b	11.4 a
Glyphosine	13.0 b	14.5 ab	14.3 ab	11.2 a
Mefluidide	13.5 b	16.4 a	15.9 a	11.9 a
Ethephon	14.8 a	16.5 a	14.6 ab	11.3 a
Endothall	15.1 a	15.1 ab	14.2 ab	11.9 a
Check	14.3 ab	15.1 ab	14.5 ab	11.9 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 8. Forage dry matter production of bermudagrass treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sep. 2	Total Yield
	--------kg/ha--------					
Chlormequat	867 a[1]	746 a	563 a	463 a	422 a	3061 a
Glyphosine	682 a	832 a	610 a	461 a	382 a	2967 a
Mefluidide	958 a	769 a	475 a	459 a	390 a	3052 a
Ethephon	753 a	774 a	638 a	472 a	388 a	3026 a
Check	825 a	789 a	408 a	485 a	378 a	2885 a

[1]Means with the same letter within a column do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 9. Selected cell wall constituents (as percent of dry matter) in forage of bermudagrass treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sep. 2
	%NDF				
Chlormequat	70.4 a[1]	70.0 a	69.7 a	71.3 a	69.5 b
Glyphosine	70.6 a	70.0 a	70.2 a	73.6 a	72.3 a
Mefluidide	70.3 a	69.9 a	71.2 a	72.5 a	71.4 ab
Ethephon	69.4 a	68.4 a	69.1 a	72.0 a	70.5 ab
Check	71.6 a	69.9 a	69.3 a	73.0 a	69.8 ab
	%ADF				
Chlormequat	33.7 ab[1]	32.8 a	31.2 a	33.7 a	31.9 a
Glyphosine	33.0 c	32.1 b	30.9 a	33.8 a	33.0 a
Mefluidide	33.2 bc	31.7 b	31.3 a	33.2 a	33.4 a
Ethephon	32.7 c	31.6 b	30.8 a	33.6 a	32.1 a
Check	33.8 a	33.0 a	30.4 a	34.4 a	32.3 a
	%Lignin				
Chlormequat	7.3 a[1]	8.0 a	5.6 a	5.6 a	5.3 a
Glyphosine	7.4 a	6.4 a	5.7 a	6.9 a	5.4 a
Mefluidide	7.5 a	8.2 a	5.6 a	5.5 a	5.5 a
Ethephon	6.4 a	7.0 a	3.5 a	5.8 a	5.3 a
Check	7.0 a	8.0 a	5.4 a	5.7 a	5.3 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 10. Selected cellular contents (as percent of dry matter) of bermudagrass treated on May 13, 1981.

Treatment	Harvest Date June 5	June 24	July 14	Aug. 10	Sep. 2
	%WSC				
Chlormequat	3.7 a[1]	4.3 a	5.4 a	6.4 a	6.9 a
Glyphosine	4.0 a	4.5 a	5.1 a	7.1 a	5.8 a
Mefluidide	3.8 a	4.8 a	5.3 a	6.4 a	6.1 a
Ethephon	4.2 a	4.8 a	5.5 a	6.7 a	6.6 a
Check	3.7 a	4.3 a	5.3 a	7.1 a	6.6 a
	%CP				
Chlormequat	14.3 c[1]	12.4 b	13.0 ab	9.6 a	9.1 a
Glyphosine	15.1 ab	13.4 ab	12.9 ab	10.0 a	9.2 a
Mefluidide	14.3 c	13.5 ab	12.6 b	9.7 a	9.1 a
Ethephon	15.6 a	13.6 a	13.2 a	9.8 a	9.3 a
Check	14.4 bc	12.6 ab	12.8 ab	9.1 a	8.7 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 11. Forage dry matter production of bermudagrass treated on June 29, 1981.

Treatment	Harvest Date July 20	Aug. 12	Sep. 2	Oct. 20	Total Yield
	kg/ha				
Chlormequat	1356 a[1]	647 ab	586 a	1637 a	4225 a
Glyphosine	532 c	765 a	627 a	1287 a	3211 a
Mefluidide	942 b	618 ab	578 ab	1482 a	3620 a
Ethephon	1049 b	541 ab	568 ab	1520 a	3679 a
Endothall	1427 a	444 b	417 b	1562 a	3850 a
Check	1493 a	535 ab	505 ab	1667 a	4199 a

[1]Means with the same letter within a column do not differ significantly at $\alpha = 0.05$ by Duncan's Multiple Range test.

NDF was increased in the August harvest by glyphosine and mefluidide, and in the September harvest by glyphosine (Table 12). No differences in NDF were observed in the July or October harvests. The ADF was also increased by glyphosine in the August harvest (Table 12). The second harvest was the only one that had ADF differences. There were no differences in lignin at any harvest date (Table 12).

Glyphosine and mefluidide reduced WSC in forage in the August and September harvests (Table 13). No differences were found in the July or October harvests. Crude protein was not affected at any harvest date (Table 13). Both bermudagrass experiments had reductions in crude protein from the early to late harvests for all treatments. Crude protein reductions in fall occur typically in bermudagrass.

1982 Experiment

Tall fescue treated on April 15, 1982

In 1982, visual observations were made on the effect of chemical treatment when applied before heading of tall fescue. Unusually cold weather in early spring 1982 appeared to delay the reproductive growth as compared to 1981. First observations were made 13 days after treatment. Height reductions occurred from glyphosine, mefluidide, and ethephon, with glyphosine having the greatest effect (Appendix B). Seedhead density appeared reduced from glyphosine, melfuidide, and ethephon, with glyphosine having the most reduction (Appendix B). On May 5 observations were made prior to harvest. Glyphosine-treated forage appeared to have

Table 12. Selected cell wall constituents (as percent of dry matter) in forage of bermudagrass treated on June 29, 1981.

Treatment	Harvest Date July 20	Aug. 12	Sep. 2	Oct. 20
	%NDF			
Chlormequat	67.8 b[1]	63.7 b	65.5 b	68.4 a
Glyphosine	72.1 ab	72.0 a	73.9 a	71.2 a
Mefluidide	73.3 a	70.8 a	70.5 ab	70.1 a
Ethephon	68.9 ab	65.2 ab	68.1 ab	69.7 a
Endothall	70.4 ab	65.4 ab	68.2 ab	70.8 a
Check	68.7 ab	62.8 b	66.2 b	70.3 a
	%ADF			
Chlormequat	31.5 bc[1]	27.0 b	28.9 b	33.4 a
Glyphosine	33.1 a	30.1 a	31.3 a	33.3 a
Mefluidide	33.1 ab	29.2 ab	30.4 ab	33.8 a
Ethephon	31.3 c	27.9 ab	30.0 ab	33.2 a
Endothall	32.3 abc	28.2 ab	29.5 ab	33.8 a
Check	31.9 abc	26.8 b	29.4 ab	34.0 a
	%Lignin			
Chlormequat	5.6 a[1]	4.8 a	5.9 a	6.5 a
Glyphosine	6.3 a	5.0 a	5.3 a	4.7 a
Mefluidide	6.2 a	4.8 a	5.1 a	6.1 a
Ethephon	5.6 a	4.8 a	4.7 a	5.7 a
Endothall	5.9 a	4.3 a	4.7 a	5.5 a
Check	5.4 a	5.1 a	5.6 a	5.9 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 13. Selected cellular contents (as percent of dry matter) in forage of bermudagrass treated June 29, 1981.

Treatment	Harvest Date: July 20	Aug. 12	Sep. 2	Oct. 20
	%WSC			
Chlormequat	6.2 a[1]	8.9 a	7.1 ab	7.9 a
Glyphosine	5.6 a	6.4 b	5.6 bc	7.7 a
Mefluidide	5.6 a	6.4 b	5.4 c	7.2 a
Ethephon	5.5 a	7.6 ab	6.8 abc	8.1 a
Endothall	6.6 a	8.4 ab	7.2 ab	9.8 a
Check	6.0 a	9.0 a	7.8 a	8.5 a
	%CP			
Chlormequat	13.4 ab[1]	13.4 a	10.9 a	7.8 b
Glyphosine	13.7 ab	12.6 a	10.2 a	9.0 a
Mefluidide	12.4 b	12.7 a	10.4 a	7.8 b
Ethephon	14.0 a	13.5 a	10.8 a	7.4 b
Endothall	12.6 b	12.7 a	10.7 a	7.7 b
Check	13.2 ab	12.6 a	10.6 a	7.1 b

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

fewer seedheads and retarded maturation to a greater degree than any other treatment.

Mefluidide-treated forage was intermediate between glyphosine and the check in this regard. Retarded maturity was noted in two of the three ethephon replications. After growth was removed on May 5, observations on May 21 indicated melfuidide reduced density of vegetative growth, with glyphosine intermediate between mefluidide and the check. Vegetative growth continued to show reduced density from mefluidide on June 9.

Glyphosine reduced yields of the early May harvest (Table 14) and mefluidide reduced yields of the late May harvest. These reduced yields can be explained by the glyphosine-suppressed development and density of stems on May 5 and mefluidide-reduced density of vegetative growth observed on May 27. Seedhead suppression by mefluidide has been reported by Glenn et al. (28).

The NDF was reduced by glyphosine and mefluidide in the first two sampling dates (Table 15). Glyphosine reduced NDF the most and resulted in decreases of 10.1 and 12.7 percent for the April and early May sampling dates, respectively. Ethephon also reduced NDF at the early May smapling date. There was no effect from chemical treatments on the last sampling date. Reductions in NDF probably resulted from the retarded maturity effect of glyphosine, mefluidide, and ethephon.

The ADF was reduced also by glyphosine and mefluidide at the first two sampling dates (Table 15). Glyphosine caused the greatest reductions in ADF, with 5.9 and 6.8 percent less for the April and early May sampling dates respectively. The ADF was slightly reduced

Table 14. Forage dry matter production of tall fescue treated on April 15, 1982.

Treatment	Sampling Date: May 5	Sampling Date: May 27	Total Yield
	----------kg/ha----------		
Chlormequat	3146 a[1]	348 a	3494 a
Glyphosine	1688 c	301 a	1989 b
Mefluidide	2207 bc	148 b	2355 b
Ethephon	2853 ab	362 a	3215 a
Check	2889 ab	340 a	3229 a

[1]Means with the same letter within a column do not differ significantly at $\alpha = 0.05$ by Duncan's Multiple Range test.

Table 15. Selected cell wall constituents (as percent of dry matter) in forage of tall fescue treated on April 15, 1982.

Treatment	Sampling Date: Apr. 29	May 5	May 27
	------------%NDF------------		
Chlormequat	51.5 a[1]	56.3 a	59.1 a
Glyphosine	42.6 c	43.7 d	59.1 a
Mefluidide	48.9 b	51.3 c	56.8 a
Ethephon	50.5 ab	53.6 b	56.3 a
Check	52.7 a	56.4 a	59.0 a
	------------%ADF------------		
Chlormequat	27.6 a[1]	30.9 a	32.6 a
Glyphosine	22.1 c	23.5 c	31.2 ab
Mefluidide	25.9 b	27.9 b	29.5 b
Ethephon	27.1 a	29.2 ab	30.4 b
Check	28.0 a	30.3 a	32.3 a
	------------%Lignin------------		
Chlormequat	4.6 a[1]	4.4 a	4.9 a
Glyphosine	4.0 a	3.9 a	4.9 a
Mefluidide	4.4 a	3.8 a	4.7 a
Ethephon	3.7 a	3.8 a	4.6 a
Check	4.5 a	3.1 a	5.6 a

[1]Means with the same letter within a column and a constituent do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

at the May sampling date by mefluidide and ethephon. Reduction trends in ADF are similar at some dates to NDF and probably resulted from retarded maturity. Lignin was not affected by chemical treatment on any harvest date (Table 15).

Increases in WSC of 10.7 and 12.3 percent were caused by glyphosine in April and early May samplings (Table 16). However, in late May glyphosine reduced WSC slightly. Evidently, there was greater partitioning of photosynthates towards WSC and away from fiber during the first two sampling dates in glyphosine-treated forage.

Crude protein was increased by ethephon in the early and late May sampling dates (Table 16). Glyphosine and mefluidide also increased crude protein in late May. Mefluidide caused a 2.8 percent increase in crude protein and was the most effective at this date.

Results indicate glyphosine was the most effective in reducing NDF and ADF, and increasing WSC when applied to tall fescue in the preboot stage, with mefluidide the next most effective. However, reductions in yield of dry matter and of water soluble carbohydrates were caused by both compounds (Appendix C). With increased forage quality animal performance will be higher, but voluntary intake will also increase and more forage will be required. If research is to continue in this area, it should be aimed at selecting an appropriate compound and rate which would increase quality without affecting yield adversely.

Table 16. Selected cellular contents (as percent of dry matter) in forage of tall fescue treated on April 15, 1982.

Treatment	Sampling Date Apr. 29	May 5	May 27
	%WSC		
Chlormequat	18.4 c[1]	17.9 b	8.9 ab
Glyphosine	30.6 a	30.7 a	8.6 b
Mefluidide	22.8 b	20.5 b	9.5 ab
Ethephon	20.3 bc	19.1 b	9.5 ab
Check	19.9 bc	18.4 b	10.0 a
	%CP		
Chlormequat	15.7 a[1]	12.2 ab	14.8 c
Glyphosine	14.2 b	11.2 b	16.9 b
Mefluidide	14.7 ab	12.4 ab	17.8 a
Ethephon	15.2 ab	13.2 a	16.7 b
Check	14.8 ab	11.8 b	15.0 c

[1]Means with the same letter within a column and a constituent do not differ significantly at $\alpha = 0.05$ by Duncan's Multiple Range test.

V. SUMMARY AND CONCLUSIONS

Mefluidide consistently reduced yields of tall fescue. Yield reductions were observed 65 days after treatment in the fescue experiment treated on June 29, 1981. However, increased yields were found from mefluidide and glyphosine 62 days after treatment in the fescue experiment treated on May 13, 1981. Glyphosine reduced yields during the first harvest period in tall fescue treated on May 13, 1981, and April 15, 1982. Glyphosine may have only affected reproductive growth, which would give rise to the short-term yield suppression. Yield reductions from ethephon were noted in one case. Total yields were not different in the fescue experiments.

In 1981 ethephon was most effective in reducing NDF. Reductions were also obtained from glyphosine and mefluidide. Glyphosine was most effective in 1982, with reductions in NDF also from mefluidide and ethephon.

Glyphosine reduced ADF in 1982 to a greater extent than any other chemical at the first two sampling dates. Reductions in ADF were also observed from mefluidide and ethephon. Mefluidide reduced ADF in the first three harvests of fescue treated on May 13, 1981. The ADF was also reduced in the second harvest by glyphosine and ethephon, and in the third harvest by ethephon. Ethephon was the only chemical effective in forage treated on June 29, and reduced ADF through the first three harvests. There were no differences in the lignin content of tall fescue, except an increase from mefluidide in the August harvest of the second 1981 experiment.

Substantial increases in WSC were caused by glyphosine in the first and second sampling dates of the 1982 fescue experiment. Mefluidide caused a small increase in WSC in the early June harvest of fescue treated on May 13, 1981. In the August harvest slight increases in WSC were noted from the other chemicals applied on June 29.

Ethephon increased crude protein at the second and third sampling dates in 1982. Glyphosine and mefluidide were also effective in the third sampling date. Mefluidide and ethephon increased crude protein in the late June and July harvests of fescue treated on May 13, 1981. Crude protein was not affected when treatments were made on June 29, 1981. Tall fescue treated in the preboot stage was most responsive to treatment, while glyphosine caused the greatest changes in forage quality. This would suggest that growth regulating chemicals increase forage quality mainly through the reduction or inhibition of reproductive growth.

Bermudagrass was less responsive to chemical treatment and in some cases responded negatively. Bermudagrass treated on May 13 had no differences in forage production, NDF, lignin, or WSC. The ADF was slightly decreased by glyphosine, mefluidide, and ethephon in the early and late June harvests. Crude protein was increased by ethephon in the early June harvest.

Bermudagrass treated on June 29 responded negatively. Yields were reduced in the July harvest by glyphosine, mefluidide, and ethephon. The NDF was increased in the August harvest by glyphosine and mefluidide, and in the September harvest by glyphosine. The ADF was increased in the August harvest by glyphosine. Glyphosine and mefluidide reduced WSC values in August and September.

The application of glyphosine to tall fescue in the preboot stage produced the most promising results, with large increases in WSC and large decreases in fiber constituents. Application of plant growth regulators could make it possible to increase animal productivity while grazing tall fescue pastures in the late spring and early summer but probably not in mid- to late-summer. To determine the most effective chemical, rate, and time of application, more research should be conducted with glyphosine, mefluidide and ethephon applied at varying rates to tall fescue at the preboot stage or earlier. Animal feeding or grazing trials would also be required to check projections from forage quality analysis. Research should also be conducted to determine the effects of yearly application on longevity of the grass.

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APPENDICES

APPENDIX A

Table 17. Height of bermudagrass on June 5 after treatment on May 13, 1981.

Treatment	Mean Height ----cm-----
Chlormequat	16.5 ab[1]
Glyphosine	14.7 abc
Mefluidide	12.4 c
Ethephon	14.0 bc
Check	17.0 a

[1]Means with the same letter within a column do not differ at α = 0.05 by Duncan's Multiple Range test.

APPENDIX B

Table 18. Height and seedhead density of tall fescue on April 28 after treatment on April 15, 1982.

Treatment	Mean Height	Mean seed-head density
	-----cm------	no./sq.m.
Chlormequat	49 a[1]	224 a
Glyphosine	30 c	88 a
Mefluidide	45 b	172 a
Ethephon	46 b	162 a
Check	51 a	198 a

[1]Means with the same letter within a column do not differ at $\alpha = 0.05$ by Duncan's Multiple Range test.

APPENDIX C

Table 19. Yield of water soluble carbohydrates in forage dry matter of tall fescue treated on April 15, 1982.

Treatment	Sampling Date May 5	Sampling Date May 27
	------kg/ha------	
Chlormequat	516	28
Glyphosine	474	23
Mefluidide	415	13
Ethephon	499	30
Check	488	31

APPENDIX D

Table 20. Weekly mean temperature and weekly total precipitation during the 1981 experiment.

Week of	Weekly Mean Temperature	Weekly Total Precipitation
	°C	mm
May 10[1]	14.3	12
17	16.3	23
24	20.2	41
31	23.1	136
June 7	24.3	26
14	24.0	0
21	24.1	31
28[2]	22.8	25
July 5	25.7	13
12	26.7	12
19	25.9	11
26	25.2	20
Aug. 2	25.3	24
9	23.9	3
16	22.6	35
23	23.1	1
30	24.7	36
Sep. 6	20.7	16
13	17.3	53
20	16.3	0
27	15.5	9
Oct. 4	13.7	15
11	14.9	16
18	8.8	1

[1]First treatment date was May 13, 1981.

[2]Second treatment date was June 29, 1981.

APPENDIX E

Table 21. Daily mean temperatures and weekly total precipitation during the 1982 experiment.

Day	Daily Mean Temperature	Weekly Precip.	Day	Daily Mean Temperature	Weekly Precip.
	°C	mm		°C	mm
Apr. 1	12.2		May 1	16.4	
2	13.3		2	16.4	
3	13.9		3	16.4	
4	12.8		4	16.7	
5	8.1		5	18.1	
6	0.3		6	20.3	
7	2.8	6	7	17.8	15
8	5.3		8	14.2	
9	3.3		9	16.1	
10	6.4		10	17.8	
11	10.3		11	18.9	
12	14.7		12	20.8	
13	15.0		13	23.3	
14	17.8	13	14	23.9	0
15[1]	20.0		15	21.7	
16	19.7		16	21.7	
17	10.3		17	21.9	
18	13.3		18	21.9	
19	13.9		19	22.5	
20	16.7		20	20.3	
21	12.2	23	21	21.7	37
22	8.6		22	23.3	
23	9.4		23	21.4	
24	11.1		24	21.7	
25	12.5		25	23.1	
26	16.4		26	23.1	
27	14.2		27	23.3	
28	12.8	32	28	21.7	96
29	14.4				
30	14.2				

[1]Treatment date was April 15, 1982.

VITA

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