WEED CONTROL WITH SHEEP ON NO-TILL WHEAT FIELDS

By

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NO-TILL WHEAT FIELDS

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Temperate cereals, such as wheat (Triticum aestivum L. em Thell.), are grown predominantly as grain crops. Use of cereals for dual production of grain and livestock production, is practiced to some extent in most areas of the world (Sharrow and Motazedian, 1987). After a wheat crop has been grazed or harvested the question is how to manage the wheat stubble field before sowing the following crop. Alternatives to control the amount of weeds present in the field include tillage systems based on repeated mechanical treatments to suppress weeds or the use of low or no-till systems using herbicides. This is probably the less risky decision to take in terms of the future production of the following wheat crop (Ghadim and Pannell, 1991), but is also a very risky decision considering the potential erosion losses from tillage or environmental contamination by the use of herbicides.

Plant competition for water and nutrients could be reduced by grazing wheat fields with sheep. This management practice could lead to increased productivity and income of the enterprise by offsetting weed control costs with income from sheep. Other areas of the farm can rest from grazing while the wheat stubble is being grazed.

One of the objectives of the trial was to analyze an alternate use of the wheat stubble fields, by grazing them with ewes during the late spring and early summer, and monitor ewe performance through the period.

CHAPTER II

LITERATURE REVIEW

Forage quality

The digestibility of herbage is largely determined by the indigestible fibrous fraction of the cell wall. Cellulose, hemicellulose and lignin increase as the plant matures. The seasonal variation in the digestibilities of several pastures species were found to be unrelated to the neutral detergent fiber (NDF) content, hence it was suggested that the main reason for variation in digestibility was the lignin content (Walsh and Birrell, 1987).

Jung and Sahlu (1989) found that maturation of forage during the grazing season resulted in declining forage quality, diet quality and livestock performance. The crude protein and in vitro organic matter digestibility of the green fraction declined with progressing grazing season while NDF content increased (Raleigh, 1970; Scales et al., 1971). Fiber content and dry matter digestibility appeared to be the forage quality components most associated with forage intake (Jung and Sahlu, 1989). Guessous et al. (1989) and Wahid (1991) have reported a decrease in quality and quantity of available biomass as the grazing period advanced, which would lead to reduced nutrient intake and animal performance. Advance in season brought significant changes in the nutrient content of plant species. Grasses were lower in CP concentration and higher in NDF than forbs and shrubs on both sites under study (Wahid, 1991). Sharrow (1983) determined that animal intake and animal performance were correlated with forage availability and nutritional quality. As quality and quantity of available forage declines, sheep expend more energy grazing and performance suffers (Jung and Sahlu, 1989; Orsini and Arnold, 1986). Additionally Allison (1985), Ellis (1978), Grovum (1986), McDonald et al. (1988) and Balch and Campling (1962) reported that intake by grazing ruminants is limited by ruminal fill because of high fiber content of forages, which at times may not allow the animal to meet maintenance and gain requirements. Gallavan et al. (1989) found that even though fresh forage intake by young lambs averaged 8.5% of body weight, average daily gain was low. This apparently was due to the low dry matter content of the wheat forage during the first five weeks of the trial. The data suggested that rumen capacity limited the performance of lambs consuming wheat forage.

Wheeler et al. (1963) and Allden and Whittaker (1970) indicated that approximately 1000 kg/ha was the break-point, after which further increases in available forage did not influence intake. Birrell (1989) has shown that as vegetative pastures increase above 1-2 t DM/ha, the qualitative rather than the quantitative aspects of the pasture become more important in determining animal responses. Under conditions of excess available forage, Jung and Sahlu (1989), have found that NDF content of the green forage is the forage quality criterion of greatest importance in determining DM intake by sheep. Selection by sheep for plant parts containing particular nutrients has not been demonstrated but it has been shown that sheep prefer plant material with high soluble carbohydrate content (Mitchell, 1973).

Tillage and soil moisture

Conserving moisture in the soil is a very important aspect of successful crop production in dryland areas. In dryland areas there is an interval between the cessation of rains and sowing a following crop, during which soil surface dries, affecting the emergence of seedlings and restricting early growth (Aujla and Cheema, 1983). In many regions, water is the factor most limiting to crop and pasture production (Svejcar, 1984). Summer precipitation events are highly variable in timing, and water evaporates quickly from the upper soil zones following precipitation; thus the water may be available for plant use in the surface zones for only short time periods (Johnson and Norton, 1979). As the soil dries there is usually a decrease in plant water potential (Hodgkinson et al., 1978). The stage of plant development during which water stress occurs is critical in terms of the various yield components and total yield. Conserving water early in growth is only important where rainfall is limited during critical growth stages. Stress during the vegetative and early reproductive phases may cause reduction in tiller number (Svejcar, 1984). Hurd (1968, 1974) determined that when moisture is available deep in the soil profile extensive root proliferation would allow the plant to use this reservoir of water for later growth.

Trimmer and Linscott (1985) stated that one of the main advantages of direct or no-tillage seeding over conventional tillage is the conservation of soil water. Moisture conservation by tillage practices has also been reported by Willis and Bond (1971) and Gill et al. (1977). However, competition from weeds and sodgrasses must be eliminated or this advantage may not be fully realized. Zero tillage is quicker and less expensive than mechanical tillage and most of the undesirable side effects of mechanized farming could be avoided, for example soil deterioration and reduced infiltration rates (Ike, 1986). Phillips et al. (1980) and Lal (1976) reported that apart from reduced labor costs and considerable time-saving, the other benefits of zero tillage include reduced soil and moisture losses, maintenance of good structure and increased land use. Ike (1986) compared a mechanical cultivation method with a zero cultivation practice and the traditional cultivation method involving a hoe. The author concluded that soil moisture content was significantly higher under zero tillage than under the other methods as the season progressed, and the weed population was significantly greater under zero tillage than under mechanical tillage. The author did not find a significant difference in soil moisture profile early in the season (5 weeks after planting). However, as the season progressed (9 to 13 weeks after planting), soil moisture content under zero tillage was significantly higher than under mechanical tillage. Tillage and chemical weed control treatments checked the growth of weeds and the moisture loss through transpiration (Willis and Bond 1971; Gill et al. 1977 and Jalota and Prihar 1979).

Generally, tillage systems involving the application of crop residues on the surface offer protection from erosion, and ensure better water intake and negligible soil moisture loss through evapotranspiration. Interpretations of the differences in soil moisture content under different tillage systems are often complicated by interactions between factors such as percolation and evapotranspiration rates, fluctuating weather conditions and differential patterns of water extraction by plant roots. The recommendation of any tillage system for a determined region will depend on ensuring that unfavorable soil conditions do not occur as a result of its use, particularly where the tillage system is to be unchanged for several years (Ike, 1986).

Trimmer and Linscott (1985) utilized nonselective herbicides prior to direct seeding of red clover as a way to reduce water utilization by the sod. The data presented by these authors suggest that suppression of the sod with herbicides increased the availability of water to red clover seed and seedlings, and that the higher soil water content was a contributing factor to successful red clover establishment. Where glyphosate or paraquat were applied, water content of the upper 20 cm of the soil profile was greater during the first 10 days after treatment, relative to unsprayed plots. The difference in soil water status among the herbicide treatments and the control became more apparent in the second 2-week period after spraying the sods. Similar results have been reported by Unger et al. (1971). They found that chemical weed control proved better than mechanical control with respect to water storage and weed control. Moleberg and Hay (1968) reported good weed control with herbicide and no differences on water storage between chemical and mechanical control. Other authors have determined that herbaceous weeds and grasses of the sod utilize substantial quantities of water from near the surface of the soil (Davis et al., 1965).

Grover et al. (1980) determined, during a 4-year period, that the soil-applied herbicides gave good control of weeds in the ditches. The authors also encountered that the transport of these herbicides in the initial water flush and their leaching into the soil profile were shown to be potential hazards for contamination. The same authors working with foliar herbicides have found that they provided yearly suppression of weeds following the third annual application.

Various authors have determined that grazing or clipping methods, used for defoliation studies, both produce a reduction in rooting mass compared to ungrazed or unclipped controls (Albertson et al., 1953; Crider, 1955; Weaver and Darland, 1947; Biswell and Weaver, 1933). Weaver (1950) found that native grasses produce much more root mass on good condition than on poor condition rangeland. This indicates that heavy grazing may reduce root production by plants, reducing the future ability to grow under certain conditions.

Wilcox and Wood (1988) determined that light grazing by sheep on steep slopes reduced infiltrability 12-17% when compared to ungrazed slopes. By the removal of plant cover and trampling, grazing can result in increased soil compaction and crusting by raindrop impact. Soil organic matter and aggregation can also be reduced all of which results in lower infiltration. Sheath and Boom (1985) reported that sloping areas were consistently drier in the surface horizon (0-50 mm), where the differences in soil moisture were greatest, because of less effective rewettting compared with flatter areas. Moisture levels in this profile declined at a similar rate for both flat and slope areas, but slopes responded less to rewetting. This determines mineralization rates and nutrient availability within this soil veneer, plant growth, and the ability to fully utilize water reserves to ensure persistence. Also the authors determined that maximum soil surface temperatures of 45-50°C were reached on clear days where low pasture cover existed on sloping areas.

Busby and Gifford (1981) suggested that impacts of grazing are cumulative rather than instantaneous. The authors found that simply the removal of vegetation by clipping did not result in an immediate decrease in infiltration rate. Thurow et al. (1986) found that the amount of cover was more important than type, indicating that protection of soil structure from direct raindrop impact was the primary function of cover on infiltration. Mannering and Meyer (1963) and Adams (1966) reported that crop residues or plastic films increased soil water content compared to bare soil. Jalota and Prihar (1979) found that where weeds were a problem mulch+herbicide resulted in a lower rate of drying and higher water storage than mulch and herbicide alone. However, under weed-free conditions, tillage was more beneficial for water conservation than mulching. Sheath and Boom (1985) and Rumball and Esler (1968) determined that grass tiller density and white clover content were both reduced during the treatment periods by grazing. Lachko (1988) found that water uptake by plants accounted from 20% to a half of the total water consumed from the soil depending on plant density for the different plant communities under study.

Another factor that affects infiltration rate is stocking density. Warren et al. (1986a), working in an intensive rotational grazing system, reported that the pasture grazed at the highest stocking density had the lowest infiltration rates. These authors concluded that rest, rather than intensive livestock activity, appears to be the key to soil hydrologic stability. Therefore, very little benefit in terms of soil hydrologic condition should be expected from large increases in the number of pastures within rotational grazing systems. Warren et al (1986c) and Wood and Blackburn (1981) found that infiltration rate was higher prior to the movement of livestock onto a pasture than after their removal, but the magnitude of the difference was dependant on seasonal climatic conditions. The impact is especially acute during the dry or dormant season and increases as stocking rates increases (Warren et al., 1986b).

Animal performance

Animal performance is related to forage availability and forage quality. Diet composition of grazing animals is affected by many different factors such as stocking rate, stocking density, forage palatability, season of the year or animal type.

Sheep are well known for the selective nature of their grazing behavior. Leaf material is preferred to stems, and green fractions are consumed to a greater degree than nongreen (Arnold, 1960). Bryant et al. (1979) found that leaf material comprised 96% of the sheep diets throughout the year. Sheep utilized grass stems only in early fall and late spring. The forage fractions preferred by sheep are also highest in nutritional quality (Terry and Tilley, 1964;Griffin and Jung, 1983). Yoder et al. (1990) working with Suffolk and Suffolk-cross ewe lambs, about 3 months old, reported that forage samples collected by esophageally fistulated lambs were significantly higher in crude protein and lower in acid detergent fiber (ADF) each year than those of hand-clipped forage, indicating that lambs selectively grazed higher-quality forage. Similar results were obtained by Jung and Koong (1985) working with wethers grazing a pasture of smooth bromegrass (Bromus inermis). Olsen and Hansen (1977) determined that domestic sheep shifted their diets more than did the larger-bodied herbivores, to optimize for low concentrations of fiber and high protein per unit of food ingested. Wilson (1976) and Wilson et al. (1969) determined that when the amount of available green pasture is as low as 100 kg per ha, sheep graze selectively, obtaining a diet which is of much higher quality than the average of the feed available.

Launchbaugh (1957) determined that steer gains were greatest during late spring, and the rate of gain tapered off during early and late summer. This occurred on all pastures regardless of available forage during the last half of the grazing season and appeared to be closely related to stage of forage maturity. The high quality forage period for warm-season perennial grasslands is limited to the first 2 1/2 months of the growing season. Grazing at times other than the high quality period results in livestock gains that are suboptimal (Owensby et al., 1988). Jung et al. (1989) determined that sheep selected diets that were higher in IVDMD and CP than the green forage material and lower in neutral detergent fiber (NDF). They also indicated that selective pressure for IVDMD and CP, and against NDF, increased as forage quality decreased but as green forage declined below 50 to 55% IVDMD, selectivity indices decreased sharply. Wahid (1991) working with sheep and goats in two different locations determined that grasses remained a major component of the diets of both goats and sheep at one location. However, sheep and goats consumed a higher percentage of shrubs with the passage of time while grazing the other location. Across all the grazing seasons, the diets of both animals were deficient in protein. Rhodes and Sharrow (1990) determined that sheep grazing reduced total current year's phytomass of browse and forbs in October. The October phytomass of graminoids was not affected by grazing. Forage from grazed areas in October generally had higher CP levels and DM digestibility than forage from ungrazed areas in October. An explanation for that is given by the fact that a greater quantity of new, succulent forage was generally present in grazed areas compared with ungrazed areas. The data suggested that sheep grazing could improve forage quality in the autumn and increase the quantity of high quality forage in spring.

Wilson (1976), using Hereford steers and Border Leicester*Merino wethers, observed that there are differences in selectivity between sheep and cattle that could be of some significance for pasture management an weed control in semiarid pastures. The cattle consumed a diet that was consistently lower in nitrogen than the diet of the sheep. This greater nitrogen intake of the sheep could give sheep an advantage over cattle in some critical periods of low pasture quality in summer-rainfall localities where the nitrogen content of the pasture is very low. Bennet et al. (1970) found that when grazing together on improved pasture, cattle gain less weight and sheep gain more weight at time of pasture shortage than do equivalent animals grazing alone.

One factor that may affect the performance of ewes under grazing is their physiological stage. This is very important to be considered when we are feeding animals in different physiological stages, because we need to adjust each ration, or feedstuff to the specific requirements of each category of animals (Russel et al., 1967). Requirements of the ewe vary during the pregnancy. In early pregnancy, fetal growth is slow and the total feed requirement of the ewe is not significantly different from the feed requirement during periods of maintenance (McDonald et al., 1988; NRC, 1984). During the last 4 to 6 weeks of gestation, ewes need more energy to meet increased nutrient demands for fetal growth and the development of the potential for high milk production (NRC, 1985).

If ewes are fat, a submaintenance ration is permissible during the first 3.5 months of gestation (non-critical period) to avoid overly fat ewes at lambing time (NRC, 1985). There is evidence that losses due to a low plane of feeding are more prevalent in young ewes or those in poor condition at mating and also in those with multiple ovulations. In ewes in good body condition at mating, a significant increase in embryo mortality can occur with severe undernutrition involving energy intakes of less than 20 percent of the maintenance for periods of up to one week. However fasting for up to 3 days at any stage in the first 12 days of pregnancy does not seem to have any detrimental effect on fertility in twin-ovulating ewes that are in good condition (Robinson, 1982). In contrast, Prior and Christenson (1976) have suggested that overfeeding in early pregnancy may have deleterious effects on embryo survival.

Percent contribution of forage classes to the diets of sheep, averaged across 12 months, was highest for grass (60%) followed by browse (22%) and forbs (18%) (Bryant et al., 1979). Kautz and Van Dyne (1978) determined that the sheep diet was mainly composed by grasses (47%), followed by shrubs (30%) and forbs (23%). Kothmann (1968) reported similar results of sheep diet composition on poor condition range. However, on good condition range, forbs dominated sheep diets (55%). Forb use by sheep increased as forb availability increased (Buchanan et al. 1972; Cook et al. 1967). During the growing season grasses and forbs dominated the diets, but when grasses and forbs were mature, browse began to replace the herbaceous components of the diet. Grasses appeared to provide the base for the diet while forbs were selected opportunistically (Bryant et al., 1979).

CHAPTER III

SPECIES COMPOSITION, FORAGE QUALITY AND STANDING CROP ON SUMMER-FALLOWED WHEAT FIELDS

Abstract

The effect of advancing season on species and chemical composition and standing crop of available forage was studied on two fallowed wheat fields in central Oklahoma. Following wheat pasture graze-out by cattle, two fields were subdivided into 4 paddocks and rotationally grazed by ewes from June to August. Hand-clipped samples were collected at the beginning and at the end of each grazing period on paddocks 1 and 3. Two exclosures were also installed in each wheat stubble field to compare the effect of grazing with no treatment and herbicide treatment on forage composition. The samples were collected by hand-clipping in all cases, and separated into three groups: cool season grasses, warm season grasses and forbs. Samples were analyzed for crude protein (CP), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF) and in vitro organic matter digestibility (IVOMD). Crude protein levels were higher

in June and declined by August for the three groups. NDF and ADF both showed an increase as the season advanced. IVOMD decreased from June to August. Total forage production was closely related to botanical composition. In late spring, when cool season grasses predominated, forage availability was 1040 kg DM/ha. When season progressed and warm season grasses became predominant, standing crop was 2140 kg DM/ha. Data collected from the exclosures showed a consistent reduction in the amount of forbs due to grazing in the early summer.

Introduction

Two of the most important factors affecting forage availability and forage quality are forage maturity and environmental conditions. In general, both intake and digestibility of a given plant species decline with advancing maturity (Cordova et al., 1978). Forage maturity is accompanied by a decline in nitrogen and an increase in fiber, that result in reduced organic matter and nitrogen digestion (Campbell, 1989).

Environmental conditions play a very important role affecting even forage quantity and quality. Severe drought, or prolonged dry periods during the growing season, may reduce or halt growth, which might be very harmful for grazing livestock operations. Similar effects on plant growth may result from the combination of dry periods and cool temperatures. All these factors may cause a wide variation in forage availability and forage quality during the growing season, which makes very difficult to manage a range to ensure the right amount, and the right chemical and botanical composition required in the diet of grazing livestock (Van Dyne and Torrell, 1964).

Materials and methods

The study was conducted at the USDA-ARS Grazinglands Research Laboratory located on El Reno, Oklahoma. Soils were predominantly Dale silt loams and Norge silt loams, 1 to 3 percent slopes. The main concerns of management for these soils are controlling erosion and maintaining soil structure and fertility (USDA, 1976). Precipitation from June 4 to August 12, 1991, was 134 mm. Average maximum and minimum temperatures during the trial were 33.5 and 20.6°C, respectively. Mean monthly precipitation and temperature during the trial and historical averages are shown in Appendix A.

Five hundred and ninety five ewes were split into two grazing flocks and placed on two wheat fields of 32.3 and 30.7 ha, respectively. Previously wheat pastures were grazed-out by cattle until late May. Two weeks after graze out was completed, ewes started grazing the wheat fields. Each wheat field was divided into 4 paddocks. Both fields were rotationally grazed: field 1 was grazed from June 5 to August 12 (69 total days) and field 2 was grazed from June 5 to August 9 (65 total days). Total grazing days for each paddock are shown in Table 1. Movements among paddocks occurred when biomass utilization was 80-90%. This estimation was done by visual appraisal.

Standing crop of vegetation was measured on the first and last days of grazing each paddock, and the disappearance calculated by difference. Measures were obtained by hand-clipping standing vegetation in 20 quadrats of 0.25 m^2 in each paddock at each clipping date. The clipped vegetation was dried at 70°C during 48 hours, and then hand-separated into 3 categories: cool season grasses, warm season grasses and forbs. A list of the major species found in the different components of the wheat stubble pastures is presented in Appendix B. The standing crop data is presented as total forage available (kg/ha) and in percentage for botanical composition. The samples were analyzed for DM, ash and Kjeldahl N (AOAC, 1984), NDF and ADF (Goering and Van Soest, 1970) and in vitro organic matter digestibility (IVOMD, Galyean, 1990).

In each wheat field, two sets of 0.16 ha exclosures containing two subdivisions were established. In each exclosure, one subdivision was an untreated, ungrazed control while the other was treated with a conventional chemical application for weed control. The herbicide used was glyphosate (Roundup) applied on June 5 at a rate of 2.34 kg AI/ha and on July 15 at a rate of 1.75 kh AI/ha.

The exclosures were established in paddocks 1 and 3 of each wheat field. Standing crop was measured within the exclosures by clipping 5 quadrats of 0.25 m^2 at 3 to 4 week intervals.

Statistical Analysis

Forage quality and standing crop data were analyzed using the TTEST and GLM procedures of the Statistical Analyses System (SAS, 1985). The model contained location (wheat stubble fields), time of sampling and location * time of sampling in a randomized complete block design.

Results and Discussion

The total availability and the botanical composition of forage in the wheat stubble fields are presented in Table 2. Total availability was closely related to its botanical composition. In June when cool season grasses accounted for more than 50% of the species total DM production was about half the standing crop in August, when more productive warm-season grasses were dominant. In June, forbs were an important component of the standing forage, but as the season progressed they decreased because of strong competition from the warm-season grasses.

Forage disappearances from the wheat stubble fields are presented in Tables 3 and 4. During the early grazing period (June), when cool season grasses were at the end of their growing season, net disappearance of cool season grasses and forbs was 74 and 61%, respectively. Warm season grasses accumulated forage equivalent to 87% of the initial standing crop. This was probably due to the combined effect of fast growth rates and selection of forbs and cool season grasses by the sheep. However, it cannot be assumed that disappearance and diet selection were similar.

Table 5 summarizes the data obtained from forage samples taken from the exclosures under three treatments: grazing, herbicide and control, in June and August. In June there were no significant differences among weed control treatments. In August the effect of grazing on reducing the standing crop of forbs was clear. This is related to the lower CP content of the warm season grasses at this time, associated with a high level of selection done by the animals looking for a diet of a higher quality.

The chemical composition of the forage samples is presented in Table 6. Chemical composition was similar in June and August for the cool season grasses, due to the fact that this group was already at the end of its growing season and in an advanced stage of maturity. Only IVOMD of cool season grasses showed a significant reduction from June to August.

For warm season grasses there were significant declines ($P<.05$) only for CP and IVOMD content. Crude protein and IVOMD both decreased as the season advanced. The observed values of CP and IVOMD during the trial were similar to those reported by other authors (Campbell, 1989; Rao et al., 1973). Rao et al. (1973) found that the average composition of all grasses analyzed showed a CP content of leaves 55% higher than the CP of whole plants. As grazing season advances the leaf/stem ratio of the standing crop decreases, and the CP content also decreases. As the season advances higher temperatures and dryer conditions are expected to decrease the quality of the available forage (Van Soest, 1982). Rao et al. (1973) found that the highest IVOMD values were obtained in late July either for esophageal or hand-clipped samples and that the sudden decrease in digestibility during August was primarily for an increase in lignin content in both esophageal and hand-clipped samples.

Forbs only showed significant differences ($P<.05$) for NDF, which increased as the season progressed, and IVOMD that followed the same pattern of the warm and cool season grasses, decreasing by August with respect to the value observed in June. The differences showed in the chemical composition of the three different groups of species were due to the effect of the time of sampling (June or August), because there was no significant effect of locations and no interaction of location and time of sampling ($P<.05$).

Implications

The data suggested that ewes preferred to eat relatively more forbs and cool season grasses in June, when they had a better opportunity to select the species of their diet, than in August. During August the high accumulation and competition of warm season grasses reduced the stand of forbs. Cool season grasses have almost disappeared as components of the pasture by August. The reduction in forage quality of all components over time was due to the increased maturity of the forage.

CHAPTER IV

PERFORMANCE OF EWES GRAZING WHEAT STUBBLE AND BERMUDAGRASS PASTURES

Abstract

A flock of 595 ewes including Rambouillet, Dorset, Polypay and crosses, varying from yearling to 6 years old, dry and pregnant, were divided into 2 groups. Each group grazed a different wheat stubble field from June to August. A separate group of 57 open dry, yearling to 6 years old Dorset and Rambouillet ewes, grazed a bermudagrass pasture from June to August. Animal performance was significantly different between the 2 wheat stubble fields ($P<.01$). No effect of breed and age was detected between the 2 wheat fields. Physiological status had an effect during August ($P<.05$) but not during June. In August, forage quality was low and the ewes had entered late gestation and nutrient requirements were higher. Ewe performance on wheat fields was lower than the control group grazing bermudagrass ($P<.01$).

Introduction

Temperate cereals, such as wheat (_Triticum aestivum_ L. em Thell.), are grown predominantly as grain crops. Use of cereals for dual production of grain and livestock production, is practiced to some extent in most areas of the world (Sharrow and Motazedian, 1987). After a wheat crop has been grazed or harvested the question is how to manage the wheat stubble field before sowing the following crop. Alternatives include tillage systems based on repeated mechanical treatments to suppress weeds, or the use of lower no-till systems using herbicides, to control the amount of weeds present in the field. This is probably the less risky decision to take thinking in terms of the future production of the following wheat crop (Ghadim and Pannell, 1991), but at the same time a very risky decision considering the potential erosion losses from tillage or environmental contamination by the use of herbicides.

Plant competition for water and nutrients could be reduced by utilizing wheat stubble with sheep. This management practice could lead to increased productivity and income of the enterprise by offsetting weed control costs with income from sheep. Other areas of the ranch can rest from grazing, while the wheat stubble is being grazed.

One of the objectives of the trial was to analyze an alternate use of wheat stubble fields, by grazing them with ewes during from June to August.

Materials and methods

The study was conducted on the USDA-ARS Grazinglands Research Laboratory located near El Reno, Oklahoma. Soil descriptions and weather records are included in Chapter 3 and Appendix A respectively.

A total of 595 ewes, mainly Rambouillet and Dorset (some Polypay and crossbred ewes were also present), were split into two grazing flocks and placed on two wheat stubble fields. Ewes were open or pregnant and varied from yearlings to 6 years of age. Wheat field 1 was 32.3 ha and wheat field 2 was 30.4 ha. Each wheat field was separated into 4 paddocks of equal size. On June 5, 149 and 153 ewes started grazing wheat stubbles 1 and 2, respectively. On June 21 the second group of 149 and 144 ewes entered wheat stubble 1 and 2, respectively. Both fields were rotationally grazed from June 5 to August 12 resulting in 69 total days grazing on wheat stubble 1, and from June 5 to August 9 resulting in 66 total days grazing on wheat stubble 2. Movements among paddocks occurred when biomass utilization was deemed adequate by the resident scientists.

Ewe performance was monitored by weighing the ewes at the beginning, middle and end of the grazing trial. At each weighing, ewes were dosed with levamisole at a rate of 3 cc per head.

An additional 57 head of open, dry Rambouillet and Dorset ewes were divided into two groups and placed on two bermudagrass pastures. These groups served as controls for comparison with the wheat grazing flocks.

Statistical Analysis

Animal performance was analyzed by using the GLM and TTEST procedures of the Statistical Analyses Systems (SAS, 1985). The model used for comparing ewe performance on wheat stubble 1 and 2 included treatment, ewe age, breed and physiological status. The model for comparing ewe performance on wheat stubble versus bermudagrass included treatment, ewe age and breed.

Results and discussion

Animal performance of the 2 wheat stubble fields is shown in Table 7. Ewe performance, expressed as kg of body weight gained or lost, was significantly different between the 2 wheat fields ($P<.01$) during the June and across the entire grazing season. Ewes on wheat stubble 1 gained weight in June but lost weight in August. Ewes on wheat stubble 2 lost weight during both periods. Pregnant ewes on wheat field 1 gained more than open ewes, but on wheat field 2 pregnant ewes lost almost 50% more weight than open ewes.

No significant effect of age and breed of the ewes was detected (P>.05, Table 7). Physiological status had no effect in June. However, during August pregnant ewes lost more (P<.05) weight than open ewes. This loss was associated with the increased requirements of the pregnant ewes during advanced gestation compared to those for early gestation. In early gestation, fetal growth is slow and total feed requirement of the ewe is not very different from the feed requirement of open, nonlactating ewes (NRC, 1985; McDonald et al., 1988). Ewes in early pregnancy may cover their requirements even on low quality pastures. During late gestation nutrient requirements of the pregnant ewes are greatly increased, with the size of the increase depending on the number of fetuses the ewe is carrying (Russell et al., 1967). In this stage one of the limiting factors for ewe performance is pasture quality. On low quality forage, ewes in advanced pregnancy are not able to meet their requirements, because rumen capacity is limited. and forage intake cannot be increased enough to cover requirements. Similar reasoning can be used to explain the significant effect of the interaction treatment * physiological status (P<.01), observed for the entire grazing period.

Interactions of age and breed in June (P<.05) and treatment and age in June (P<.01) and August (P<.05) were noted. Older animals, in June, gained more weight than yearlings on wheat stubble 1, but on wheat stubble 2 they lost more weight than yearlings. During August, 6 year old ewes on wheat field 1 lost more weight than yearlings. Conversely on wheat field 2 yearlings lost more weight than older ewes.

Ewe performance on the wheat stubble fields is compared to ewe performance on bermudagrass in Table 7. Ewe performance was significantly affected by the pasture type ($P<.01$) but not by breed or age of ewe. During June the ewes on bermudagrass and wheat stubble 1 gained similar amounts of weight. Ewes on wheat stubble 2 lost weight during the same period. These results are similar to those reported by Arnold et al. (1978) who found that sheep response to lupin stubble ranged from a slight gain to a loss of weight at a rate of up to 200 g/day. During August and across the entire grazing period the control group of ewes gained weight, while both groups of ewes grazing wheat stubble pastures lost weight.

Several factors may be acting together to produce the type of results observed. One of the factors is related to the different pasture conditions. During June, pasture availability could be the explanation for the low ewe performance observed in some cases. Later in the grazing season, forage quality appeared to be limiting ewe performance, because forage availability in the August was practically double that of the June. Under those conditions ewes have to spend more energy selecting a diet that meets their requirements for growing and gaining weight. The last factor that could be affecting the results of this trial is stocking rate (Table 9). Sheep have a very selective grazing behavior. They prefer leaf to stems and young green than old mature forage (Arnold, 1960). If they are not allowed to make a good selection of the materials they have available for grazing, for example through a high stocking density, then forage consumption may not meet their daily requirements. This is a probable explanation for the fact that, in almost all periods, ewes grazing wheat fields exhibited losses of weight, and those losses were higher in pregnant than in dry ewes in August.

Implications

Grazing wheat stubble fields with ewes during June and August may be a good alternative management practice, but ewe performance was depressed and may affect survivability and growth. The critical period was August, when pasture quality was low and pregnant ewes had reduced rumen capacity and increased nutrient requirements. This must be considered in order to get a good ewe performance, good weight of lambs at lambing and good milk production of the ewes.

CHAPTER V

SOIL WATER LEVELS AND WHEAT FORAGE PRODUCTION

Abstract

The effects of three summer fallow treatments - herbicide, intensive sheep grazing and untreated, ungrazed control - on soil water profiles and future production of wheat forage were studied on two wheat stubble fields in central Oklahoma. Four exclosures were installed in each wheat field; 2 exclosures were ungrazed and untreated while 2 exclosures were chemically-treated. Chemical treatments were 2.34 and 1.75 kg/ha of glyphosate applied in June 4 and July 15, respectively. Two access tubes for neutron probes were established in each exclosure and in a grazed area adjacent to the exclosures to monitor soil water. Soil water profile was measured in June 4, June 26, July 17 and August 7 at 6 depths. Moisture content increased with increased soil depths. Differences among treatments were greater at shallower depths. Herbicide treated areas had more moisture at 20 cm of depth, probably due to reduced losses of moisture by

transpiration. Herbicide-treated areas produced more forage than grazing or control areas ($P<.01$); this was associated with a higher soil water content in the upper profile and a better weed control during the summer fallow period. Control and grazing treatments had similar amounts of forage production.

Introduction

Moisture content of the soil, especially in the upper profile, is an important factor affecting establishment and subsequent production of a crop. The effect of water stored during spring and summer is more important in drier areas (Aujla and Cheema, 1983).

Different management practices may alter water storage in the soil, by reducing or eliminating competition of weeds and grasses during fallow periods. Herbicide application is a commonly used practice for weed control in minimum-till and no-till systems, while mechanical tillage is also an option. Herbicides have an immediate impact on the plant community, by eliminating vegetation and reducing water losses by transpiration (Willis and Bond, 1971). Herbicide applications are expensive and have the potential for environmental contamination (Grover et al., 1980). Use of herbicides may also increase the risk of erosion by leaving the soil surface uncovered for a period of time. Tillage practices which leave crop residues on the surface, act to protect the soil from erosion and reduce soil moisture losses through reduced evapotranspiration (Ike, 1986).

The effect of grazing as a means on reducing vegetation to increase water storage in the soil has not been studied. Low or moderate grazing could reduce the stand of forbs and grasses, leaving a sod cover on the soil surface. As a result, grazing would potentially reduce the losses of water by transpiration and evaporation, and increase water available for establishment of the next crop. Heavy grazing, on the other hand, could increase soil compaction, which will reduce the infiltration rate of the soil, reducing its ability to accumulate water for the following crop (Wilcox and Wood, 1988). Also, grazing does not have as immediate an impact on the plant community as do herbicides and mechanical tillage. Therefore water losses may not be reduced to the same extent.

The following study was conducted to evaluate the impacts of grazing and herbicide applications on soil moisture storage on summer-fallowed wheat fields.

Materials and methods

The study was conducted on the USDA-ARS Grazinglands Research Laboratory located near El Reno, Oklahoma. Soils were predominantly Dale silt loams and Norge silt loams, 1 to 3 percent slopes. The main concerns of management for these soils are controlling erosion and maintaining soil structure and fertility (USDA, 1976). Precipitation from June 4 to August 13, 1991, was 134 mm. Average maximum and minimum temperatures during the trial were 33.5 and 20.6°C, respectively. Mean monthly precipitation and temperature during the trial and the averages for the period 1951-1980 are shown in Appendix A.

Five hundred and ninety-five ewes, varying from yearling to 6 years of age, were split into two grazing flocks and placed on two fields of wheat stubble. Previously, wheat pasture was grazed in fall and winter period with cattle and through the graze-out period in May. About 2 weeks after the removal, the sheep were placed on the fields. Grazing management plans are described in Chapter 3. Each wheat field contained two 0.16 ha exclosures, which were subdivided into two equal areas. In each exclosure, one subdivision was an untreated, ungrazed control while the other was treated with a conventional chemical application for weed control. The herbicide used was glyphosate (Roundup). It was applied on June 4, at a rate of 2.34 kg of AI/ha and on July 15, at a rate of 1.75 kg of AI/ha. The exclosures were established in paddocks 1 and 3 of each wheat field.

Access tubes for neutron probe were established in the exclosures and in grazed areas adjacent to the exclosures to monitor soil water profile. Two tubes were installed for each treatment. Soil water profile was measured on June 4, June 26, July 17 and August 7 in all the exclosures, at 6 depths: 20, 40, 60, 80, 100 and 120 cm. The results are expressed in cm of water per cm of soil depth.

The following fall and winter, wheat forage production was determined in the exclosures and grazed areas. Forage standing crop was measured by clipping 5 quadrats of 0.25 m^2 in each area on January 8, February 28 and March 27, 1992. Results of total wheat forage production are expressed in kg/ha.

Statistical Analysis

Data including moisture content of the soil and wheat forage yield, were analyzed using ANOVA and TTEST procedures of the statistical analyses systems (SAS 1985). The model for soil moisture included location (two wheat fields), paddock, treatment (herbicide, grazing and control), date of sampling, depth and probe. For wheat forage production the model included location, paddock, date of sampling and treatment.

Results and discussion

The water content of the soil was slightly greater, on average, on herbicide-treated areas, followed by grazed and control areas (Figure 1). Similar results were reported by Moleberg and Hay (1968). The authors found no difference between chemical and mechanical control but water profile was improved above no treatment.

Moisture content increased significantly with increased soil depths on all the treatments (Figure 2). The differences among treatments were greatest at the shallow depths, with herbicide-treated areas having higher water contents than the other treatments at 20 and 40 cm. Below 60 cm no differences in water profile were found. Similar results were reported by Seath and Boom (1985). This may be an effect of the vegetation cover, which, under grazing and control treatments, reduced losses of water by evaporation from the upper part of the soil but increased water losses by transpiration. The herbicide reduced losses in the upper profile. Davis et al. (1965) reported that on herbicide-treated areas the soil remained uncovered during summer. As a result, water losses by evaporation from the upper part of the soil profile were higher than those observed in vegetation covered areas. The low water content in the top 20-40 cm of soil in the grazed and control areas could reduce seed germination and seedling establishment and result in a reduced number of plants, lower forage and grain production.

The effect of time of sampling over moisture content on the soil profile was significant ($P<.01$), and differed among treatments (Figure 3). Herbicide-treated areas showed a lower soil water content in June, but as season advanced more water was accumulated on these areas than on grazed and control areas. Grazing and control both showed a reduction in water content per cm of soil as season advanced, indicating that losses of water due to plant transpiration were probably more important than those due to evaporation from the uncovered soil surface of the herbicide-treated areas.

Herbicide-treated areas yielded significantly more wheat forage than grazed or control areas. Although no statistical difference ($P>.05$) was noted, grazed areas (800 kg/ha) tended to produce more forage than control areas (560 kg/ha).

A treatment*time interaction was observed ($P<.01$). Wheat forage production on the herbicide-treated areas was higher than forage yields obtained on the other treatments at all sampling dates; but the difference was more pronounced at the last sampling date (Figure 4). The main effect of herbicide application was to rapidly eliminate plant growth from the soil surface, and to allow a good water accumulation in the soil profile in the summer. The reduction increased the production of forage, and this effect is more marked at the end of the wheat growing season. This could be due to increased number of plants on herbicide-treated areas, which resulted in higher forage yields compared with grazing or control areas. Trimmer and Linscott (1985) working with red clover, determined that elimination of the sod by the use of herbicide increased water available for seeds and seedlings and increased forage production of the pasture.

Implications

It is very important to allow the soil to accumulate water during the pre-seeding period to ensure good seedling emergence and a rapid early growth to establish a vigorous root system. Control of weeds and grasses prior to seeding will conserve water. The data indicate that herbicide application was the most effective practice for water conservation. Ewe grazing tended to increase forage production although water storage was not improved. Perhaps more severe defoliation regimes with sheep would improve water storage but ewe performance would suffer.

Economic analyses must be conducted to determine the marginal profitability of the different management practices. Grazing with sheep may prove to be a good alternative management practice, despite potentially lower crop production, if the cost/benefit ratios are better than chemical and mechanical practices.

TABLE 1. TOTAL GRAZING DAYS PER PADDOCK OF 2 WHEAT FIELDS.

	PADDOCK 1	2	3	4	TOTAL
WHEAT FIELD 1	19	17	20	13	69
WHEAT FIELD 2	19	24	13	9	65

TABLE 2. TOTAL PASTURE PRODUCTION AND AVERAGE SPECIES COMPOSITION OF WHEAT STUBBLE IN JUNE AND AUGUST.

	SAMPLING TIME	
	JUNE	AUGUST
TOTAL DM, kg/ha	1040 [a]	2140 [b]
SPECIES GROUP	%	
COOL SEASON GRASSES	53 [a]	5 [b]
WARM SEASON GRASSES	25 [a]	94 [b]
FORBS	22 [a]	1 [b]

[a,b] Row means with uncommon superscripts are different ($P<.05$).

TABLE 3. TOTAL PASTURE PRODUCTION, SPECIES DISAPPEARANCE AND AVERAGE SPECIES COMPOSITION OF WHEAT STUBBLE IN JUNE AND AUGUST.

	SAMPLING TIME					
	JUNE			AUGUST		
	BEG	END	DIS	BEG	END	DIS
TOTAL DM, kg/ha	1040	760	280	2140	1010	1130
SPECIES GROUP	---- % ----		kg/ha	---- % ----		kg/ha
COOL SEASON GR.	53 [a]	23 [b]	380	5 [a]	1 [b]	100
WARM SEASON GR.	25 [a]	63 [b]	-220	94 [a]	99 [b]	1020
FORBS	22 [a]	14 [b]	120	1 [a]	0 [a]	10

[a,b] Row means within sampling time with uncommon superscripts are different ($P<.05$).

TABLE 4. SPECIES DISAPPEARANCE OF THE DIFFERENT COMPONENTS OF WHEAT STUBBLE IN JUNE AND AUGUST.

	SAMPLING TIME			
	JUNE		AUGUST	
	DIS	DIS/EWE/DAY	DIS	DIS/EWE/DAY
TOTAL DM, kg/ha	280	0.58	1130	1.07
SPECIES GROUP	kg/ha	kg/AD	kg/ha	kg/AD
COOL SEASON GRASSES	380 [c]	0.79	100 [c]	0.10
WARM SEASON GRASSES	-220 [d]	-0.47	1020 [d]	0.96
FORBS	120 [e]	0.26	10 [e]	0.01

[c,d,e] Column means within sampling time with uncommon superscripts are different (P<.05).

TABLE 5. SPECIES COMPOSITION AMONG TREATMENTS (GRAZING=GRZ, HERBICIDE=HERB AND CONTROL=CTRL) OF WHEAT STUBBLE IN JUNE AND AUGUST.

	SAMPLING TIME					
	JUNE			AUGUST		
	GRZ	HERB	CTRL	GRZ	HERB	CTRL
TOTAL DM, kg/ha	1040	1040	960	2140	0	1770
SPECIES GROUP	%					
COOL SEASON GRASSES	53	53	52	5 ^{a}	0 ^{b}	12 ^{c}
WARM SEASON GRASSES	25	22	23	94 ^{a}	0 ^{b}	73 ^{c}
FORBS	22	24	25	1 ^{a}	0 ^{a}	15 ^{b}

^{a,b,c} Row means within sampling time with uncommon superscripts are different (P<.05).

TABLE 6. NUTRIENT COMPOSITION (% OF DRY MATTER) OF THE DIFFERENT COMPONENTS OF THE STANDING CROP IN JUNE AND AUGUST.

	SAMPLING TIME					
	JUNE			AUGUST		
	COOL	WARM	FORBS	COOL	WARM	FORBS
CP, %	11	14 [c]	17	10	7 [d]	10
ASH, %	11	15	10	6	11	9
NDF, %	73	62 [c]	58 [c]	74	73 [d]	79 [d]
ADF, %	38	30 [a]	37	45	40 [b]	59
IVOMD, %	67 [a]	54 [c]	75 [c]	52 [b]	44 [d]	55 [d]

[a,b] Row means within forage component with uncommon superscript are different (P<.10).

[c,d] Row means within forage component with uncommon superscript are different (P<.05).

TABLE 7. PERFORMANCE OF EWES GRAZING WHEAT STUBBLE FIELDS DURING LATE SPRING AND EARLY SUMMER IN EL RENO, OKLAHOMA.

	WHEAT STUBBLE 1					WHEAT STUBBLE 2				
	DORSET		RAMBOUILLET			DORSET		RAMBOUILLET		
EWE GROUP	DRY	PREGN	DRY	PREGN	$\bar{X}$	DRY	PREGN	DRY	PREGN	$\bar{X}$
Initial wt (kg)	54	54	53	53	53	58	60	59	55	58
Weight change (kg)										
Late spring	3.0	3.7	3.1	3.7	3.4^{a}	-4.4	-4.8	-4.2	-4.9	-4.6^{b}
Early summer	-2.8	-2.8	-2.6	-2.8	-2.7	-3.2	-5.1	-1.9	-3.5	-3.4
Total season	0.2	0.9	0.4	1.0	0.6^{a}	-7.3	-10.0	-6.0	-8.3	-7.9^{b}

	WHEAT STUBBLE 1	WHEAT STUBBLE 2
DRY EWES		
Initial	53	58
Late spring	3.0^{c}	-4.3^{d}
Early summer	-2.7	-2.6
Total season	0.3^{c}	-6.6^{d}
PREGNANT EWES		
Initial	53	57
Late spring	3.7^{c}	-4.8^{d}
Early summer	-2.8^{a}	-4.3^{b}
Total season	0.9^{c}	-9.1^{d}

^{a,b} Row means between wheat stubbles with uncommon superscripts are different ($P<.05$).

^{c,d} Row means between wheat stubbles with uncommon superscripts are different ($P<.01$).

TABLE 8. PERFORMANCE OF EWES GRAZING WHEAT STUBBLE AND BERMUDAGRASS FIELDS DURING LATE SPRING AND EARLY SUMMER IN EL RENO, OKLAHOMA.

	WHEAT STUBBLE 1			WHEAT STUBBLE 2			BERMUDAGRASS		
EWE GROUP	DORSET	RAMBOUILLET	$\bar{X}$	DORSET	RAMBOUILLET	$\bar{X}$	DORSET	RAMBOUILLET	$\bar{X}$
Initial wt (kg)	54	53	53	58	59	58	56	53	55
Weight change (kg)									
Late spring	3.0	3.1	3.0^{a}	-4.4	-4.2	-4.3^{b}	4.2	3.0	3.6^{a}
Early summer	-2.8	-2.6	-2.7^{a}	-3.2	-1.9	-2.6^{b}	0.9	1.4	1.2^{c}
Total season	0.3	0.4	0.3^{a}	-7.3	-6.0	-6.6^{b}	5.1	4.5	4.8^{c}

^{a,b,c} Row means between wheat stubbles with uncommon superscripts are different ($P<.05$).

TABLE 9. AVERAGE STOCKING RATE, FORAGE AVAILABILITY AND GRAZING DAYS OF BERMUDAGRASS AND 2 WHEAT STUBBLE FIELDS.

	WHEAT STUBBLE 1		WHEAT STUBBLE 2		BERMUDAGRASS
Area (ha)	32.3		30.4		8.1
AD/ha	562.4		563.4		387.0
Grazing days	69		66		55
	LATE SPRING	EARLY SUMMER	LATE SPRING	EARLY SUMMER	
kg DM/ha	964	2108	1112	2176	ND

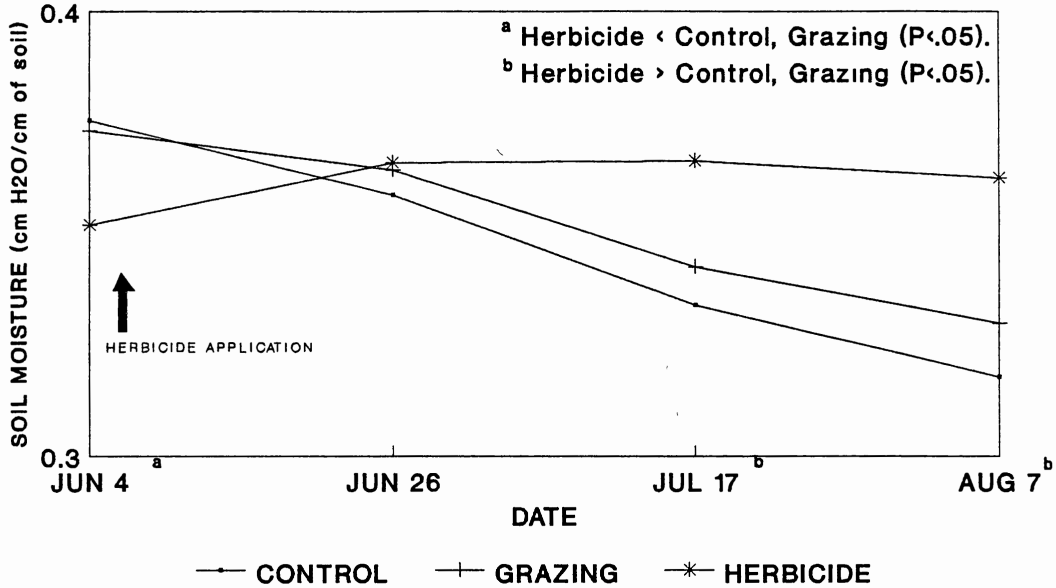

FIGURE 1. SOIL WATER CONTENT UNDER 3 TREATMENTS AND 5 DIFFERENT DATES.

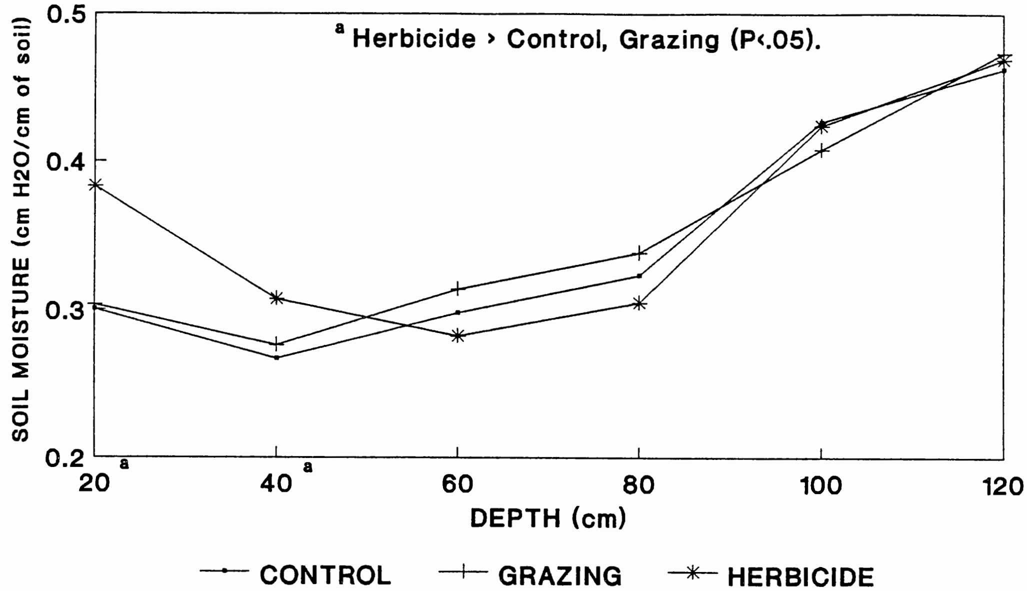

FIGURE 2. SOIL WATER CONTENT UNDER 3 TREATMENTS AT 6 SOIL DEPTHS.

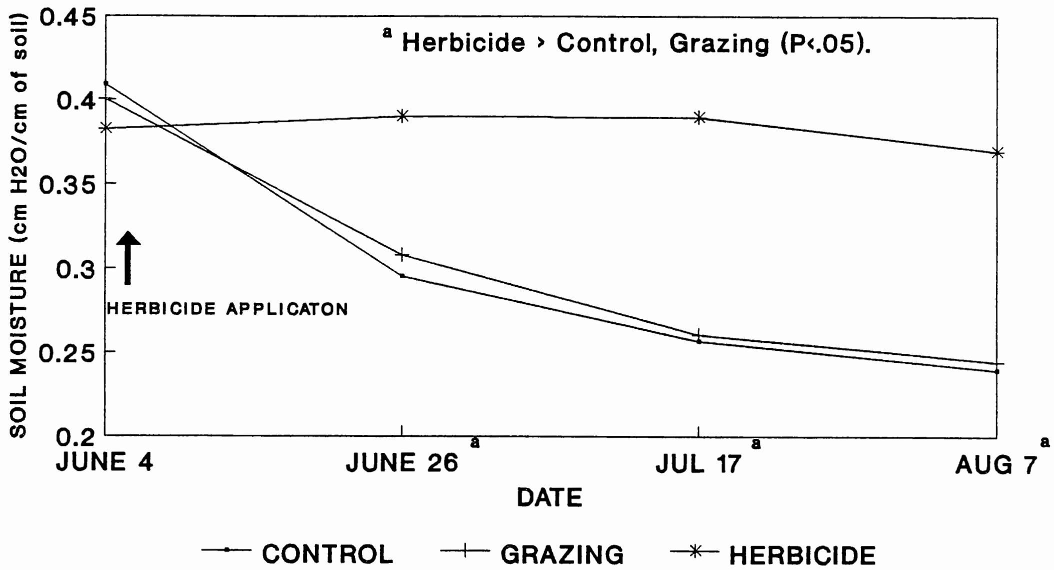

FIGURE 3. SOIL WATER CONTENT UNDER 3 TREATMENTS AT 20 cm OF DEPTH.

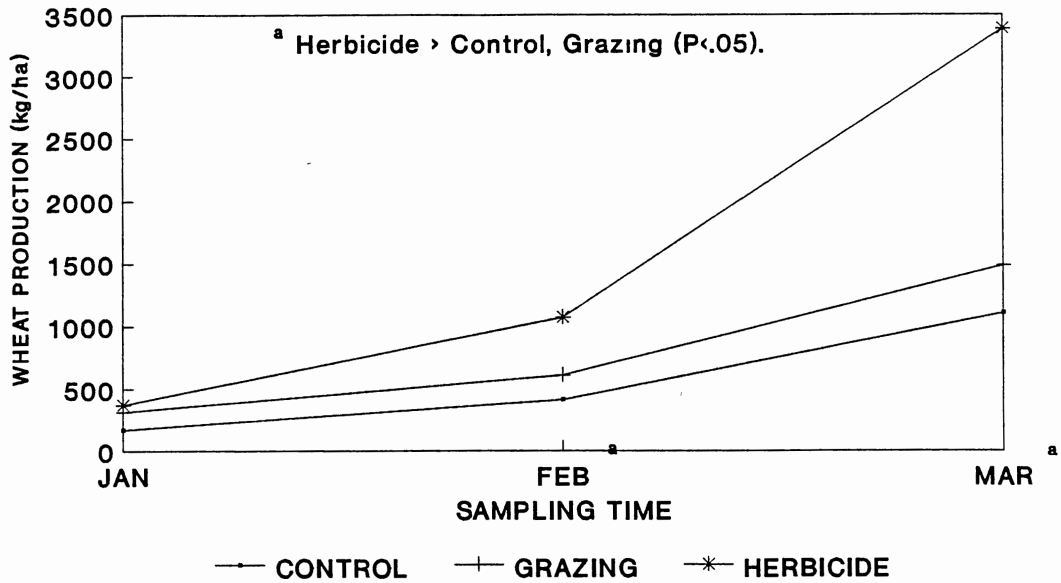

FIGURE 4. FORAGE WHEAT PRODUCTION AT 3 DATES OF SAMPLING AND 3 TREATMENTS.

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APPENDICES

APPENDIX A

MONTHLY PRECIPITATION (mm) AND TEMPERATURE (°C) AT EL RENO, OKLAHOMA, APRIL, 1991, THROUGH MARCH, 1992, AND HISTORICAL AVERAGES (1951-1980).

MONTH	PRECIPITATION		TEMPERATURE	
	1991-1992	1951-1980	1991-1992	1951-1980
APRIL	81	65	16	16
MAY	119	131	22	20
JUNE	120	92	25	25
JULY	70	70	27	28
AUGUST	59	58	26	27
SEPTEMBER	81	92	21	23
OCTOBER	78	73	16	17
NOVEMBER	47	42	6	9
DECEMBER	103	26	6	4
JANUARY	16	21	4	2
FEBRUARY	13	28	3	5
MARCH	40	47	9	10

APPENDIX B

MAJOR SPECIES FOUND IN THE DIFFERENT COMPONENTS OF THE WHEAT STUBBLE PASTURES.

COOL SEASON GRASSES

cheatgras . . . . Bromus tectorum L.
Japanese brome . . . Bromus japonicus Thunb.
rescue grass . . . . Bromus catharticus Vahl.

WARM SEASON GRASSES

crabgrass . . . . Digitaria sanguinalis (T..) Scop.
cupgrass . . . . Eriochloa spp.
fall witchgrass . . . Leptoloma cognatum (Schult.) Chase

FORBS

redroot pigweed . . . Amaranthus retroflexus L.
curly dock . . . . . . Rumex crispus L.
bitter rubberweed . . Hymenoxys odorata DC.
mares tail . . . . . . Conyza canadensis (L.) Cronq.
common sunflower . . Helianthus annuus L.
prickly lettuce . . . Lactuca serriola L.
shepard's purse . . . Capsella bursa-pastoris (L.) Medic.
mustards . . . . Brassica spp.

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