Oklahoma Panhandle Research & Extension Center

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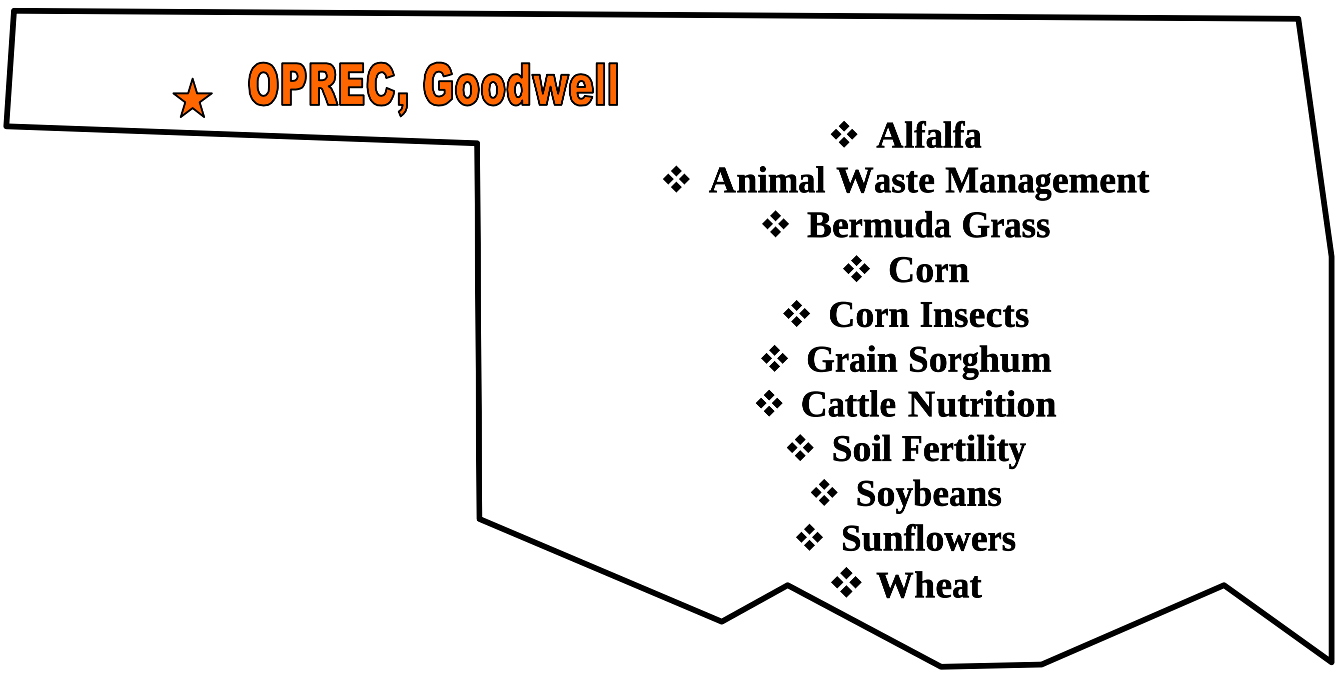

2000 Research Highlights

Division of Agricultural Sciences and Natural Resources
Oklahoma Panhandle Research and Extension Center
Oklahoma State University
Department of Animal Science
Department of Entomology and Plant Pathology
Department of Plant and Soil Sciences
Department of Biosystems and Agricultural Engineering
USDA – ARS

THE OKLAHOMA PANHANDLE RESEARCH AND EXTENSION CENTER
Division of Agricultural Sciences and Natural Resources
Department of Plant and Soil Sciences
Oklahoma Agricultural Experiment Station
Oklahoma Cooperative Extension Service
Oklahoma State University

The Division of Agricultural Sciences and Natural Resources (DASNR)/Oklahoma Agricultural Experiment Station (OAES)/Oklahoma Cooperative Extension Service (OCES) at Oklahoma State University (OSU) have a long history working cooperatively with Oklahoma Panhandle State University (OPSU). A Memorandum of Agreement that outlined the major missions of each entity strengthened this cooperative effort in July 1994. OPSU's primary role is teaching. OAES is the research arm of the DASNR and is responsible for the continuum of the most fundamental to strictly applied research. OCES transfers technology generated from research programs to clientele. These three entities complete the spectrum and constitute a true partnership to service problems related to panhandle agriculture.

The Department of Plant and Soil Sciences with sole support from OAES and OCES has staffed the Oklahoma Panhandle Research and Extension Center (OPREC) with a Director, Area Crop-Soils Research/Extension Specialist, Area Livestock Extension Specialist, Senior Office Assistant, Senior Station Superintendent, Field Foreman, Field Assistant/Equipment Operator, wage payroll and part-time OPSU student labor. The Director, in addition to his day-to-day administrative duties, and the two Area Specialists are fully engaged in on- and off-station applied research and extension programs throughout the panhandle area.

Oklahoma State University faculty in departments of Plant and Soil Sciences, Entomology and Plant Pathology, Biosystems and Agricultural Engineering, Agricultural Economics, Animal Science, and USDA/ARS continue to expand their research and extension efforts on the Center and in the panhandle area. Development of management practices to achieve maximum economic yield of all the crops, as well as potential new crops adapted to the area has been the focal point of both research and educational programs. Other studies have concentrated on varietal development of both hard red winter wheat and the new crop, hard white winter wheat. Performance of bermudagrass, buffalograss, alfalfa, soybean, wheat, grain sorghum, corn, and the efficient use of fertilizer, pesticides, water, and animal waste are being evaluated.

Progress made in development of research and educational programs adapted to the panhandle area has been significant since establishing the Center. However with increased fuel, fertilizer, pesticide, and irrigation costs much more work needs to be initiated. Your continued support in our research and extension programs will help serve the clientele of the panhandle area.

Robert L. Westerman
Assistant Director
OAES

Oklahoma Panhandle Research and Extension Center

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2000 Oklahoma Panhandle Research and Extension Center

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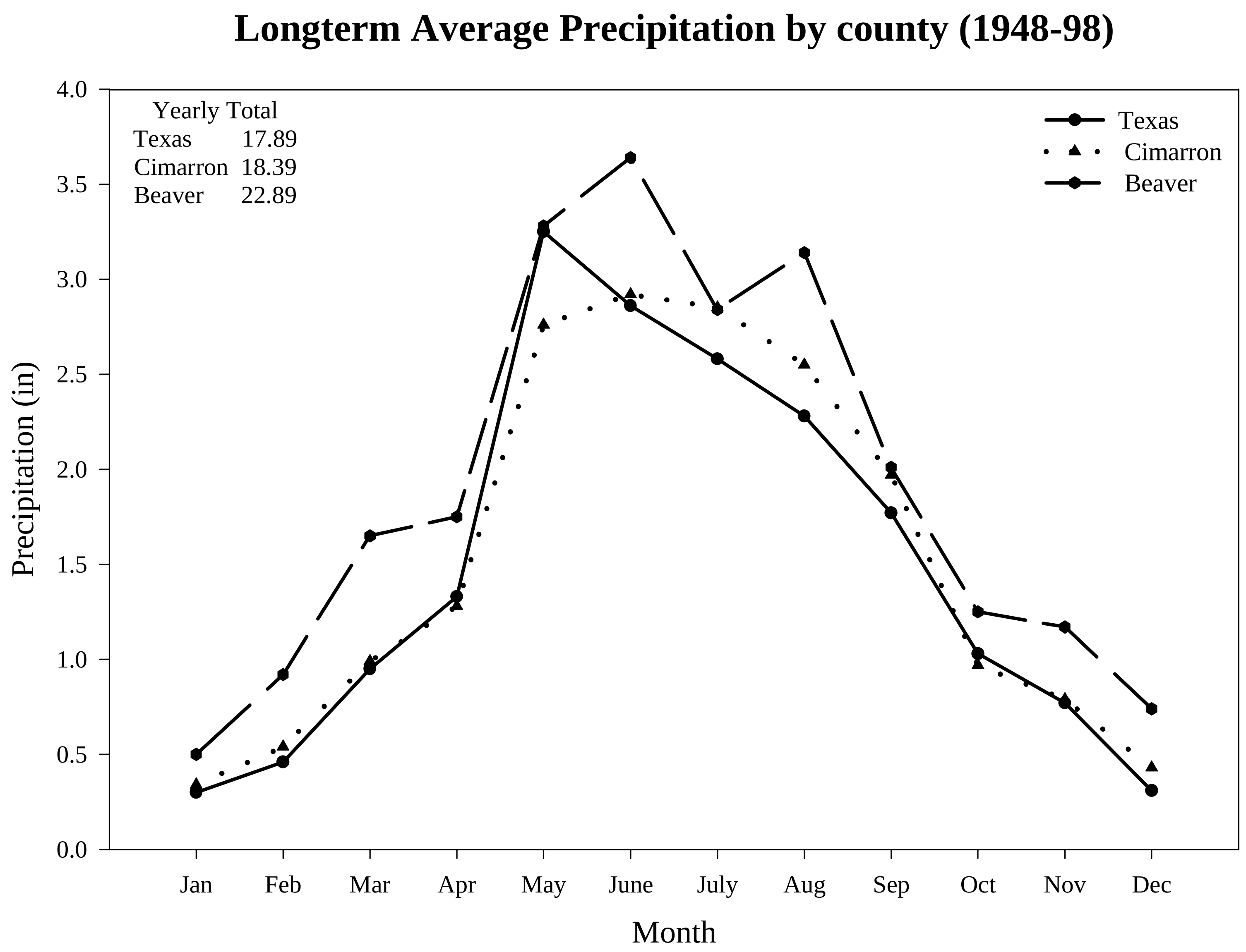
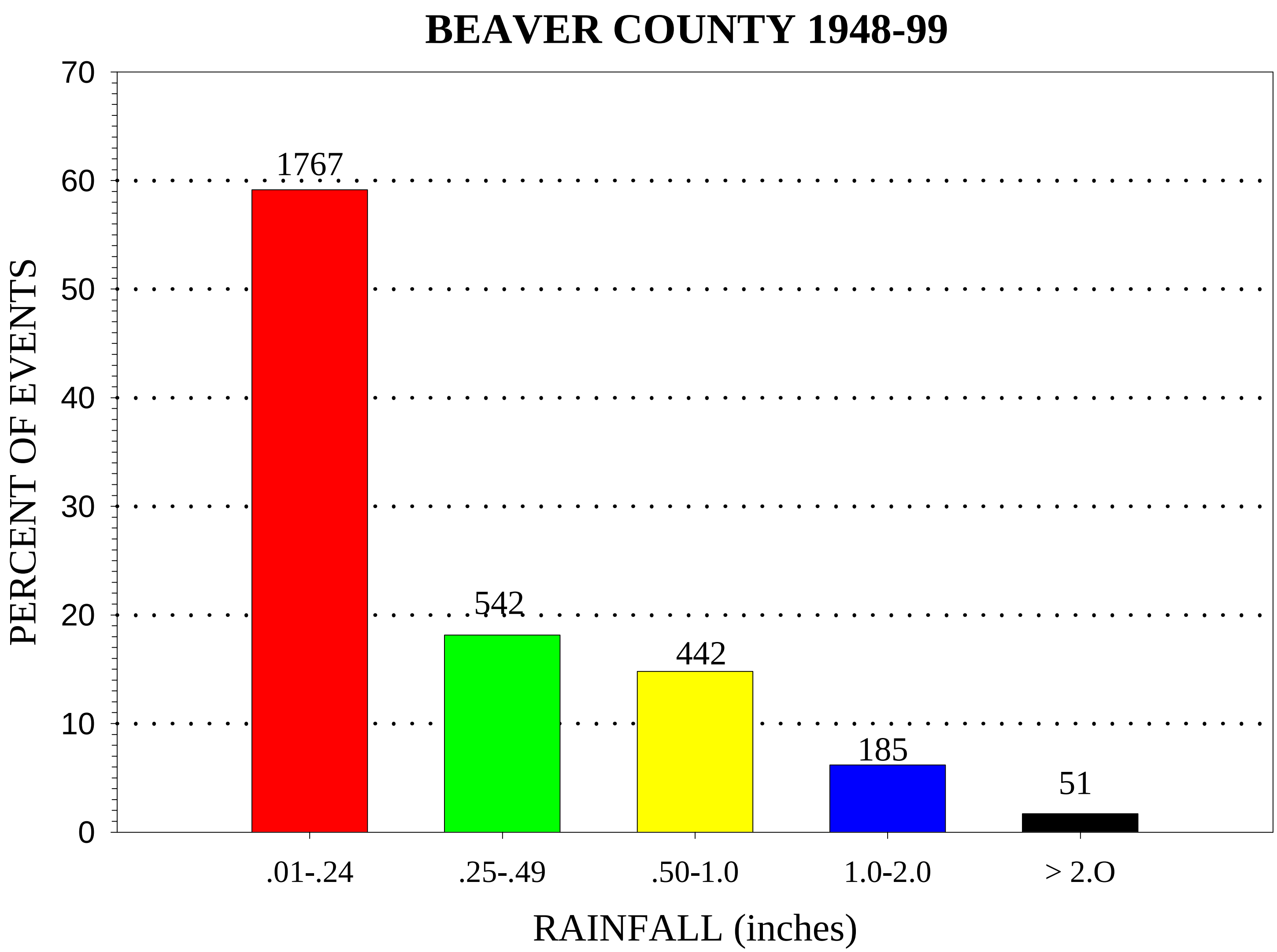
Climatological data for Oklahoma Panhandle Research and Extension Center, 2000.

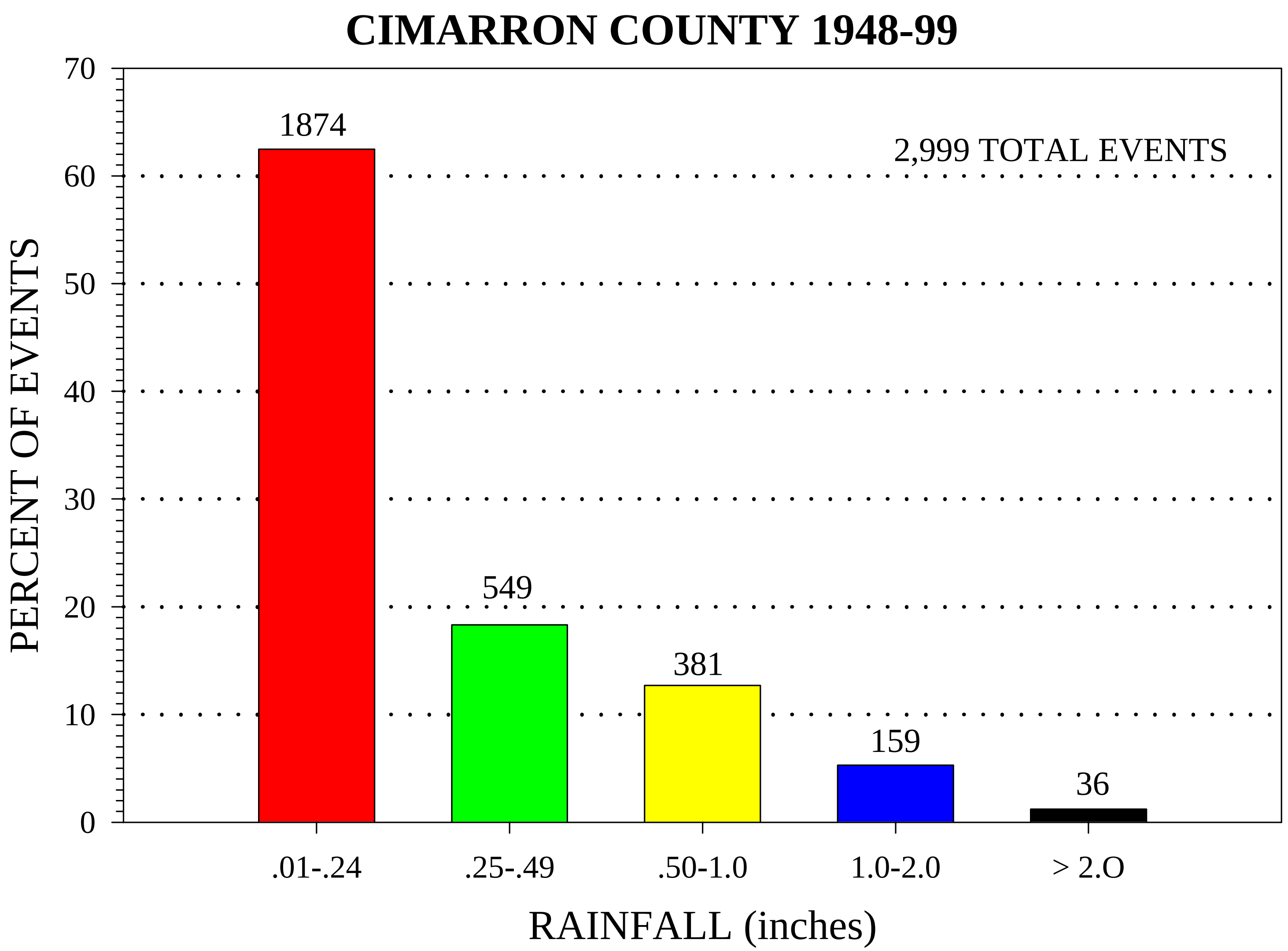
	Temperature				Precipitation			Wind	
Month	Max	Min	Max. mean	Min. mean	2000 Inches	Long term mean	One day total	AVG mph	Max mph
Jan	71	9	52	22	0.20	0.30	0.15	11.0	51.4
Feb	79	15	62	29	0.05	0.46	0.04	13.1	59.2
March	77	23	58	33	5.39	0.95	1.50	12.6	57.0
April	90	25	71	40	1.93	1.33	1.09	14.3	52.6
May	99	35	82	51	1.01	3.25	0.28	13.8	81.2
June	96	50	86	60	2.29	2.86	0.51	14.0	68.6
July	103	59	95	66	0.76	2.58	0.37	12.2	58.7
Aug	104	58	98	66	1.09	2.28	0.57	12.3	60.1
Sept	104	29	90	56	0.03	1.77	0.02	13.6	47.4
Oct	96	29	70	46	5.68	1.03	1.77	11.9	49.9
Nov	66	15	51	25	0.02	0.77	0.01	11.2	44.8
Dec	63	4	43	18	0.14	0.31	0.12	11.7	63.9
Annual total			71.5	42.7	18.59	17.9	NA	NA	NA

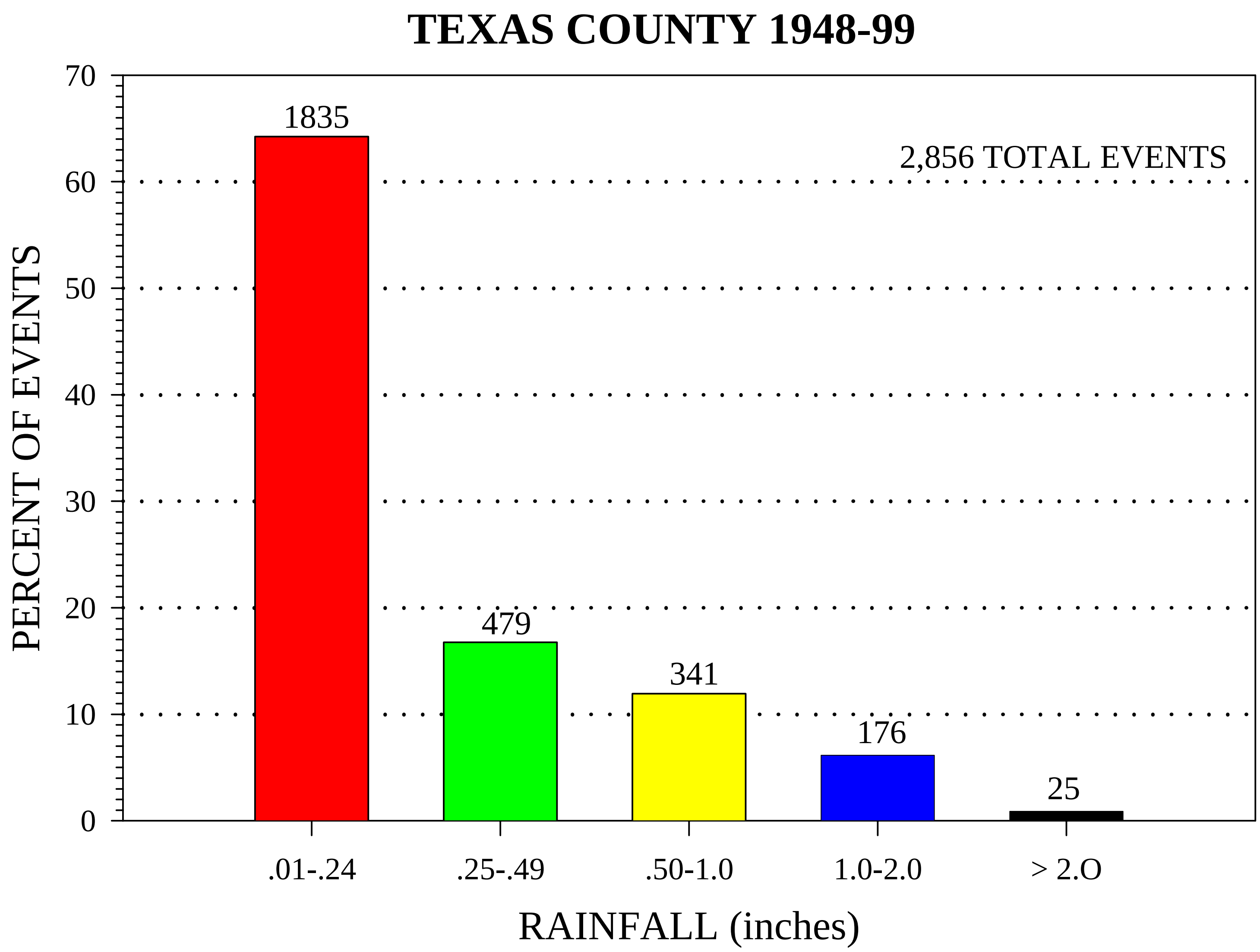
Data from Mesonet Station at OPREC



Longterm Average Precipitation by county (1948-98)
Yearly Total
Texas 17.89
Cimarron 18.39
Beaver 22.89
Texas
Cimarron
Beaver
Precipitation (in)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
Month


BEAVER COUNTY 1948-99
PERCENT OF EVENTS
70
60
50
40
30
20
10
0
1767
542
442
185
51
.01-.24
.25-.49
.50-1.0
1.0-2.0
> 2.O
RAINFALL (inches)


CIMARRON COUNTY 1948-99
2,999 TOTAL EVENTS
PERCENT OF EVENTS
0
10
20
30
40
50
60
70
1874
549
381
159
36
.01-.24
.25-.49
.50-1.0
1.0-2.0
> 2.O
RAINFALL (inches)


TEXAS COUNTY 1948-99
2,856 TOTAL EVENTS
1835
479
341
176
25
70
60
50
40
30
20
10
0
PERCENT OF EVENTS
.01-.24
.25-.49
.50-1.0
1.0-2.0
> 2.O
RAINFALL (inches)

Oklahoma Panhandle Research & Extension Center
2000 Research Highlights

Animal Waste

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Progress Report

Buffalograss Fertilization with Animal Manures

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An experiment was continued evaluating animal manure on irrigated buffalograss. The manure sources evaluated were solid cattle manure (SCM), liquid swine manure (LSM), composted dairy manure (CDM), and inorganic nitrogen fertilizer (IOF) applied at three rates (0, 60, and 120 kg/ha) on 19 May and 17 July 2000. Two forage harvests were taken during the growing season and forage height was measured before each harvest. Plots were harvested on 14 July and 16 October 2000. Significant differences ($P<0.01$) in average forage height was found for manure sources ($P<0.01$; IOF, 21 cm; LSM, 21 cm.; CDM, 18 cm; SCM, 18 cm.) and manure application rates ($P<0.05$; 0, 17; 60, 20, and 120, 23.) Significant differences in season total forage dry matter (DM) production was found for manure application rates ($P<0.01$; 15,460 kg/ha DM at 120 kg/ha application rate; 11,650 kg/ha DM at 60 kg/ha application rate; and 7,770 kg/ha DM at 0 application rate). A year by application rate interaction was found for DM production when data were combined over the last three years ($P<0.01$). Similar DM production across treatments in the year after establishment (1998) accounted for the interaction. Manure source ($P>0.45$) and manure source by application rate interactions ($P>0.11$) were absent for forage DM production when years were combined.

Other publication on fertilization of buffalograss:

Springer, T.L. 2000. Utilization of animal manure for the production of buffalograss in the southern High Plains. Southern Pasture Crop Improvement Conference Proceedings, June 12-14, 2000, Raleigh, NC.

Springer, T.L. and C.M. Taliaferro. 2001. Nitrogen fertilization of buffalograss. Crop Science 41:139-142

EFFECTS OF LONG-TERM SWINE WASTE APPLICATION IN FORAGE PRODUCTION SYSTEMS

J. Parton, C. Turner, R Kochenower, J. Warren and J. Hattey.

OBJECTIVES

1. To evaluate warm-season and cool-season forage production in the southern Great Plains region when managed for high yield potential as part of a swine waste management program.
2. Evaluate the effects of long-term land application of swine waste on biological, chemical and physical properties of the soil.

INTRODUCTION

Livestock production is an important component of agriculture production in the Oklahoma panhandle. Current livestock production includes beef, dairy, and swine. Therefore an effort is important to evaluate integration of the livestock production systems through the use of swine effluent applications to forage production systems. To efficiently utilize forages and swine effluent in a production system, a combination of warm-season and cool-season grasses would be ideal. For the first objective, warm-season grasses and cool-season grasses suitability will be evaluated for swine waste-nutrient management program in the southern Great Plains. Each of the forage species selected have proven to be productive in various management systems but none have been evaluated for the benefit of high yielding systems in the southern Great Plains. Selected cultivars of each of these forages will be established in small plots to determine their cold tolerance, limitations, persistence and response in high yield potential systems.

PROCEDURE

Forage plots were established during the 1998-growing season with soil samples collected prior to establishment of the plots. Cool-season and warm-season perennial grasses were selected. Warm-season grasses were bermudagrass (Midland *Cynodon dactylon* (L.) Pers.), and buffalograss (Bison, *Buchloe dactyloides* (Nutt.) Engelm.). Perennial cool-season grasses selected were pubescent wheatgrass (Luna, *Thinopyrum intermedium* (Host) Barkworth and Dewey), and orchardgrass (Paiute, *Dactylis glomerata* L.). During the 1999 growing season, N was applied at 0, 50, 150 and 450 lb. N ac^{-1} as swine effluent or urea. Forages were harvested as needed during the growing season to determine yields. Plot establishment for this experiment was 3x6 m plots with borders separating plots and replications to minimize effluent movement between plots.

RESULTS

Forage yields for 2000 indicate that there was a significant difference among forage species with production increasing as the quantity of N applied increased regardless of the source. The response of all forage species was linear suggesting that yields would continue to increase with added N (Fig.1). The greatest yields averaged across swine effluent and urea was observed for buffalograss, followed by bermudagrass and wheatgrass from N added at 450 lb. ac^{-1} with 7.0, 6.4, and 6.2 ton ac^{-1} respectively. The level of production for buffalograss was higher in both 1999 and 2000 indicating that these high production levels can be maintained. These yield levels will continue to be evaluated for several years establishing long-term results. These forage plots were established during 1998, and in 2000 ragweed (*Ambrosia),* kochia [*Kochia scoparia* (L.) Schrad.] and pigweed (*Amaranthus*) had invaded increasing with nitrogen rate increases. Dry matter yields were harvested so that only the desired forage was harvested. Management for weed species is in forage systems is currently being evaluated. Loss of stand has been monitored for the two years and in a monoculture cropping system they have done well. Research in mixed forage systems has shown that buffalograss is out competed in dual forage cropping systems (Richard, C.E. and E.F. Redente. 1995). This is especially true for buffalograss, a native species to the southern Great Plains but generally not included in intensive management systems.

Figure 1 shows that buffalograss outperformed bermudagrass at all levels of N applied with exception of the 50 lb N ac^{-1} applied using swine effluent. Although buffalograss has constantly out performed bermudagrass they were very similar in their response to swine effluent applications. A similar response was observed with the cool season species where wheatgrass consistently responded to added N with yields greater than orchardgrass. Annual production from the warm season buffalograss and cool season wheatgrass indicate they were comparable for total production. This would suggest that a grazing system developed to utilize these forages during their optimum growing season could decrease the time period for supplemental feeding.

Comparison of N sources indicated that there is no significant difference between swine effluent and urea for these grasses. All grasses responded similar, which is valuable to know. Previous work at the Oklahoma Panhandle Research Extension Center found that a significant quantity of NH_3 could volatilize from swine effluent application to fallow soils. From the two years of work it appears that it is not the case when applied to the forages. It must be noted that this is only two years of data and it is still to be determined if the trend will continue. But the prospects of a sustained production system are encouraging.

A comparison of the warm season forages indicates that there was a significant difference in yield between buffalograss and bermudagrass (Table 1) for 1999. That difference between forages was not significant in 2000 due to failure of an irrigation system that limited water supply to the study during a 21-day period of August 2000. For the cool-season species, Wheatgrass consistently yielded more than Orchardgrass for both years.

Table 1. Forage production from selected warm and cool season species for 1999 and 2000 averaged across nitrogen rates at Oklahoma Panhandle Research and Extension Center, Goodwell, OK.

	Yield	
Forage Species	1999	2000
	----------(Ton acre^{-1})----------	
Bermudagrass	5.2	3.2
Buffalograss	7.0	3.6
Orchardgrass	5.6	3.7
Wheatgrass	7.2	4.3

FUTURE WORK

Forage harvest will continue on a seasonal basis and the viability of each stand will be monitored. In addition, soil samples will be collected to measure soil properties to measure biological changes in soil environment due to the additions of moisture, organic C and readily available nutrients. Other soil properties of interest will be inorganic N, phosphorus loading, soil organic carbon and salt levels. Of particular importance in these soils will be movement of salts at various depths within the soil profile. With high rates of evapotranspiration in this semiarid environment there is a potential for increased levels of salt accumulation in the upper portion of the soil profile. Over the long term high rates of salt accumulation in the profile will limit agronomic production and be of major concern in this agroecosystem. Physical properties will include bulk density, soil structure, and water infiltration.

Acknowledgements:

The authors thank the support of USDA, Grant CRIS 0179232 and the Oklahoma Agricultural Experiment Station for support of this project.

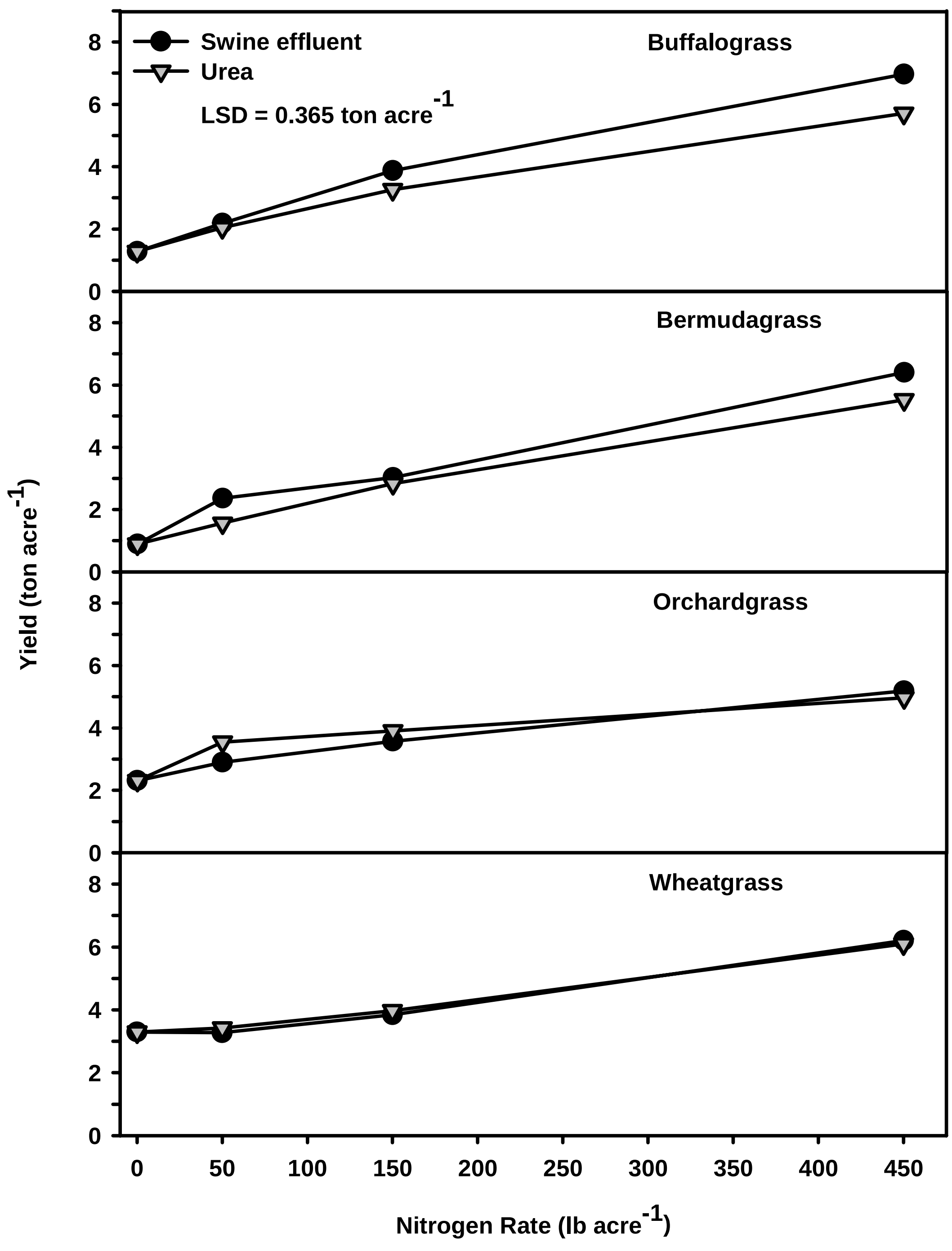

Figure 1. Forage dry matter production from warm-season and cool-season grasses as affected by N applications from swine effluent and urea for 2000 at the Oklahoma Panhandle Research and Extension Center.

Corn Planting Date

Rick Kochenower, Oklahoma Panhandle Research and Extension Center, Goodwell

Previous research has reported that planting corn before the optimum date reduces yields less than planting after the optimum date (Fig. 1). Therefore, in April 2000 a study was initiated to determine the effect of planting date and starter fertilizer on corn ensilage and grain yield. Six planting dates were selected April (1, 10, 20, 30) and May (10 and 20). On each selected date corn was planted with and without a starter fertilizer (5 gal/ac 10-34-0) in the row. Nitrogen level was 250 lb/ac (soil test level + applied), 40 lbs/ac P_2O_5 was applied based on soil test requirements, and K was sufficient. The hybrid DK 647BtY was planted in four 30-inch rows by 30 feet long plots with an average plant population of 28,500 plants per acre. Ten feet of one outside row was harvested for ensilage production and the two middle rows were harvested for grain production.

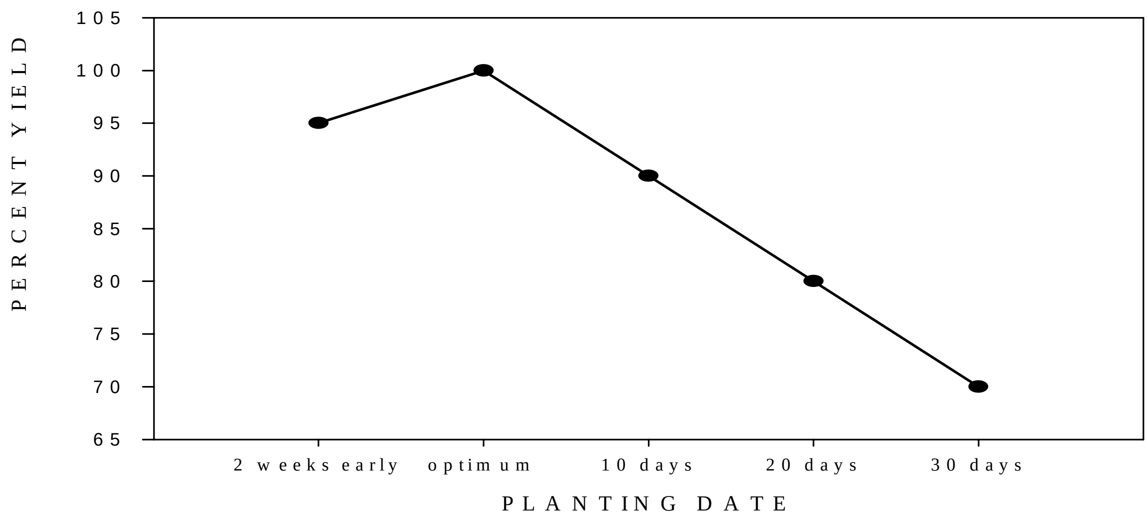

Figure 1. Ten years of grain yields at Lansing, Michigan. Source modern corn production

Results

Starter fertilizer did not affect ensilage or grain yield (Fig. 2 and 3). An April 24 hailstorm slowed growth of corn planted on April 1 and 10. Ensilage and grain yields were not statistically different for planting dates April 1 until April 30. Later planting reduced both ensilage and grain yields. Test weight was affected by planting date more strongly than either ensilage or grain yields with the highest test weight occurring prior to April 20 (Table 1). In 2000, planting as early as April 1 did not reduce yield or test weight as expected from the Michigan data. This may have been because the earliest date (April 1) is not too early for optimum yield. The unusually warm temperatures of spring 2000 were likely responsible and results may differ in subsequent years with different environmental conditions. Several more years of data are needed to determine the optimum planting date ensilage and grain yields.

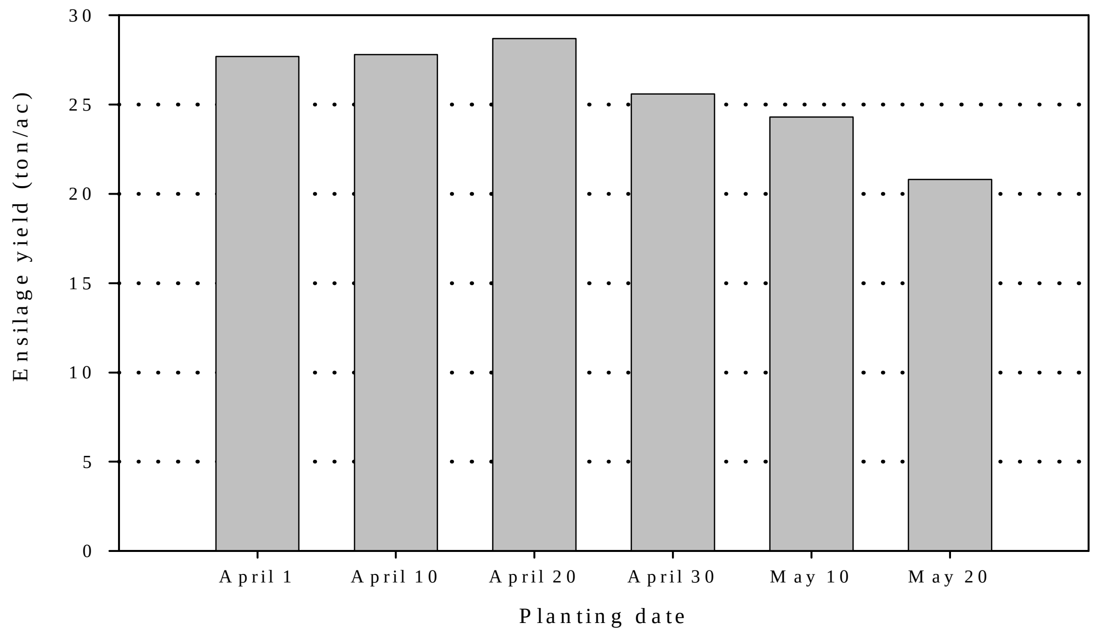

Figure 2. Ensilage yields from corn planting date 2000.

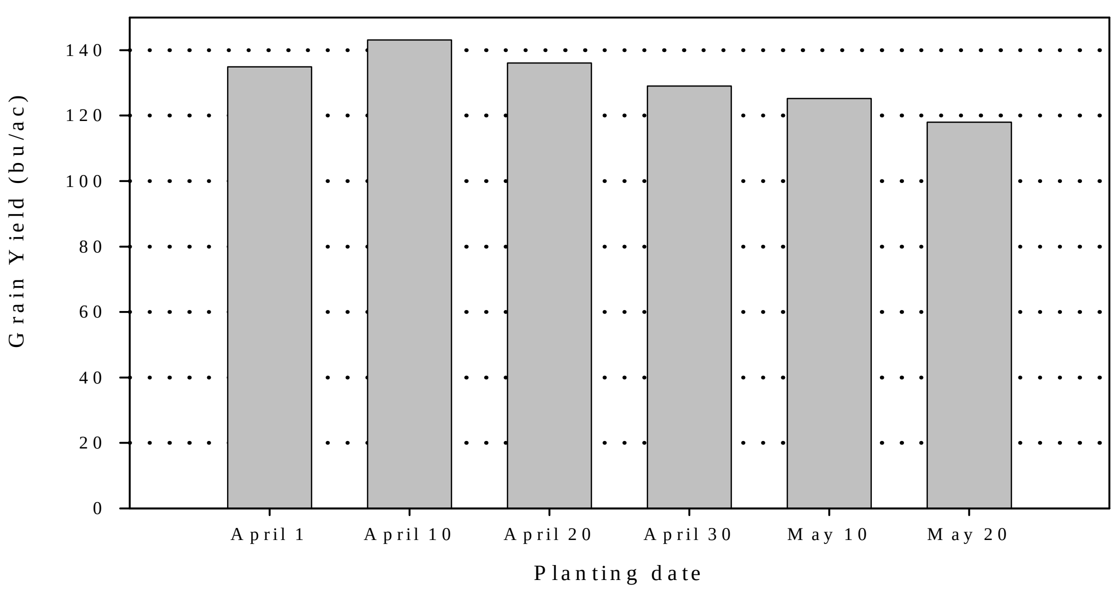

Figure 3. Grain yields from corn planting date 2000.

Table 2. Grain yields and test weights from planting date study 2000.

PLANTING DATE	STARTER FERTILIZER	TEST WEIGHT LB/BU	DRY MATTER %
April 10	Yes	58.3a	0.379ab
April 1	Yes	57.8a	0.387a
April 10	No	57.0ab	0.376ab
April 1	No	56.5abc	0.372abc
April 20	No	56.5abc	0.344cd
April 20	Yes	55.8bc	0.357bc
April 30	No	55.5bc	0.327de
April 30	Yes	54.8c	0.311e
May 10	No	52.5d	0.316de
May 10	Yes	52.5d	0.311e
May 20	No	51.3d	0.263f
May 20	Yes	50.8d	0.271f
Mean		54.9	0.334
CV %		2.5	6.1
LSD		2.0	0.029

Note: Means with different letters are significantly different at the 0.05 level.
Harvest date: Ensilage August 14, 2000; Grain September 8, 2000

GENETIC IMPROVEMENT AND VARIETY DEVELOPMENT IN WINTER WHEAT: RELEVANCE TO THE OKLAHOMA PANHANDLE

Brett Carver, Wheat Breeding Project Leader
Dept. of Plant and Soil Sciences, Stillwater

The Wheat Improvement Team

Wheat variety development research at Oklahoma State University rests in the hands of the Wheat Improvement Team, comprising scientists with expertise in breeding and genetics, genomics, pathology, entomology, management, physiology, biotechnology, and cereal chemistry. This team has adopted the unified goal to develop hard red and hard white winter varieties with marketable grain quality and specific adaptation to all wheat-production zones in Oklahoma.

OSU Wheat Breeding

The core breeding program can be divided into three phases, from early to late in the 10-year breeding cycle: i) parent hybridization and seed increase, ii) identification of worthy breeding populations and lines within populations, and iii) statewide testing of breeding lines. The earlier phases, identified as (i) and (ii), receive heavy emphasis on selection under early-planting conditions, with the intent to provide Oklahoma wheat producers with varieties better adapted to dual-purpose management systems. Thus, all breeding materials up through the F6 generation (six generations following the last cross) are planted early to accommodate either cattle grazing or mechanical removal of forage. Much of that work is conducted in central Oklahoma (Stillwater and at the Wheat Pasture Center near Marshall). Breeding lines in subsequent generations are evaluated in two clusters of sites distinguished mostly by disease pressure, specifically leaf rust: Western cluster (Goodwell, Sweetwater, and Altus), and Central cluster (Lahoma, Enid, Marshall, Ft. Cobb, and Stillwater). Field selection encompasses a myriad of agronomic traits, but four which are emphasized most include: i) leaf rust resistance, ii) wheat soil-borne mosaic virus resistance, iii) adaptation to low-pH soils, and iv) adaptation to a dual-purpose system. Weakness in any one of these must be compensated by exceptional strengths in other traits. With regard to physical grain quality, test weight receives highest priority due to its importance in grain grading and its perceived relationship to milling quality.

Importance of the Oklahoma Panhandle to OSU Wheat Breeding

The Oklahoma Panhandle offers a unique environment to the mix of target environments for which selection is intended. With reduced pressure from foliar diseases more common in central Oklahoma, the full genetic potential of a given variety is often expressed in grain production, provided that irrigation is supplied in optimal amounts. Thus, irrigated breeding trials, located at Goodwell, provide critical information on "yield potential" of breeding lines, reflecting the upper range of performance. Without irrigation, grain production is primarily limited by drought stress, reflecting the lower end of the yield distribution. Yield potential, however, only partially explains performance under drought. Thus, our breeding strategy is to identify and select lines having improved yield potential in irrigated trials and improved water-use efficiency or drought tolerance in dryland trials, before they are promoted for release.

The Oklahoma Panhandle Research and Extension Center provides a critical site for determining genetic variability under both irrigated and dryland conditions. Approximately 1,071 field plots under irrigated and 918 plots under dryland conditions are currently dedicated to advanced breeding line evaluation at the Center. In addition, one USDA-ARS sponsored regional nursery, containing candidate cultivars from public and private breeding programs throughout the Great Plains, is evaluated annually, and the results are used to base selection decisions in this program. The Southern Regional performance nursery, features lines with wider adaptation to central and western regions of the southern Great Plains. The results are distributed to breeding programs throughout the region, and they are posted on the Wheat Improvement Team's website at: http://clay.agr.okstate.edu/wheat/regnurs.html.

Finally, the Center serves another function by supplying a high-yielding environment for breeder seed multiplication of candidate cultivars currently under consideration for release. Four such cultivars are under increase, including OK96717-99-6756 (Abilene/2180//Chisholm), OK94P549-99-6704 (HBY756A/Siouxland//2180), OK97508 (2174/Cimarron), and OK98680 (Odessa 06/Mesa). All candidate cultivars appear well suited for the Panhandle region and are available for observation by visitors to the Center.

Greenbug IPM Research

Gerritt Cuperus, Kris Giles, and Tom Royer, Department of Entomology and Plant Pathology, Oklahoma State University, Stillwater
Norm Elliott and Dean Kindler, USDA-ARS Plant Science and Water Conservation Research Laboratory, Stillwater
David Waits, SST Development Group, Inc., Stillwater.

The goal of the greenbug IPM project is to develop better tools for managing greenbugs in winter wheat. The project involves developing sampling methods and economic thresholds for the greenbug in winter wheat that are valid throughout Oklahoma, and developing an expert system to help growers determine when and how they should manage greenbug infestations in winter wheat fields.

This year we report on progress towards developing improved economic thresholds for the greenbug in winter wheat fields in Oklahoma. This is the third year of studies at four locations: Goodwell, Stillwater, Chickasha, and Tipton to establish improved economic thresholds. We achieved good infestations of greenbugs in our experimental plots this autumn at Goodwell, Stillwater, and Chickasha, but not at Tipton. Data for the statewide study are still being processed so we cannot report our results. However, results are available for a 4-year study conducted at Stillwater prior to initiating the statewide project. The Stillwater study yielded several interesting results. First, all greenbug susceptible winter wheat cultivars tested (‘Karl’, ‘Karl-92’, ‘2137’, and ‘2163’) suffered the same amount of yield loss for a particular number of greenbugs per tiller. Second, the same amount of yield was lost for a particular number of greenbugs per tiller regardless whether greenbugs infested the wheat in autumn or in spring. This result probably would not hold for heavy infestations in seedling wheat; but heavy infestations prior to the onset of tillering are unusual in Oklahoma so our results apply to the situation that typically occurs in winter wheat in Oklahoma. Third, the amount of yield lost to greenbugs when wheat is under drought stress is about twice that lost when moisture conditions are adequate.

A model was developed to predict the amount of yield lost in relation to the number of greenbugs per tiller in a wheat field. The model is meant for use in conjunction with sampling using recently developed methods (Giles et al. 2000) to determine the number of greenbugs per tiller for the field. The yield loss model is:

Bushels per acre yield loss = 0.22 x (the number of greenbugs per tiller), under conditions of adequate soil moisture.

Bushels per acre yield loss = 0.51 x (the number of greenbugs per tiller), under drought conditions.

The model needs to be tested at various locations in the state and modified if necessary. We hope our research at Goodwell will allow us to verify that the model works for wheat grown in the Panhandle or will allow us to modify the model so that it works under Panhandle conditions. Once we have tested the model, it can be used in conjunction with sampling to make economically justified control decisions for greenbugs in winter wheat.

References

K. L. Giles, T. A. Royer, N. C. Elliott, and S. D. Kindler. 2000. Binomial sequential sampling of the greenbug in Oklahoma winter wheat. Journal of Economic Entomology 93:1522-1530.

IRRIGATED CROP ROTATION 2000

Rick Kochenower, Oklahoma Panhandle Research and Extension Center, Goodwell

In 1999, an irrigated crop rotation study was established to determine if the crop rotation effect reported by researchers in dry-land systems exist under a high yield environment. In 2000, problems with insects, birds, and water well were encounter so data was not collected but will be collected in 2001. Researchers at Kansas State University have reported 12 bu/ac yield increases in grain sorghum rotated yearly with soybeans when proper fertilization is used (Gordon, B., et al., 1999). Researchers at the University of Minnesota have reported yield increases of 12% (138 vs. 122 bu/ac) in corn rotated with soybeans when compared to continuous corn (Porter, P.M., et al., 1997). The crop rotation effect is not clearly understood and has many possible explanations. What is understood are the benefits in weed management, breaking of insect and disease cycles, improved soil physical properties, and increased water use efficiency. Rotations include corn-soybean, corn-sorghum, sorghum-soybean, along with continuous corn, soybeans, and grain sorghum. Plot size is 10 feet by 30 feet long, planted with a John Deere 1710 Maxemerge 4-row 30-inch planter. Plots will be harvested for grain yield with a Massey-Ferguson 8 plot combine. Yields will be collected to evaluate if the crop rotation effect does exist in an irrigated cropping system.

References:

Gordon, B., D. Whitney, and R. Lamond. 1999. Grain Sorghum Nutrient Management in Reduced Tillage Systems. Proceeding of the 21st Biennial Grain Sorghum Research and Utilization Conference. p 8-10.

Porter, P.M., J.G. Lauer, W.E. Lueschen, J.H. Ford, T.R. Hoverstad, E.S. Oplinger, and R.K. Crookston. 1997. Environment effects the corn and soybean rotation effect. Agron. J. 89:442-449.

IRRIGATED WHEAT FOR FORAGE AND GRAIN EXPERIMENT

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Irrigated wheat is planted in the panhandle region each year to utilize fall forage for cattle as well as harvest grain the next spring. In the fall of 2000, an experiment was initiated to determine the effects of seeding rate, planting date, and variety on fall forage and grain production. Three seeding rates were used 60, 120 and 180 pounds per acre. Three widely grown Hard Red Winter Wheat varieties (HRW) (TAM 107, Custer, and Jagger) and a recently released Hard White Winter Wheat (HWW) (Intrada) from Oklahoma State University were used. Plots where 5 feet wide by 22 feet long planted with a Hege plot planter. Planting dates were September 1, October 1, and November 1. The September 1 planting date coincides with planting wheat following corn ensilage production. The October 1 planting date is reflective of planting wheat following corn for grain harvest. The November 1 planting date was selected to determine grain production on late-planted wheat. Forage from the September 1 planting date was harvested on October 12, and November 1. Forage from the October 1 planting date was harvested on December 15. The September 1 planting date was scheduled to be harvested again on December 15, but cold temperatures in November stopped growth. Three feet of row from each end of a plot was hand clipped to soil surface and placed in drying oven for 48 hours to determine forage production. Plots were then mowed with a 5-foot finishing mower to simulate forage removal by grazing. After mowing, the September 1 planting area that was hand clipped was marked so same area could be hand clipped again for later harvest.

Results

There were no differences in forage yields associated with varieties for the September 1 planting date, therefore the reported forage yields are an average of all varieties. Seeding rate and planting date has the largest impact on fall forage production (Fig. 1). The 180 lb/ac seeding rate and the September 1 planting date resulted in the highest forage production at 2,790 lbs/ac of dry matter. The 180 lb/ac seeding rate will also allow earlier grazing due to increased early forage production (Fig. 2). Grain will be harvested in June to determine if seeding rate, planting date, and forage removal effects grain yield.

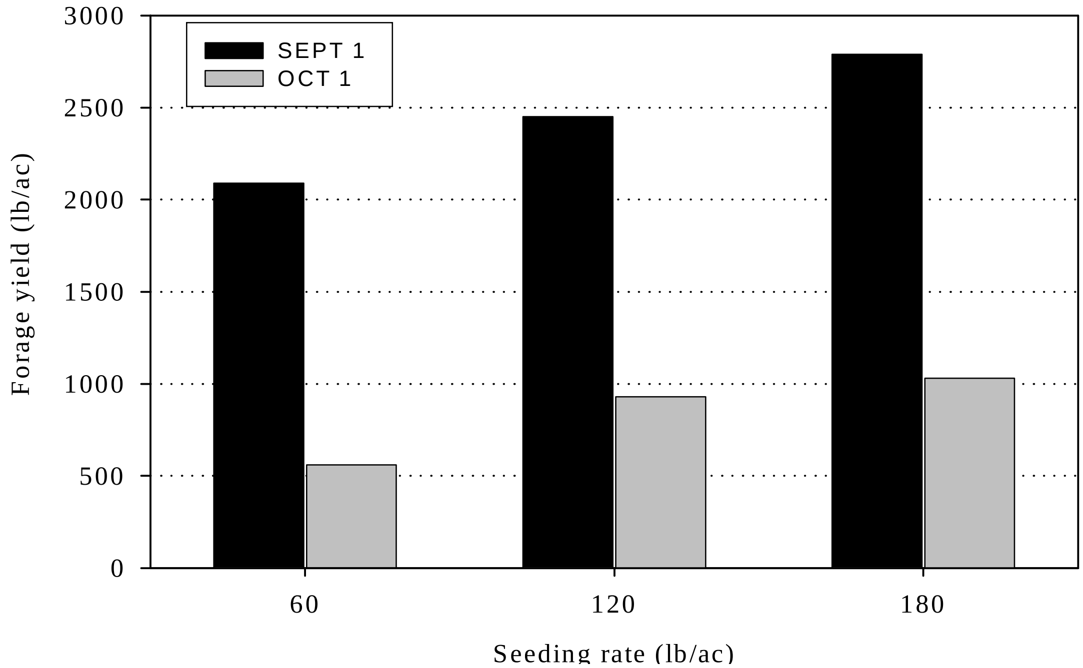

Figure 1. Total fall forage harvested by December 15 for selected seeding rates and dates.

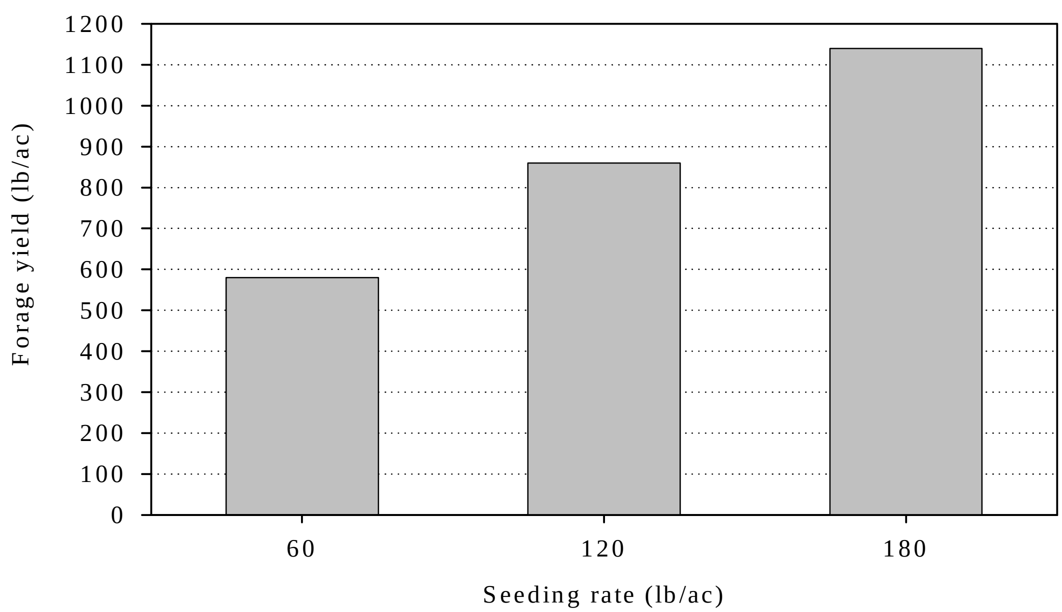

Figure 2. Forage for September 1 planting date when harvested October 12.

Narrow Row Soybean Weed Control

M.L. Wood
Oklahoma Panhandle Research and Extension Center

An experiment was initiated to evaluate fifteen herbicide treatments in a Roundup Ready soybean system. The experiment was located on the Oklahoma Panhandle Research and Extension Center, near Goodwell, Oklahoma. Experimental design included four replications in a randomized complete block design with plots that were 10 ft wide (eight 15" rows) by 30 ft long. Plots were planted on June 19, in a Richfield clay loam with a pH of 7.1 and an organic matter content of 0.78%. Planting population was 150,000 seeds/acre using Asgrow 4602 Roundup Ready soybean seed. Treatments were herbicides applied alone or in a tank mix as a pre-emergent (PRE), early post (EPOST), or a mid post (MPOST), and an untreated check. Treatment particulars are listed in (Table 1). Target weed species for the experiment were Johnsongrass represented by the five-letter code (SORHA) and large crabgrass (DIGSA). Harvest data was not evaluated due to a late hailstorm coupled with the irrigation well going down in August. Data that were evaluated include crop injury and weed control listed in (Table 2).

Table 1. Herbicide application data including: date, timing, weed size at application and rating.

Application type	PPI[1]	PRE[2]	EPOST[3]	MPOST[4]
Date applied [mm/dd/yy]	06/19/00	06/19/00	07/17/00	07/26/00
Incorporation equipment	Field Cultivator	N/A	N/A	N/A
Incorporation depth [in]	2"	N/A	N/A	N/A
Air/Soil temperature [F]	85/78	87/79	73/82	78/81
Relative humidity [%]	Low	Low	Moderate	Low
Wind [mph, direction]	12.5, S>N	12.5, S>N	6, S>N	0, N/A
Weather [sunny, etc.]	Ptly. Clody	Ptly. Cloudy	Hazey	Clear
Soil moisture	High	High	High	High
Crop stage/Height	N/A	N/A	V3/6-8"	V4/8-10"
Sprayer type/mph	Cub/4	Cub/4	Cub/4	Cub/4
Nozzle type/Size	FF/XR11003VS	FF/XR11003VS	FF/XR11003VS	FF/XR11003VS
Boom ht/# Noz/spacing in)	16"/6/20"	16"/6/20"	16"/6/20"	16"/6/20"
GPA/Psi	15.5/25	15.5/25	15.5/26	15.5/26
Applied by	MLW	MLW	MLW	MLW
Rainfall (in)				
0-24 hr/1-3 days	0.00/0.19	0.00/0.19	0.01/0.12	0.00/0.00
4-7 days/2nd week	0.66/0.27	0.66/0.27	0.00/0.00	0.00/0.00
3rd week/4th week	0.13/0.00	0.13/0.00	0.00/1.33	0.00/1.33
Weed species	----- population/height/# leaves ------			
SORHA	N/A	N/A	3-4/sqft/6-10"/4-8	3-4/sqft/12"/4-8
DIGSA	N/A	N/A	1-2/5ft/8"-heading	1-2/5ft/8"-heading

Weed size at rating-----Species/rating/height/# leaves/density

Johnsongrass	Large crabgrass
SORHA/4 WAP/6-10"/4-8/3-4/sqft	DIGSA/4 WAP/8-10"/heading/1-2/5ft
/8 WAP/30-36"/heading/2-3/sqft	/8 WAP/8-10"heading/1-2/5ft

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[1]PPI-pre-plant incorporated.
[2]PRE-represents pre-emergent.
[3]EPOST-represents early post emergent.
[4]MPOST-represents mid post emergent.

Table 2. Percent crop injury and weed control four weeks and eight weeks after planting.

					Crop Injury	SORHA Control	DIGSA Control	SORHA Control	DIGSA Control
	Rating Date				7-26-00	7-26-00	7-26-00	8-18-00	8-18-00
#	Treatment	Conc. & Type	Rate	Appl. Code	%	%	%	%	%
1	Pendimax/ Roundup Ultra + Ammonium Sulfate	3.3 EC 3 SL S	1 QT/A 1 QT/A 2 % W/W	PPI MPOST	4 abc[1]	86 abc	98 ab	100 a	100 a
2	Prowl/ Extreme + NIS + Ammonium Sulfate	3.3 EC 2.17 EC L S	1 QT/A 1.5 QT/A 0.125 %V/V 1.5 % V/V	PPI MPOST	1 bc	90 ab	100 a	100 a	100 a
3	Micro-Tech/ Roundup Ultra + Ammonium Sulfate	4 ME 3 SL S	2 QT/A 1 QT/A 2 % W/W	PRE MPOST	0 c	49 d	100 a	93 b	100 a
4	Firstrate/ Roundup Ultra + Ammonium Sulfate	84 WG 3 SL S	0.305 OZ/A 1 QT/A 2 % W/W	PRE MPOST	3 abc	73 bc	96 ab	99 a	100 a
5	Firstrate/ Roundup Ultra + Ammonium Sulfate	84 WG 3 SL S	0.6 OZ/A 1 QT/A 2 % W/W	PRE MPOST	3 abc	80 abc	96 ab	98 ab	100 a
6	Boundary/ Roundup Original + NIS + Ammonium Sulfate	7.8 EC 3 SL L S	1.25 PT/A 1.5 PT/A 0.5 % V/V 2 % W/W	PRE MPOST	0 c	65 cd	100 a	98 ab	100 a
7	Domain/ Roundup Original + NIS + Ammonium Sulfate	60 DF 3 SL L S	10 OZ/A 1.5 PT/A 0.5 % V/V 2 % W/W	PRE MPOST	0 c	79 abc	100 a	100 a	100 a
8	Canopy/ Roundup Original + NIS + Ammonium Sulfate	75 DF 3 SL L S	3 OZ/A 1.5 PT/A 0.5 % V/V 2 % W/W	PRE MPOST	6 ab	88 ab	90 c	100 a	100 a
9	Canopy XL/ Roundup Original+ NIS + Ammonium Sulfate	56.3 DF 3 SL L S	3.41 OZ/A 1.5 PT/A 0.5 % V/V 2 % W/W	PRE MPOST	8 a	79 abc	94 bc	99 a	100 a
10	Extreme + NIS + Ammonium Sulfate	2.17 EC L S	1.5 QT/A 0.125 % V/V 1.5 % V/V	EPOST	4 abc	100 a	100 a	99 a	100 a
11	Roundup Ultra+ Ammonium Sulfate	3 SL S	1 QT/A 2 % W/W	MPOST	ND[2]	ND	ND	98 ab	100 a
12	Roundup Ultramax + Ammonium Sulfate	3.7 SL S	1.62 PT/A 2 % W/W	MPOST	ND	ND	ND	98 ab	100 a
13	Firstate+ Roundup Original + NIS + Ammonium Sulfate	84 WG 3 SL L S	0.6 OZ/A 1.5 PT/A 0.5 % V/V 2 % W/W	MPOST	ND	ND	ND	99 a	100 a
14	Roundup Ultra + Ammonium Sulfate/ Roundup Ultra + Ammonium Sulfate	3 SL S 3 SL S	1 QT/A 2 % W/W 1 QT/A 2 % W/W	MPOST LPOST	ND	ND	ND	98 ab	100 a
15	Check	N/A	N/A	N/A	0 c	0 e		0 c	0 b
	LSD (0.05)				6.1	21.4	5.8	5.5	0.0
	CV				169.5	20.7	4.5	4.16	0.0

[1]Means followed by the same letter do no significantly differ (P=0.05, LSD)
[2]ND-represents no data. At time of rating treatment was not yet complete

NO-TILL VS MINIMUM-TILL DRY-LAND CROP ROTATIONS

Rick Kochenower, Oklahoma Panhandle Research and Extension Center, Goodwell

In 1999, a study was started to evaluate four different dry-land cropping rotations and two tillage systems for their long-term sustainability in the panhandle region. Rotations include Wheat-Sorghum-Fallow (WSF), Wheat-Corn-Fallow (WCF), Wheat-Soybean-Fallow (WBF), and Continuous Sorghum (CS). Tillage systems include no-till and minimum tillage, all summer crops will be planted no-till following wheat. Wheat will be planted no-till as well as with minimum tillage practices following summer crops. Two maturity classifications were used with all summer crops in the rotations to determine optimum maturity classifications. Most dry-land producers in the panhandle region utilize the WSF rotation. Other rotations would allow producers flexibility in planting, weed management, insect management, and marketing.

Results

In both 1999 and 2000, precipitation for May through August was lower than the long-term mean (Table 1). There was no difference in wheat yield in 2000 among rotations or tillage treatments with a yield of 27 bushel per acre. Wheat yields were lower than variety trials on the station, which are in a wheat-fallow-wheat rotation. The year 2000 was the first year of continuous grain sorghum and it was not harvested. With the lack of precipitation the grain sorghum never headed out. Grain sorghum yields for 1999 were higher for full season hybrids, but the same for 2000 (Table 2). The low grain sorghum yields for 2000 can be partially explained by less than desirable weed control. The lack of precipitation did not allow for herbicide activation. Corn yields have been higher for the 112-day corn than the 108-day corn, however yields from either would not be economically feasible (Table 2). Soybean yields have been the same with both Group III and Group IV soybean (Table 2). It appears after two years of the study that the WSF rotation is best suited for the panhandle region, however if in succeeding years more precipitation is received yield may improve for corn and soybean.

Table 1. Summer growing season precipitation.

Month	1999	2000	Long-term mean
April	4.93	1.93	1.33
May	1.82	1.01	3.25
June	2.85	2.29	2.86
July	0.20	0.76	2.58
August	0.75	1.09	2.28
Total	10.6	7.08	12.3

Table 2. Yields from summer crops in dry-land tillage and crop rotation study.

Crop	Maturity	1999 yield bu/ac	2000 yield bu/ac	Mean
Soybean	Group III	12.3	8.3	10.3
	Group IV	11.3	10.2	10.8
Grain sorghum	Medium	52.0	18.0	35.0
	Late	61.8	17.3	39.6
Corn	108 day	2.5	5.3	3.7
	112 day	15.6	8.6	12.1

SOYBEAN PLANTING DATE 2000

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Ron Sholar, Dept. of Plant and Soil Science, Oklahoma State University, Stillwater

Soybeans are a crop with increasing interest among producers in the Oklahoma panhandle. Previous soybean research concentrated mostly on variety selection through variety trials at Oklahoma Panhandle Research and Extension Center (OPREC) Goodwell, OK. Research was started in 1999, to determine optimum planting date for irrigated soybeans for the region. Plots were 10 feet by 20 feet planted with a 4-row 30-inch planter on 5 dates (Table 1). Asgrow AG4602RR was planted at a rate of 160,000 seeds per acre. In 1999, plots were harvested on October 18, with a Massey-Ferguson 8 plot combine to determine yield. Data was not collected in 2000 due to a hailstorm and irrigation problems occurring the first two weeks of August. The month of May was the optimum planting period 1999. The highest yields were realized on plots planted on May 15, 1999 (Table 1). Planting during the first two weeks of June also produced acceptable yields. The June 15 planting date resulted in a yield of 45.7 bu/ac. When planting after this date soybean plants do not have sufficient growth prior to the start of flowering to produce a yield comparable with the earlier planting dates. The soybean is a photoperiod sensitive plant, so when the length of sunlight changes flowering is initiated. Additional research will be conducted to determine if maturity group selection will have an effect on yields at different planting dates.

Table 1. 1999 Irrigated Soybean planting date study, OPREC, Goodwell, OK.

Planting date	Yield bu/ac	Test wt lb/bu
May 5	60.5	54.0
May 15	72.5	54.8
June 1	60.1	55.3
June 15	45.7	53.6
July 2	33.9	51.3
Mean	54.5	53.8
LSD (0.05%)	8.6	2.3
CV	10.3	2.8

SOYBEAN PLANTING RATE 2000

Rick Kochenower, Oklahoma Panhandle Research and Extension Center, Goodwell
Ron Sholar, Dept. of Plant and Soil Sciences, Oklahoma State University, Stillwater

Soybeans are a crop with increasing interest from producers in the Oklahoma panhandle. Previous soybean research concentrated mostly on variety selection through variety trials at Oklahoma Panhandle Research and Extension Center (OPREC) Goodwell, OK. Research was started in 1999 to determine optimum planting rate for irrigated soybeans for the region. In 1999, plots were 5 feet by 20 feet long planted with a wheat drill with 7.5 inch spacing on June 1, at selected seeding rates (Table 1). In 2000 plots were planted May 15, with wheat drill with 7.5 inch spacing as well as with a 2-row 30-inch planter. The use of two row spacings is to determine if a difference in seeding rate exist between row spacing. Asgrow AG4602RR, a Roundup Ready variety was selected for planting. Plots were harvested on October 14, 1999 with a Massey-Ferguson 8 plot combine to determine yield. Data was not collected in 2000 due to a hailstorm and irrigation problems occurring the first two weeks of August. Target populations, yield in bushels per acre, number of seeds per acre planted, and seed cost associated with planting rate are listed in (Table 1). In 1999, results show that a target population of 100,000 plants/ac produced a yield that was comparable to a target population of 250,000 plants/ac. No difference in yields existed between any of the seeding rates. Oklahoma State University generally recommends a seeding rate of 140,000 - 160,000 seeds/ac to insure an optimum plant population. Results from 1999 indicate this seeding rate is adequate for the panhandle. Future research will look at seeding rates for optimum yields with 7.5, 15, and 30 inch row spacing.

Table 1. 1999 Irrigated Soybean planting rate study, OPREC, Goodwell, OK.

Target Population plants/ac	Yield Bu/ac	Seeds/ac planted	Seed cost $/ac
100,000	54.3	125,000	16.79
125,000	52.8	156,250	20.98
150,000	55.5	187,500	25.19
175,000	51.4	218,750	29.38
200,000	52.1	250,000	33.57
225,000	53.6	281,250	37.76
250,000	50.9	312,500	41.95

Effect of Nitrogen and Residue Management on Yield and Grain Nitrogen Uptake of Irrigated Corn

R.W. Mullen, W.E. Thomason, K.J. Wynn, K.W. Freeman, G.V. Johnson, and W.R. Raun

ABSTRACT

Improving the efficiency of nitrogen use in corn production remains important relative to decreasing environmental contamination and increasing net return. In 1995, one field study was initiated to determine the effects of residue and N management on corn yield and N uptake. Two N sources, three N application timings, three N management schemes, and two residue management regimes were investigated. In 1999, urea applied preplant increased yields 22% over anhydrous ammonia injected preplant. Grain yield and N uptake were not affected by timing of N application or residue incorporation in any year of the study. In the past two years of the study corn grain yields were increased via applied N. Soil profile inorganic N was high at the start of this experiment which partially explains the lack of differences due to treatment (residue management and N source) thus far.

Table 1. Initial surface (0-15 cm) soil test characteristics and soil classification at Goodwell, OK.

Location	pH	Total N	Organic C	NH_4-N	NO_3-N	P	K
		-----------g kg^{-1}-----------		-------------------mg kg^{-1}-----------------			
Goodwell	7.7	1.4	11.7	65	25	29	580

Classification: Richfield clay loam (fine, montmorillonitic, mesic Aridic Argiustoll)
pH-1:1 soil:water, Total N and organic C-dry combustion, NH_4-N and NO_3-N – 2M KCl extraction, P and K – Mehlich III extraction.

Table 2. Treatment structure.

Treatment	N rate (kg ha^{-1})	N source	N method	N management	Residue management
1	0	----	---	---	IAH
2	0	----	---	---	IPP
3	118	Urea	BAH	IAH	IAH
4	236	Urea	BAH	IAH	IAH
5	354	Urea	BAH	IAH	IAH
6	118	Urea	BAH	IPP	IPP
7	236	Urea	BAH	IPP	IPP
8	354	Urea	BAH	IPP	IPP
9	118	AA	AAI	KPP	IPP
10	236	AA	AAI	KPP	IPP
11	354	AA	AAI	KPP	IPP
12	118	Urea	BPP	IPP	IPP
13	236	Urea	BPP	IPP	IPP
14	354	Urea	BPP	IPP	IPP

AA-anhydrous ammonia, BAH-N broadcast after harvest, NAAI-N injected preplant, BPP-N broadcast preplant, IAH-incorporated after harvest, IPP-incorporated preplant, KPP-N knifed preplant.

Table 3. Effect of treatment on grain yield and N uptake in 1995.

Treatment	**Yield**	**Grain N uptake**
	-------------kg ha^{-1}------------	-----------kg N ha^{-1}----------
1	2869.1	52.6
2	1725.0	32.5
3	2846.2	31.0
4	2350.4	64.3
5	3117.5	55.9
6	3695.4	68.4
7	1893.7	36.7
8	2461.9	45.3
9	2388.5	44.7
10	2915.6	53.2
11	1791.4	34.8
12	1922.2	36.1
13	2059.3	37.5
14	1953.1	36.9
SED	826.7	18.0

SED-standard error of the difference of two equally replicated means.

Table 4. Effect of treatment on corn grain yield and N uptake in 1996.

Treatment	**Yield**	**Grain N uptake**
	-----------kg ha^{-1}----------	-----------kg N ha^{-1}----------
1	10732.5	150.0
2	10767.9	145.3
3	9262.1	129.2
4	10151.6	134.6
5	9659.0	133.2
6	11782.5	153.3
7	11259.7	156.8
8	9636.9	136.9
9	10234.8	143.5
10	9693.8	137.3
11	11325.5	155.3
12	9606.01	134.6
13	10440.4	143.2
14	9014.5	129.1
SED	1403.9	18.0

SED-standard error of the difference of two equally replicated means.

Table 5. Effect of treatment on corn grain yield and N uptake in 1997.

Treatment	**Yield**	**Grain N uptake**
	-----------kg ha^{-1}----------	-----------kg N ha^{-1}----------
1	7302.2	141.0
2	7480.5	129.3
3	7594.6	142.1
4	6938.5	135.1
5	6924.3	129.5
6	6589.1	120.7
7	7009.8	124.3
8	7544.7	136.9
9	7123.9	123.9
10	7088.3	124.1
11	7402.0	129.9
12	7658.8	137.7
13	7416.3	133.6
14	7074.0	130.4
SED	647.4	13.4

SED-standard error of the difference of two equally replicated means.

Table 6. Effect of treatment on corn grain yield and N uptake in 1998.

Treatment	**Yield**	**Grain N uptake**
	-----------kg ha^{-1}----------	-----------kg N ha^{-1}----------
1	10205.3	153.8
2	8721.3	120.2
3	10888.8	162.1
4	10677.9	158.3
5	9422.1	141.4
6	10626.0	161.0
7	9486.5	135.9
8	9806.0	151.4
9	10541.8	155.1
10	10151.4	163.0
11	7808.8	123.6
12	9401.4	136.5
13	10912.4	162.9
14	10789.1	164.9
SED	914.4	14.2

SED-standard error of the difference of two equally replicated means.

Table 7. Effect of treatment on corn grain yield and N uptake in 1999.

Treatment	**Yield**	**Grain N uptake**
	-----------kg ha^{-1}----------	-----------kg N ha^{-1}----------
1	4871.6	70.3
2	4305.1	59.0
3	6140.6	93.3
4	5116.2	80.4
5	6314.1	104.3
6	5955.9	96.9
7	6106.4	101.4
8	5318.3	90.7
9	4879.3	81.5
10	5468.1	91.2
11	3803.4	66.0
12	6250.0	100.9
13	5438.9	89.9
14	6045.1	102.6
SED	910.7	14.9
Contrasts		
Urea v AA		
Preplant	**	**

**-Significant to 0.05 probability level. SED-standard error of the difference of two equally replicated means.

Table 8. Effect of treatment on corn grain yield and N uptake in 2000.

Treatment	**Yield**	**Grain N uptake**
	-----------kg ha^{-1}----------	-----------kg N ha^{-1}----------
1	3547.1	50.6
2	4461.1	72.8
3	3470.8	60.1
4	3666.5	66.8
5	3569.5	65.3
6	3301.2	59.5
7	4166.1	76.6
8	4448.8	83.7
9	-------	------
10	2682.3	50.7
11	5445.8	99.2
12	2909.8	51.8
13	5245.8	104.2
14	3724.2	63.0
SED	1067.5	18.8

SED-standard error of the difference of two equally replicated means.

Improving Fertilizer Nitrogen Use Efficiency Using Alternative Legume Interseeding in Continuous Corn

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C.W. Woolfolk, R.W. Mullen, G.V. Johnson, and W.R. Raun

Abstract

Many alternative management systems have been evaluated for corn (*Zea mays* L.), soybeans (*Glycine max* L.), and wheat (*Triticum aestivum* L.) production, however, most have involved rotations from one year to the next. Legume interseeding systems which employ canopy reduction techniques in corn have not been thoroughly evaluated. One study was initiated in 1994 at the Panhandle Research Station near Goodwell, OK, on a Richfield clay loam soil, to evaluate five legume species: yellow sweet clover (*Melilotus officinalis* L.), subterranean clover (*Trifolium subterraneum* L.), alfalfa (*Medicago sativa* L.), arrowleaf clover (*T. vesiculosum* L.) and crimson clover (*T. incarnatum* L.) interseeded into established corn. In addition, the effect of removing the corn canopy above the ear (canopy reduction) at physiological maturity was evaluated. Canopy reduction increased light interception beneath the corn thus enhancing legume growth in late summer, early fall, and early spring the following year prior to planting. Legumes incorporated prior to planting were expected to lower the amount of inorganic nitrogen fertilizer needed for corn production. Crimson clover appeared to be more shade tolerant than the other species, and intereseeding this species resulted in the highest corn grain yields when no N was applied. In the last two years, interseeding crimson clover at physiological maturity, followed by canopy reduction resulted in a 21 bu/ac increase in yield compared to conventionally grown corn with no N applied.

Introduction

Canopy reduction has been used in third world countries as a means of increasing light interception for a relay crop. Canopy reduction is imposed when the corn reaches physiological maturity when nutrient and water uptake has ceased). Over the past 20 years, various researchers have evaluated intercropped legumes for increased nitrogen (N) supply in corn (*Zea mays* L.) production. As sources of inorganic nitrogen fertilizer become less dependable and prices increase, organic forms, particularly legumes, are being considered as alternative sources for non-legume crops. Searle et al. (1981) stated that corn grain yield was not affected by legume intercrop, indicating neither competitive depression nor nitrogen transfer from the legume. Nair et al. (1979) showed that intercropping corn with soybeans increased yield 19.5% when compared to monoculture corn. Scott et al. (1987) noted yields following medium red clover (*T. pratense* L.) were equivalent to the addition of 17 kg ha^{-1} fertilizer-N.

Even though intercropping usually includes a legume, applied nitrogen may still confer some benefits to the system as the cereal component depends heavily on nitrogen for maximum yield (Ofori and Stern, 1986). Chowdhury and Rosario, (1993) found that intercropping corn with mungbeans (*Vigna radiata* L.) increased yields 71% when the N application rate was increased from 0 to 90 kg/ha. Ebelhar et al. (1984) reported with no fertilizer N applied, there was an increase in corn grain yield from 2.5 to 6.2 Mg ha^{-1} with hairy vetch (Vicia villosa L.) treatment compared with corn residue. Corn yields increased 62% with applied N (0 versus 120 kg N ha^{-1}).

Canopy reduction is defined as the removal of the corn canopy just above the ear at physiological maturity, where the cut portion is allowed to drop to the soil surface. Some of the basis of canopy reduction come from regions where a relay crop like common beans is produced following corn. In order to increase light interception beneath the corn canopy for the bean plant, the tops of the corn can be removed once physiological maturity is reached. This in turn does not sacrifice the corn yield while increasing the chances of producing a bean crop that would not have been possible if planting took place following corn harvest.

The objective of this work was to evaluate the effect of interseeded legume species and nitrogen rates combined with canopy reduction on corn grain yield and grain protein.

Materials and Methods

One experiment was established in the spring of 1994 at the Oklahoma Panhandle Research and Extension Center near Goodwell, OK on a Richfield clay loam (fine, montmorillonitic, mesic Aridic Argiustoll). Initial soil test characteristics and soil classification are reported in Table 1. A randomized complete block experimental design with three replications was used. Plot size consisted of four rows (30 inch) x 25 ft. All treatments received 90 lb N/ac of urea (45-0-0) in the fall of 1995. In 1996 and for the remaining years of this experiment, treatments 1-5, 7 and 12 received no N to assess legume N fixation compared to identical treatments with 45 lb N/ac. Each year, corn was planted at a seeding rate of 30,000 seeds ac between late April and early May.

Canopy reduction was imposed by removing the tops of the corn plants just above the ear using a machete. This allowed sunlight to reach the legume seedbed. In August, when the corn had reached physiological maturity, five legume species were interseeded by hand at the following seeding rates: yellow sweet clover (*Melilotis officinalis* L.) 40 lb/ac, subterranean clover (*Trifolium subterraneum* L.) 40 lb/ac, alfalfa (*Medicago sativa* L.) 30 lb/ac, arrowleaf clover (*T*. *vesiculosum* L.) 20 lb/ac and crimson clover (*T. incarnatum* L.) 40 lb/ac. Physiological maturity was determined by periodic monitoring grain black layer formation. Following interseeding and canopy reduction, 5 cm of irrigation water was applied for legume establishment and to prevent reduction in growth caused by moisture stress. The legume seeds were inoculated prior to planting with a mixture of *Rhizobium meliloti* and *R. trifolii* bacteria. Harvest area consisted of two rows (30 inches) x 25 ft. Harvesting and shelling were performed by hand. Plot weights were recorded and sub-sampled for moisture and chemical analysis. Subsamples were dried in a forced-air oven at 150°F and ground to pass a 140 mesh screen. Total nitrogen concentration was determined on all grain samples using dry combustion (Schepers et al. 1989). Protein N in corn grain can be determined by multiplying %N by 6.25.

Interseeded legumes remained in the field until the following spring when they were incorporated prior to corn planting using a shallow (4 inches) disk. Legumes were only used for ground cover and potential nitrogen fixation and as such were not harvested for seed or forage.

Results and Discussion

By imposing the alternative management practice of canopy reduction, we visually observed an increase in light interception beneath the corn canopy, thus enhancing legume growth in late summer, early fall before corn harvest, and early spring the following year prior to planting. Crimson clover had superior spring growth compared to the other species evaluated as visual biomass production was greater when incorporated in early April prior to planting. No grain yield response to applied N was observed in 1996, or 1997, but by 1998, yields increased 21 bushels as a result of applying N (12 vs 13, Table 2). The lack of fertilizer N response at this site restricted the early evaluation of legume N contribution and species comparison.

There was no significant difference between grain yields when tops were cut at physiological maturity compared to the normal practice (5 vs 7, crimson clover with and without canopy reduction, with no N applied) in 1996, 1997 or 1998. However, by 1999, interseeding crimson clover and using canopy reduction resulted in increased yields when compared to that observed where no canopy reduction was employed. It was important to find no differences between canopy reduction and conventional management early on, because it demonstrated the applicability of interseeding in late summer. Weeds, multiple hailstorms, and a lack of timely irrigation severely limited yields of the 2000 crop. No significant treatment effects were found in the 2000 crop year since yields were so low that evaluation of treatments was not thought advisable (Table 2). The average yields for the 7 years of the study indicate no significant differences in yield due to treatment (Table 2).

In the 1998 and 1999 crop years, interseeding crimson clover at physiological maturity, followed by canopy reduction resulted in a 21 bu/ac increase in yield when compared to conventionally grown corn with no N applied (5 versus 12). This N fertilizer savings of approximately 24 lb N/ac would have an economic value of $4.80. Legume interseeding and canopy reduction costs would likely be greater than $4.80, thus restricting what can be promoted at this point in time.

Nitrogen uptake values were calculated for all treatments by multiplying total yield by percent N in the grain (Table 3). In 1997, N uptake was highest in the plots with normal management and either 0 or 90 lb/ac N. This was probably due to residual N mineralization from the soil. Crimson and arrowleaf clover plots also had high N uptake. N uptake for the 1998 crop year was greatest for the 90 lb/ac N rate, however there were no significant differences between this treatment and those with alfalfa or arrowleaf clover. 1999 values for N uptake were highest for plots with crimson and arrowleaf clover. Overall, there is no difference in N uptake for plots treated with 90 lb N/ac or plots with crimson or arrowleaf clover interseeded.

Although not evaluated in this study, mechanized canopy reduction could decrease the time required for grain to lose moisture since more sunlight would directly come in contact with the corn ears when the tops were removed. When grain moisture is high it can delay harvest and/or significantly increase drying costs. Legume seeding rates, alternative species, method of interseeding and interseeding date will all need to be thoroughly evaluated prior to the mechanization and implementation of this practice.

Since nitrate leaching and soil erosion are becoming major concerns in production agriculture today, this experiment may lead to practices that can decrease both, via lowering the amount of inorganic fertilizer N needed for corn production and reducing the amount of bare soil susceptible to wind and water erosion.

References

Chowdhury, M.K. and E.L. Rosario. 1994. Comparison of nitrogen, phosphorus and potassium utilization efficiency in maize/mungbean intercropping. J. of Agric. Sci., Cambridge. 122:193-199.

Ebelhar, S.A., W.W. Frye and R.L. Blevins. 1984. Nitrogen from legume cover crops for no-tillage corn. Agron. J. 76:51-55.

Nair, K.P., U.K. Patel, R.P. Singh and M.K. Kaushik. 1979. Evaluation of legume intercropping in conservation of fertilizer nitrogen in maize culture. J. Agric. Sci. Camb. 93:189-194.

Ofori, Francis and W.R. Stern. 1986. Maize/cowpea intercrop system: effect of nitrogen fertilizer on productivity and efficiency. Field Crops Res. 14:247-261.

Schepers, J.S., D.D. Francis and M.T. Thompson. 1989. Simultaneous determination of total C, total N and 15N on soil and plant material. Commun. Soil Sci. Plant Anal. 20:949-959.

Scott, T.W., J. Mt. Pleasant, R.F. Burt and D.J. Otis. 1987. Contributions of ground cover, dry matter, and nitrogen from intercrops and cover crops in a corn polyculture system. Agron. J. 79:792-798.

Searle, P.G.E., Yuthapong Comudom, D.C. Shedden and R.A. Nance. 1981. Effect of maize + legume intercropping systems and fertilizer nitrogen on crop yields and residual nitrogen. Field Crops Res. 4:133-145.

Table 1. Initial surface (0-15 cm) soil test characteristics and soil classification at Goodwell, OK.

Location	pH	Total N	Org. C	NH_4-N	NO_3-N	P	K
			$^{-1}$ ---------	--------mg kg^{-1} --------		-------mg kg^{-1}------	
Goodwell	7.7	1.4	11.7	65	25	29	580

Classification: Richfield clay loam (fine, montmorillonitic, mesic Aridic Argiustoll)

pH - 1:1 soil:water, Total N and Organic C - dry combustion, NH_4-N and NO_3-N - 2M KCl extraction,
P and K - Mehlich III extraction.

---------- g kg

Table 2. Treatment structure including legume species interseeded, management of corn canopy and N rate, and corn grain yield means (bu/ac), 1994-2000.

Treatment	Legume	Management	N rate, lb/ac	1994	1995	1996	1997	1998	1999	2000	Average
				------------	------------	------------	------------	--bu/ac--	------------	------------	------------
1	Yellow Sweet Clover	Tops cut at PM	0	164	130	181	109	116	142	49	114
2	Subterranean Clover	Tops cut at PM	0	118	158	189	101	99	116	50	105
3	Alfalfa	Tops cut at PM	0	130	96	180	109	103	97	42	101
4	Arrowleaf Clover	Tops cut at PM	0	167	137	183	110	111	103	39	104
5	Crimson Clover	Tops cut at PM	0	72	139	168	95	111	162	63	115
6	Subterranean Clover	Tops cut at PM	45	143	160	173	94	118	124	48	106
7	Crimson Clover	Normal	0	148	112	170	105	119	142	47	111
8	Yellow Sweet Clover	Tops cut at PM	45	95	143	160	91	108	137	76	110
9	Alfalfa	Tops cut at PM	45	121	184	177	96	113	150	41	110
10	Arrowleaf Clover	Tops cut at PM	45	148	90	177	98	122	157	50	116
11	Crimson Clover	Tops cut at PM	45	145	134	192	92	117	148	46	113
12	No Legume	Normal	0	143	119	172	111	101	129	49	107
13	No Legume	Normal	90	162	159	190	107	132	141	51	119
SED†				23.6	24.6	23.3	8.5	9.1	21.4	16.4	23.6
CV‡				21.4	22.3	16.1	10.25	9.8	19.4	41.4	37.5

†SED-Standard error of the difference between two equally replicated means

‡CV- Coefficient of variation

Table 3. Treatment structure including legume species interseeded, management of corn canopy and N rate, and corn grain N uptake means (lb/ac), 1997-2000.

Treatment	Legume	Management	N rate, lb/ac	1997	1998	1999	2000	Average
				-----------	-----------	--lb/ac--	-----------	-----------
1	Yellow Sweet Clover	Tops cut at PM	0	95	81	103	-	93
2	Subterranean Clover	Tops cut at PM	0	93	73	78	-	81
3	Alfalfa	Tops cut at PM	0	97	74	67	-	79
4	Arrowleaf Clover	Tops cut at PM	0	100	75	67	-	81
5	Crimson Clover	Tops cut at PM	0	92	81	123	-	99
6	Subterranean Clover	Tops cut at PM	45	95	88	92	-	92
7	Crimson Clover	Normal	0	101	86	105	-	97
8	Yellow Sweet Clover	Tops cut at PM	45	88	80	112	-	94
9	Alfalfa	Tops cut at PM	45	90	82	111	-	94
10	Arrowleaf Clover	Tops cut at PM	45	91	91	128	-	104
11	Crimson Clover	Tops cut at PM	45	91	94	120	-	102
12	No Legume	Normal	0	105	69	87	-	87
13	No Legume	Normal	90	101	103	111	-	105
SED†				10.1	9.4	18.2	-	17.1
CV‡				12.9	13.9	41.4	-	22.5

†SED-Standard error of the difference between two equally replicated means

‡CV-Coefficient of variation