Research Reports 1977

Southwest Missouri Center
Mt. Vernon, Missouri

College of Agriculture
University of Missouri-Columbia
Special Report 205

University of Missouri

AGRICULTURAL EXPERIMENT STATION
Southwest Missouri Center

Science in the Public Service

Route 3
Mount Vernon, Missouri 65712

Area Code 417 466 2148

September 30, 1977

Welcome:

You are invited to read and study this research report. We welcome your suggestions. You are also invited to visit the Center often and observe the research in progress. The Center belongs to the people of this area and its progress depends on your continued interest and support. Agricultural research is our primary endeavor but the Center is also active in other areas. Agriculture Education is one example. The Center was host to more than 2,000 FFA students who used it as an outdoor laboratory during the past year.

The Extension Division continues to offer many educational programs for all age groups. You are invited to take part in these and other programs held at the Center throughout the year. We have an "open door" policy and visitors are always welcome.

There was a combined attendance of more than 8,000 visitors and participants at Center activities last year.

Come see us!

Sincerely yours,

Norman

Norman Justus
Superintendent

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SOUTHWEST MISSOURI CENTER[1]

Farmers and businessmen worked closely with the College in the establishment of the Southwest Center near Mount Vernon. A limited program of research in soil fertility and field crops had been conducted on a small piece of land near Pierce City for a number of years.

Most of the farms in the area are relatively small and the level of soil fertility is generally low. Several years with below normal rainfall were climaxed with a severe drouth in 1954. Many farmers were in serious financial trouble and a number of them abandoned their farms. The economy of the entire area was affected adversely and business and industrial people, who realized the importance of agriculture in the area, were interested in the establishment of an agricultural research program in the area.

The problems of the area were discussed by farm people and business people and by groups composed of rural and urban representatives. Agricultural college staff members participated in the discussions. From the discussions the belief emerged that an agricultural research center, which would conduct investigations of the problems of the area, would develop valuable information which would help solve some of the major problems. An areawide committee with a representative from each of the 22 counties was formed, with Mills H. Anderson, a Carthage banker, as chairman. The committee requested the Agricultural Experiment Station to develop a research program for the area.

The director of the Experiment Station appointed a committee of College staff members January 23, 1957, and directed the committee to develop a research proposal and to consider the establishment of a research center in the area. The committee moved rapidly and submitted the proposed plan, which was approved by the director. The Board of Curators approved the proposal and a bill was introduced in the General Assembly providing for the establishment of a research center in southwest Missouri. The bill was passed and became law July 6, 1957.

The Board of Curators included in the University appropriations request for fiscal 1958-59 the amount of $75,000 for the purchase of land. The amount requested was approved by the General Assembly.

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[1] This information was taken from THE CENTENNIAL REPORT--1870-1970--OF THE COLLEGE OF AGRICULTURE, written by Dr. John H. Longwell, dean emeritus of the College. Copies of THE CENTENNIAL REPORT are available from the Editor's Office, 1-98 Agriculture Building, University of Missouri-Columbia, Columbia, Missouri 65201 at a cost of $2.50 each.

On May 2, 1958, the director appointed a committee of staff members to conduct a search for a suitable location for the center and make recommendations to the director. The site selection committee established criteria to be used in making the selection. More than 50 suggested farms were proposed and members of the committee inspected about 25 of them. Two farms lying on opposite sides of Highway 166, about 2.5 miles southwest of Mount Vernon were chosen as the most desirable location. The two farms have a total of 590 acres and were bought for $70,000. The Southwest Research Center was officially dedicated November 5, 1959.

The General Assembly has appropriated funds to pay for necessary building, facilities, equipment, and operations. A comprehensive research program has been developed and results of value to the agriculture of the area are being obtained.

Since 1965 three adjoining tracts totalling 308 acres have been bought and included in the area.

The center has been designated the University of Missouri-Columbia Southwest Missouri Center and serves as the headquarters for the area extension program as well as the research center.

WEATHER DATA FROM MT. VERNON, MISSOURI
AGRICULTURAL EXPERIMENT STATION FOR 1976-77

PRECIPITATION
(In Equivalent Inches of Water)

1976	Monthly Total	Departure
January	0.50	-1.17
February	0.91	-1.31
March	3.46	+0.47
April	5.79	+1.52
May	4.12	-0.81
June	4.62	-0.10
July	5.20	+1.58
August	3.29	+0.35
September	2.25	-1.86
October	3.60	+0.16
November	0.65	-1.69
December	0.71	-1.74
1976 Total	35.10	-4.60
1977		
January	1.26	-0.41
February	1.74	-0.48
March	3.49	+0.50
April	3.78	-0.49
May	3.53	-1.40
June	8.11	+3.39
July	2.84	-0.78

Pan Evaporation

1976	Adjusted Total Inches
May	6.08
June	8.45
July	8.93
August	8.02
September	5.63
1977	
May	6.58
June	8.98
July	8.15

Dry Periods*
May, 1976 through July, 1977

6/07/76 - 6/22/76
7/05/76 - 7/27/76
8/16/76 - 9/08/76
5/29/77 - 6/18/77

*Dry Periods: At least 15 consecutive days with less than 0.25 inch per day.

Compiled by Department of Atmospheric Science
College of Agriculture

WEATHER DATA FROM MT. VERNON, MISSOURI AGRICULTURAL EXPERIMENT STATION FOR 1976-77

AIR TEMPERATURE
(Degrees Fahrenheit)

	Mean Max.	Mean Min.	Average	*Normal	Departure	No. Days with Temperatures: 90° or Above	100° or Above	32° or Below	0° or Below
January	42.2	21.2	31.7	32.9	-1.2	0	0	25	2
February	58.1	36.4	47.3	37.0	+10.3	0	0	12	0
March	61.0	38.5	49.8	44.0	+5.8	0	0	9	0
April	67.6	46.7	57.2	56.5	+0.7	0	0	2	0
May	69.9	48.2	59.1	65.1	-6.0	0	0	1	0
June	80.3	58.5	69.4	73.6	-4.2	0	0	0	0
July	85.6	65.4	75.5	77.8	-2.3	8	0	0	0
August	86.0	62.3	74.2	77.1	-2.9	8	0	0	0
September	80.5	55.7	68.1	69.3	-1.2	2	0	0	0
October	62.9	40.6	51.8	59.0	-7.2	1	0	6	0
November	50.2	25.8	38.0	45.5	-7.5	0	0	5	0
December	46.8	19.7	33.3	36.0	-2.7	0	0	27	1
1976 Avg.	65.9	43.3	54.6	56.2	-1.6	19	0	87	3
1977									
January	28.2	8.5	18.4	32.9	-14.5	0	0	31	10
February	49.1	26.5	37.8	37.0	+0.8	0	0	19	0
March	61.3	39.5	50.4	44.0	+6.4	0	0	11	0
April	70.7	49.6	60.2	56.5	+3.7	0	0	1	0
May	79.6	58.4	69.0	65.1	+3.9	0	0	0	0
June	86.4	63.8	75.1	73.6	+1.5	9	0	0	0
July	88.7	69.4	79.1	77.8	+1.3	17	0	0	0

*Springfield Normal used.

Compiled by Department of Atmospheric Science
College of Agriculture

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Department of Agronomy, University of Missouri

Abstract: Knowledge of agronomic performance of various hybrids and varieties is valuable as an aid in selecting superior performing cultivars. A large number of corn and grain sorghum hybrids and soybean varieties or blends are available to the grower. They all offer claims of superiority. The Crop Performance Program of Missouri is set up to provide an information base for selecting the cultivars most likely to give the best performance under Missouri conditions. Since data from greater than one location are more reliable than single location data, two- and three-year averages are provided where possible. The following tables summarize the performance of corn, grain sorghum, soybean, and alfalfa cultivars at the Southwest Research Center during the past few years.

Corn

Performance record of hybrids evaluated under irrigation at the Southwest Research Center (SWC, Lawrence County) during the two-year period 1974-75 and the three-year period 1973-75.**

BRAND--HYBRID	2-YEAR AVERAGE					3-YEAR AVERAGE				
	ACRE YIELD (BU)	LODGING ROOT (%)	LODGING STALK (%)	DROPPED EARS (%)	EAR HEIGHT (FT)	ACRE YIELD (BU)	LODGING ROOT (%)	LODGING STALK (%)	DROPPED EARS (%)	EAR HEIGHT (FT)
GROUP 1 MATURITY										
ACCO UC6601(SX)	148.4	1.6	13.8	0.2	3.3	-	-	-	-	-
FEDERAL FX34(SPX)	163.8	1.3	11.9	0.4	3.3	-	-	-	-	-
FUNKS G-4507(SX)	170.7	2.8	12.9	1.0	3.6	-	-	-	-	-
MCALLSTR SX7408(SX)	160.3	2.4	12.4	0.7	4.1	-	-	-	-	-
GROUP 2 MATURITY										
ASGROW RX100(SX)	157.6	1.6	8.1	0.4	3.8	158.0	1.1	7.5	0.2	3.9
ASGROW RX90(SX)	158.9	2.2	9.6	1.2	3.8	-	-	-	-	-
FUNKS G-4737(SX)	168.9	1.0	10.3	0.2	3.3	-	-	-	-	-
SUPERCROST S-85(SX)	147.4	1.5	7.3	0.2	3.6	142.8	1.0	6.0	0.1	3.7
IOWA-MC SX19(SX)	162.8	2.5	5.4	0.0	3.5	-	-	-	-	-
MFA V-16(SX)	171.8	0.6	7.0	0.4	3.5	167.3	0.4	9.2	0.3	3.7
MORTON 6700(SX)	143.1	0.6	9.6	0.8	3.6	146.2	0.4	9.8	0.5	3.7
MUNCYCHIEF SX878(SX)	152.5	8.2	17.3	0.3	3.7	142.7	5.8	15.2	0.5	3.7
MUNCYCHIEF SX662(SX)	141.4	4.1	10.9	0.0	3.0	-	-	-	-	-
MCALLSTR SX6837(SX)	163.8	0.8	11.8	0.2	3.5	-	-	-	-	-
MCNAIR X-170(SX)	161.0	1.3	11.6	1.0	3.5	-	-	-	-	-
C'S GOLD SX5500(SX)	158.4	0.6	8.4	0.2	3.7	157.8	0.4	9.4	0.6	3.8
C'S GOLD SX5500A(SX)	161.9	1.2	10.2	0.6	3.7	-	-	-	-	-
PAG SX98(SX)	154.6	1.2	10.5	0.4	3.5	152.7	0.8	10.6	0.5	3.7
PIONEER 3325(SX)	168.9	0.8	3.9	0.2	3.9	-	-	-	-	-
PRINCETON SX805(SX)	151.8	0.9	5.3	0.4	3.7	-	-	-	-	-
TROJAN TXS113(SPX)	165.4	3.2	13.7	0.2	3.4	158.5	2.2	11.7	0.1	3.6
TROJAN TXS115A(SX)	156.2	4.2	9.4	0.8	3.9	-	-	-	-	-
HULTING X9880(3X)	131.0	1.7	16.7	1.0	3.5	-	-	-	-	-
HULTING X980(SX)	180.6	0.6	6.2	0.4	3.6	-	-	-	-	-
WILSON 1800(SX)	141.1	3.5	9.2	0.5	3.9	-	-	-	-	-
GROUP 3 MATURITY										
BO-JAC X7L-24(SPX)	164.9	0.8	10.9	0.0	3.7	-	-	-	-	-
LEWIS X808(SX)	168.1	6.1	7.6	0.0	3.7	-	-	-	-	-
MCCURDY MSX88(SX)	170.6	1.6	9.1	0.2	3.6	162.7	1.0	7.8	0.7	3.7
AVERAGE	158.8	2.1	10.0	0.4	3.6	154.3	1.5	9.7	0.4	3.7

*WHITE HYBRID.

** A late spring frost in 1976 caused severe stand loss, thus no data are available for 1976.

Grain Sorghum

Performance of grain sorghum hybrids evaluated at the Southwest Center (SWC) near Mt. Vernon, Mo. (Lawrence County) during the 2-year period 1975-76.

BRAND / HYBRID	ACRE YIELD (LB)	GRAIN MOIS-TURE (%)	LODGED PLANTS (%)	HEADS IN 20 FEET (#)	HEADS CMPT-NESS (1-5)	HEADS EXSER-TION (1-5)	OFF-TYPE HEADS (%)	TALL PLANTS (%)	PLANT HEIGHT (")
PIONEER 8501	4554	16.1	4.5	69	3.1	2.6	0.0	0.0	40
DEKALB BR-54**	4453	16.3	1.1	73	4.7	3.6	0.0	0.0	47
ACCO BR-Y93**	4207	15.6	3.0	71	4.5	3.3	0.4	0.7	40
WARNER W-866	4123	15.7	0.9	66	3.8	2.0	0.0	0.0	41
WARNER W-832	4102	15.6	1.0	59	2.1	2.3	0.0	0.3	40
FMC ADVANCE 80	4040	13.6	2.4	67	3.8	1.6	0.2	0.0	38
FUNK G-522+	4036	13.9	1.7	71	3.8	1.5	0.0	0.3	36
FUNK G-516BR**	4005	16.1	4.1	66	5.0	3.5	0.0	0.3	40
ACCO R109-A+	4002	13.6	4.8	69	4.0	2.2	0.0	0.0	38
ACCO R1090	3996	14.1	10.4	64	4.5	2.5	0.0	0.0	40
NK 180	3986	15.4	3.9	76	2.3	3.2	0.0	0.0	43
DEKALB E-59++	3941	14.9	2.1	64	3.1	2.3	0.0	0.0	39
M-F-A GS10+	3850	13.6	1.8	70	3.8	1.8	0.0	0.0	37
NK 278	3768	16.3	2.4	64	3.1	2.0	0.2	0.0	37
ASGROW DORADO+	3728	17.1	4.7	64	3.5	2.0	0.0	0.0	36
PIONEER 8386	3618	18.2	5.1	68	3.6	2.6	0.0	0.0	36
PIONEER 8877	3617	11.8	10.1	75	5.0	2.5	0.0	1.3	35
PIONEER 8311+	3596	16.8	2.5	62	3.0	1.5	0.0	0.0	37
MCNAIR 654+	3593	16.0	4.8	51	4.7	2.5	0.0	0.0	40
NK 222A+	3591	14.1	3.5	69	4.1	2.3	0.0	0.3	37
ACCO R1019	3586	13.2	2.6	49	4.0	2.0	0.0	0.0	37
ACCO R1029-A	3529	14.3	1.9	59	4.1	2.0	0.3	0.0	38
NK 222G+	3483	15.4	3.6	59	3.6	2.5	0.3	0.0	38
PIONEER 8442+	3447	15.6	3.3	65	3.0	2.0	0.0	0.3	36
DEKALB C-42Y++	3446	14.2	2.1	57	4.0	3.3	0.0	0.0	41
FUNK G-766W	3218	13.1	1.8	70	3.0	2.6	0.0	0.0	42
NK SAVANNA 3+	3206	18.3	6.1	57	5.0	2.8	0.0	0.3	38
T-E BIRD-A-BOO II**	3191	16.3	5.4	63	4.8	2.5	0.0	0.4	37
DEKALB E-57+	3071	16.1	2.7	56	4.8	3.6	0.5	0.0	41
T-E 88A	3007	15.8	1.4	64	3.1	2.3	1.3	0.0	37
MARTIN	2004	15.9	4.4	49	3.3	2.3	0.0	0.0	35
AVERAGE	3677	15.3	3.6	64	3.8	2.5	0.1	0.1	

**BIRD RESISTANT HYBRID. SINCE DIFFICULTY IS OFTEN ENCOUNTERED IN MARKETING THESE HYBRIDS, THEY SHOULD ONLY BE GROWN AFTER CAREFUL CONSIDERATION OF POTENTIAL BIRD AND MARKETING PROBLEMS

+WIDELY GROWN HYBRID

Soybeans

Average performance of soybean varieties evaluated at the Southwest Center near Mt. Vernon, Mo. (Lawrence County) during the 2-year period 1975-76 and the 3-year period 1974-76.

BRAND-VARIETY	ACRE YIELD (BU)	LODG-ING SCORE* (1-5)	PLANT HEIGHT (IN)	MA-TURITY DATE
		2-YEAR AVERAGE		
WAYNE	42.7	2.1	38	9-02
WOODWORTH	44.7	1.4	36	9-02
SRF 307P	41.3	2.3	39	9-03
CALLAND	43.8	1.4	38	9-04
SRF 350	45.9	2.3	39	9-04
SRF 400	34.1	1.8	37	9-04
BONUS	42.3	1.6	43	9-06
CLARK 63	37.0	2.1	38	9-07
WILLIAMS	43.1	1.0	36	9-07
CUTLER 71	42.1	1.9	42	9-10
SRF 425	45.4	2.3	42	9-11
POMONA	39.6	1.0	39	9-14
KENT	41.9	1.0	39	9-15
MITCHELL	45.8	2.9	40	9-18
CUSTER	34.4	2.0	49	9-19
SRF 450	42.6	1.0	40	9-20
SCOTT	41.0	1.8	45	9-22
COLUMBUS	47.9	2.0	42	9-23
OKSCY	38.6	2.3	45	9-25
HILL	30.4	3.1	39	10-01
ESSEX	46.8	2.4	37	10-06
MACK	39.3	3.5	44	10-06
DARE	36.3	3.1	44	10-07
YORK	40.8	2.8	42	10-10
DYER	27.2	3.7	36	10-11
FFR 556	34.6	2.0	57	10-12
FFR 555	32.3	2.5	48	10-16
FORREST	35.1	3.1	47	10-18
AVERAGE	39.9	2.2	41	
		3-YEAR AVERAGE		
WAYNE	42.5	2.5	37	9-06
WOODWORTH	43.6	1.8	36	9-06
SRF 400	36.9	2.2	37	9-07
CALLAND	44.4	2.0	37	9-08
BONUS	44.2	1.8	42	9-09
WILLIAMS	45.2	1.2	36	9-10
CLARK 63	38.9	2.4	38	9-14
CUTLER 71	43.4	1.9	41	9-16
SRF 425	45.4	2.5	42	9-16
KENT	43.0	1.2	39	9-19
POMONA	41.3	1.0	39	9-20
SRF 450	44.5	1.2	40	9-23
COLUMBUS	47.9	2.5	43	9-27
HILL	31.8	3.4	39	10-05
ESSEX	47.4	2.4	37	10-09
MACK	35.9	3.7	42	10-11
DARE	35.5	3.8	43	10-12
YORK	36.5	2.9	41	10-14
CUSTER	31.3	2.7	47	**
AVERAGE	41.0	2.3	40	

*1 = NO LODGING; 5 = COMPLETE LODGING

**MATURITY DATE NOT AVAILABLE.

Alfalfa

Longevity of Stand. The following table summarizes the yield performance of 16 alfalfa varieties from 1970 through 1976. These varieties were grown on the upland Gerald silt loam soil. At the end of the 1976 growing season these plots were abandoned. The table indicates the relative stand rating for each variety (0 would be no stand and 100 would be a perfect stand).

Summary of Alfalfa Variety Performance 1970-76 in Lawrence County[1], Missouri (LAG70). Seeded: Spring 1970. Soil Type: Gerald sl.

	1976			Production, 1970-76		
				Tons/ac		
Variety	Yield tons/ac	% of Check[2]	Stand Rating[3]	Total	Avg.	% of Check[2]
Cody	2.21	100	47.5	17.5	2.50	108
Kanza	2.30	104	67.5	16.9	2.42	104
[2]Vernal (VCC63)	2.68	---	70.0	18.3	2.62	---
[2]Ranger (RCC63)	2.06	---	55.0	15.7	2.24	---
520	2.94	132	60.0	19.1	2.73	118
Scout	2.06	93	42.5	16.0	2.28	98
Dawson	2.53	114	55.0	17.5	2.50	108
[2]Buffalo (BCC63)	1.92	---	45.0	14.7	2.10	---
Tempo	2.71	122	55.0	18.8	2.69	116
Thor	2.54	114	52.5	18.0	2.57	111
Apex	2.28	103	35.0	17.9	2.55	110
Warrior	2.71	122	60.0	17.6	2.51	108
Saranac	2.51	113	47.5	18.2	2.60	112
WL 303	2.48	112	47.5	17.9	2.55	106
A-59	2.61	118	52.5	18.4	2.63	113
Weevlchek	2.56	115	60.0	17.2	2.46	106
Average	2.44			17.5	2.50	
LSD (.05)	0.44				0.15	
C.V. (%)	12.8				12.0	

[1] Agricultural Experiment Station, Southwest Center, Mt. Vernon, Missouri.

[2] Check varieties, Average = 2.32 tons/acre , 1970-76; 2.26 tons/acre 1976.

[3] Percent ground cover on 5-21-76

Fertilizer applied: 350 lb/A, 0-14-42+B, after 1st and 3rd harvest.

Maximum Production. The following table presents information on alfalfa production under optimum conditions. These plots are located in the Spring River valley on a Huntington silt loam soil. This soil is well drained, has good water holding capacity, and is well fertilized.

Summary Performance of 30 Alfalfa Varieties (1975-76) in Lawrence County, Missouri (LAHF74, Huntington sl soil).

	Dry Matter, Tons/Acre				
Variety	1975	1976	Total	Average	% of Check
NS72 Syn. 2	3.78	6.22	10.00	5.00	100
NC83-1	3.81	6.43	10.24	5.12	103
Apollo (NAPB)	4.20	6.73	10.93	5.46	109
NS79 Syn. 2	3.77	5.98	9.75	4.88	98
T3X-303 (Teweles)	4.48	6.10	10.58	5.29	106
NC83-2	3.69	6.47	10.16	5.08	102
[1] Dawson (DCC72)	3.55	6.25	9.80	4.90	---
KS49 (Kansas)	4.11	6.60	10.71	5.36	107
Ramsey (Minn.)	3.35	6.41	9.76	4.88	98
Tempo (FFR)	4.03	6.48	10.51	5.26	105
Victoria (Ark.)	4.00	6.44	10.44	5.22	105
DeKalb 131	3.74	6.21	9.95	4.98	100
Aztec (Asgrow)	4.02	6.14	10.16	5.08	102
Lancer (NK,K0100)	4.12	6.42	10.54	5.27	106
Victor (NAPB)	3.82	6.69	10.51	5.26	105
Team (USDA)	4.09	6.20	10.29	5.14	103
[1] Vernal (VCC72)	3.83	6.02	9.85	4.92	---
TX-221 (Teweles)	4.22	6.20	10.42	5.21	104
[1] Saranac (SCC72)	4.30	6.24	10.54	5.27	---
G-777 (Funks)	4.24	5.96	10.20	5.10	102
WL-307 (MFA)	3.98	6.36	10.34	5.17	104
[1] Kanza (KCC72)	3.29	6.43	9.72	4.86	---
Agate (Minn.)	3.76	6.19	9.95	4.98	100
71F (Pioneer)	4.25	6.63	10.88	5.44	109
KS52 (Kansas)	3.85	6.41	10.26	5.13	103
Arc (USDA)	4.06	6.62	10.68	5.34	107
WL-318 (MFA)	4.10	6.37	10.47	5.24	105
521 (Pioneer)	3.82	6.50	10.32	5.16	103
Weevlchek (FFR)	3.96	6.60	10.56	5.28	106
Gladiator (NK)	4.11	6.32	10.44	5.22	105
Average	3.94	6.35	10.29	5.14	
LSD (.05)	0.30	0.44		0.17	
C.V. (%)	4.6	4.2		3.6	

[1] Check varieties, mean = 4.99 tons/acre.

Fertilizer applied: 350 lb/ac of 0-14-42+B after 1st and 3rd harvest each year.

SMALL GRAINS RESEARCH

Boyd Strong, Dale Sechler, J. M. Poehlman, Paul Rowoth
Tim Flanders and Matt Renkoski

Department of Agronomy

Small grain research at the Southwest Center involves wheat, barley, and both spring and winter oats. A few observations are also made on rye and triticale. Variety trials of all the grains were grown in 1976-77 as well breeding materials for selection and nurseries for insect and disease evaluation.

Wheat breeding efforts are concentrated on developing high yielding varieties of soft red winter wheat which will tolerate the production hazards of the area. Short, stiff-strawed, fertilizer responsive varieties that are resistant to hession fly and diseases such as Septoria, rust, smut, and mildew are desired. Twenty-eight segregating populations, hopefully segregating for better combined traits, were space planted at the Center for selection on an individual plant basis. Forty advanced wheat selections and varieties were evaluated in a replicated trial. In addition 160 selections were evaluated in preliminary yield trials. The Uniform Hessian Fly Nursery was grown to assess the fly race pattern. Wheat yields were excellent, ranging from 30 to 80 bu/A. Diseases were not particularly damaging although some Septoria, mildew and leaf rust were present. Several new varieties were evaluated including Parker 76 and Larned from Kansas, Hart from Missouri, and BEAU from Indiana.

Forty spring oat varieties and advanced selections were tested at the Center in 1977. There were virtually no disease or insect problems. This was the first in many years that BYDV had not been a limiting factor in production. New spring oat varieties evaluated included Bates from Missouri and Lang from Illinois. Two winter oat tests, including 69 varieties or selections, were grown at the Center along with 520 observation rows. Twenty-seven segregating populations were also space planted for selection. The winter was relatively severe and winter oats killed the worst in many years. Improved winterhardiness is a primary objective in the program and we are only interested in those that consistantly survive. Chilocco and Pennwin are newer winter oat varieties.

Seventy varieties and experimental lines of two- and six-rowed winter barley were evaluated in 1976-77. Major emphasis in the program has been concentrated on malting barley, utilizing both 2- and 6-row types as parents. No malt varieties are yet recommended for the area. Perry, a 6-row feed barley, is being released in 1977. It is winter hardy, high yielding, and well adapted to the area.

Eleven rye, triticale, wheat, barley, and oat varieties were evaluated for use for forage in the fall, winter, and early spring and then left to develop a grain crop. Due to the cool, dry fall, little vegetative development occured at the Center in the fall. Both the barley and wheat varieties produced excellent spring growth however.

Comparative performance and descriptions of wheat, oat, and barley varieties adapted to the area are available from extension personnel and in current UMC Agricultural Guides.

BREEDING TALL FESCUE

D. A. Sleper, Department of Agronomy
M. L. Mitchell, Department of Agronomy
K. L. Hunt, Department of Agronomy

Abstract: Progeny testing continues to be conducted at the Southwest Research Center. We have more than 40 synthetics under evaluation. Objectives center around breeding tall fescue varieties with improved animal performance. Selection has been placed on vigor, disease resistance, maturity, leafiness, drought tolerance, winterhardiness, and forage quality.

New tall fescue source nurseries have been planted at Mount Vernon and Columbia. After another season's evaluation, desirable plants will be removed and progeny tested. Tall fescue clonal lines selected from previous broad-base source nurseries continue to be progeny tested. Selection in these source nurseries has been placed on vigor throughout the growing season, disease resistance, maturity, leafiness, drought tolerance, and winterhardiness. Since these selected clonal lines are now in synthetic combinations, we are dealing with fewer numbers of entries, therefore, more emphasis can be placed on forage quality. The Tilley-Terry in vitro fermentation technique is being used to evaluate these new synthetics. A better understanding of the relationships between plant factors and animal performance is needed. We need more detailed information on what chemicals and/or morphological features of tall fescue lend themselves to improving animal performances. Work in this area is being done in cooperation with A. G. Matches (USDA, ARS, Agronomy) and F. A. Martz (Dairy Husbandry) at the Southwest Center.

Many tall fescue lines and their progenies have been examined for their photosynthetic efficiency and desirable leaf growth characteristics. This work is being done in cooperation with C. J. Nelson (Agronomy). It has recently been demonstrated that the rate of leaf area expansion was positively associated with yield of forage regrowth in the field. Leaf area was determined by multiplying leaf width by rate of leaf elongation. A selection experiment has been initiated whereby we have been selecting for leaf area expansion with the ultimate objective of improving vegetative forage yields. The original source population (C_O) included a broad-based population of 1,000 plants selected for early maturity. One cycle has been completed and we hope to complete the next one this year. We have been selecting the upper and lower 5% to perpetuate the next cycle. Plants expressing a low leaf area expansion rate have high tillering rates and we anticipate that these could be used for turf. It is hoped that the selections for rapid leaf area expansion could be used to improve vegetative forage yields.

During the past several years, we have put considerable effort into the breeding program to study the genetic variation and heritability of minerals in tall fescue. Improper levels of minerals in forages can cause diseases such as grass tetany in grazing cattle. Grass tetany seems to be a complex problem as it is related to both a low level of magnesium in the ingested forage and poor absorption of magnesium in the intestinal tract. Several researchers have also demonstrated the importance of the K/(Ca+Mg) ratio and its relationship to grass tetany. When the ratio is less than 2.2, the incidence of grass tetany is reduced. Table 1 contains heritability estimates for Mg and K/(Ca+Mg) (meq/100g dry matter). These values indicate that it should be possible to manipulate these minerals through plant breeding. First, second, and third harvest values were obtained in early May, mid-July, and early November of each year, respectively.

Table 1. Heritability estimate calculated by the progeny-parent regression method for Mg and K/(Ca+Mg).

		Heritability (%)		
Mineral	Year	First harvest	Second harvest	Third harvest
Mg	1	57	74	69
	2	52	57	65
K/(Ca+Mg)	1	97	84	65
	2	69	31	45

Research or developing a tall fescue variety for fall and winter grazing is in progress using introductions from Tunisia, North Africa. These introductions that have proven only slightly winterhardy, have been crossed to native winterhardy clones. The resulting hybrids are vigorous with growth continuing farther into the winter than existing native varieties. Unfortunately the hybrids have very low seed set. A backcross program has been undertaken, which entails crossing the low seed set, but vigorous hybrids back to native winterhardy tall fescue clones, allowing the chance for an increase in seed set. Several cycles of backcrossing and selection for the desired traits may be needed before a superior good seed producing variety can be developed.

Research on using tall fescue for turf is continuing with the cooperation of J. H. Dunn (Horticulture). Much of Missouri is located in the "transition" zone of the United States. This area is south of the optimum range of bluegrass and too far north for the warm season turf species. Varieties such as 'Kentucky 31' and 'Alta' have been used for lawn and turf, but have been criticized for excessive coarseness. Tall fescue is well adapted to this region and selection is being placed on fine leaves, short growth habit, dense sod, drought tolerance, and resistance to disease. A variety trial which includes several of the University of Missouri's turf selections has been planted and will be evaluated for several years at both the Southwest Center and at Columbia, Mo.

ALTERING FORAGE MAGNESIUM WITH SOIL TREATMENTS

J. R. Brown, Wm. Rice, M. Farley and J. Kerr, Columbia
Boyd Strong, Mt. Vernon

Abstract: The data from the second and third full years of a study on the effect of soil treatments on fescue yield and composition are presented. These data provide evidence that the K/Ca+Mg ratio in fescue can be altered by soil treatments.

One of the many factors which helps to trigger outbreaks of grass tetany in cattle is the content of magnesium in the forage the animals eat. Based upon information gleaned from work in other areas of the U.S. and world a study was initiated in 1972 at the Southwest Center. The objective of the study was to determine the effect of lime sources and timing of top-dressed N, P, and K on the concentration of Mg in fescue tissue at several times during the year.

Methods

In this study there are four basic treatments as follows:

- Dolomitic limestone at one half the recommended rate
- Magnesium oxide to supply 240 lbs Mg per acre
- Dolomitic limestone as above plus 72 pounds of elemental sulfur
- Calcitic limestone at one half the recommended rate

These four basic treatments were worked into the plow layer of Gerals silt loam in 100' x 35' blocks prior to seeding Kentucky 31 fescue in the spring of 1972.

Plots were laid off in 10 35' x 10' plots per block. Half of the plots in each block received 240 lbs Mg/A as MgO worked into the surface soil. Five timing treatments of top dressed fertilizer based upon 1972 recommendations were selected as indicated in Tables 1, 2 and 3.

The sampling and harvest plan selected was a compromise to simulate grazing where grazing would be impractical due to plot numbers and size. The fall growth was allowed to accumulate and go dormant. In January, after being leached by fall precipitation, the fall growth was removed, dry matter yields were determined and the material analyzed for K, Ca and Mg. (The January harvests are considered as yield of the previous calendar year.) The "February" treatment was applied after removal of the stock piled material. In the spring when new growth reached a 5-inch leaf length grab samples from each plot were taken at intervals and analyzed for K, Ca and Mg. The entire growth was harvested at initiation of seed head emergence for yield and analysis. No grab samples were taken after the first harvest until fall. Soil samples from each plot were taken and the appropriate top dress treatments were made after the first harvest. The late spring-summer growth was harvested for yield and analysis in early July and the "August" treatment was applied. After the first frost periodic grab samples were taken until growth ceased. The plant material was dried, ground and analyzed by routine methods.

Results

Dry Matter Yields

As this study continues it seems that the timing of topdressing can be altered without changing total drymatter production over the year (Table 1). When nitrogen is not applied prior to spring growth but is applied after the first harvest there is a significant shift in the period when the drymatter was produced. Under the conditions of this study the delay in N application until late spring lengthened the drymatter production period in both 1974 and 1975.

Neither the basic lime treatments nor the extra magnesium had any effect on drymatter yield.

Cation Ratio

The ratio of K to the sum of Ca and Mg in the grass is supposed to be an indicator of potential grass tetany problems. If this ratio exceeds 2.2 in a forage that forage may have Mg in poor balance with K and may induce grass tetany.

In this study none of the samples had cation ratios which would cause problems (Tables 2 and 3). When N was held off the plots until late spring there was a slight lowering of the ratio ie. compare treatment 1 and 3 in Tables 2 and 3.

Soil Tests

Table 4 shows that this study has caused the soil K to decline in spite of the quantity of K applied. For this reason the treatment in 1975 was increased to 100 lbs of K annually per acre.

The added magnesium in dolomitic limestone and in the soluble MgO shows up clearly in the soil test.

Summary

The 1975 results support the 1974 results as reported in the 1976 Research Reports from the Southwest Center. The major problem is that environmental conditions have been such that the fescue in this study could not be considered to trigger grass tetany even if we could include animals in the study.

On the other hand it seems clear that under the conditions of the study delayed N treatment until late spring provides more even dry

Table 1. Effect of topdressing treatments on tall fescue yield - 1974, 1975.

Treatment		1974 Harvest				1975 Harvest			
Time[1]	$N+P_2O_5+K_2O$[2] --lbs/A----	May	June	Jan	Total	May	June	Jan	Total
F M A	80+40+80 0 80+ 0 + 0	3.2	.8	2.4	6.4	3.3	0.5	1.6	5.4
F M A	80+40+40 0 80+ 0 +40	3.2	1.0	2.8	7.0	3.1	0.5	1.7	5.3
F M	0 80+40+40 80+ 0 +40	1.4	2.4	2.9	6.7	1.6	1.5	1.9	5.0
F M A	0 80+40+80 80+ 0 + 0	1.4	2.3	2.6	6.3	1.5	1.7	1.8	5.0
F M A	80+40+40 40+ 0 +40 40+ 0 + 0	3.1	1.7	1.7	6.5	3.1	1.1	1.1	5.3
	lsd .05	.02	.37	.19	-	.11	.08	.17	-

[1]F = after January residue removal, M = after first harvest in the spring, A = August.
[2]K rates in 1975 were 50 and 100 lbs K_2O/Acre.

Table 2. Effect of topdressing treatments on the cation ratio in tall fescue[1] - 1974.

Top Dress					Sampling Date					
Time[2]	Treatment									
	N	P_2O_5	K_2O	Number	16 Mar	28 Mar	10 Apr	11 Nov	9 Dec	4 Jan
	-----lbs/A---------									
F	80	40	80							
M	0	0	0	1	1.8	1.7	1.4	0.6	0.6	0.6
A	80	0	0							
F	80	40	40							
M	0	0	0	2	1.7	1.6	1.4	0.8	0.9	0.8
A	80	0	40							
F	0	0	0							
M	80	40	40	3	1.5	1.5	1.2	0.8	0.9	0.7
A	80	0	40							
F	0	0	0							
M	80	40	80	4	1.4	1.3	1.1	0.6	0.7	0.7
A	80	0	0							
F	80	40	40							
M	40	0	40	5	1.6	1.6	1.3	0.6	0.7	0.6
A	40	0	0							
	lsd .05				.07	.10	.08	.06	.08	.06

[1]Ratio = me K/100g drymatter ÷ (me Ca + me Mg per 100g drymatter)
[2]F = January application, M = application after the first harvest, A = August application.

Table 3. Effect of topdressing treatments on the cation ratio in tall fescue[1] - 1975.

Top Dress					Sampling Date						
Time[2]	Treatment				27 Mar	7 Apr	18 Apr	30 Apr	13 Nov	4 Dec	6 Jan
	N	P_2O_5	K_2O	Number							
	-----lbs/A-------										
F	80	40	100								
M	0	0	0	1	1.5	1.5	1.5	1.4	0.6	0.6	0.6
A	80	0	0								
F	80	40	50								
M	0	0	0	2	1.5	1.4	1.5	1.4	0.8	0.8	0.7
A	80	0	50								
F	0	0	0								
M	80	40	50	3	1.4	1.3	1.4	1.4	0.8	0.7	0.8
A	80	0	50								
F	0	0	0								
M	80	40	100	4	1.3	1.2	1.3	1.3	0.7	0.7	0.7
A	80	0	0								
F	80	40	50								
M	40	0	50	5	1.4	1.4	1.3	1.3	0.7	0.6	0.6
A	40	0	0								
	lsd .05				.07	.05	.08	.08	.07	.06	.06

[1]Ratio = me K/100g drymatter ÷ (me Ca + me Mg per 100g drymatter)
[2]F = January application, M =aapplication after the first harvest, A = August application.

matter production over the growing season. It should be remembered that the rainfall pattern has much to do with this.

Acknowledgements

The financial support of the Missouri Cattlemen's Association and the Tri-County Livestock Association is greatly appreciated. Magnesium oxide used in this study was donated by Basic Chemicals, Cleveland, Ohio.

Table 4. Soil Test Results-May 1975 Sampling

a. Potassium

Treatment No	Soil Test K lbs/A
1	115
2	108
3	100
4	86
5	95

b. Calcium & Magnesium

Lime Treatment 1	Ca	Mg
	----lbs/A------	
Dolomitic	1510	271
Calcitic	1700	186
MgO	1440	314
D + Sulfur	1710	286

SOIL FERTILITY RESEARCH WITH FORAGE CROPS

Earl M. Kroth, UMC and Richard Mattas, SWC

Introduction

Decisions as to the quantities of limestone, superphosphate, and potash to apply to soils to produce top economic yields are made by comparing the results of soil tests with soil test values accepted as standards. In the case of row or other rotated crops these "basic" or "corrective" treatments are plowed down or worked into tilled soil in some manner. Where long lay crops such as fescue are concerned, recommended lime or fertilizer is applied as topdressing to the soil surface.

Studies with forage crops at the Southwest Center since 1961 have shown that forage crops do not need corrective quantities of fertilizers plowed into the surface seven inches for optimum yields. Topdressing small quantities of P_2O_5 and K_2O annually have proved to be just as effective. (Missouri Research Bulletin 1005--Yields and Soil Test Values Resulting from Topdressing Forage Crops.)

Limestone, phosphorus and potassium do not move into the soil rapidly and if recommendations based on conventional soil testing methods are followed when making applications to forage crops, high concentrations of calcium, phosphorus, and potassium accumulate in the surface two or three inches. In cases of low magnesium containing soils, low magnesium containing forage could result; magnesium uptake by plant roots could be hindered by high concentrations of calcium and potassium.

Each soil fertility study now underway at Southwest Center is evaluating some phase of the topdressing method for supplying limestone and fertilizer to forage crops.

Results

A. Method and Rate of Supplying Limestone to Tall Fescue

This study consists of a comparison of four limestone treatments as main blocks (0, 3T and 6T topdressed, 8T plowed down) and five N, P, K treatments topdressed annually on each of the limestone blocks. The variables in these treatments are rates and times of application; total annual quantities of nutrients are equal. Treatments are evaluated by comparing yields as tons/acre hay and P, K, Ca and Mg content of the forage in spring and fall.

The 8T/A limestone treatment was applied (4T plowed down, 4T disked into plowed surface) and the fescue seeded in the spring of 1972 using a 60 + 30 + 30 starter fertilizer. The 3T and 6T limestone treatments were topdressed in May 1973. The annually topdressed treatments are as follows:

TABLE 1. Topdressed N, P, K Treatments for Limestone Study.

Treatment	December	After 1st Harvest	August
	Time of Application		
1.	80 + 50 + 150	0	80 + 0 + 0
2.	80 + 25 + 75	0	80 + 25 + 75
3.	80 + 50 + 75	0	80 + 0 + 75
4.	80 + 0 + 0	0	80 + 50 + 150
5.	0	80 + 25 + 75	80 + 25 + 75

TABLE 2. Yields T/A of Tall Fescue Related to Limestone and N,P, K Topdressings, 1976

NPK Treatment	No Lime	3T Topdressed	6T Topdressed	8T Plowed Down
	Yields T/A			
1	2.4	2.2	2.4	2.7
2	2.2	2.3	2.5	2.7
3	2.2	2.5	2.6	2.7
4	2.1	2.3	2.4	2.5
5	2.3	2.3	2.5	2.7
Average	2.2	2.3	2.5	2.7

These data show that plots that received 3T and 6T/A limestone topdressed in March 1973 produced slightly higher but not statistically different yields than plots getting no limestone. Plots having 8T/A limestone worked into the plowed layer show 0.5T/A increase over plots getting no limestone. This is a statistically significant yield increase but would not be worth the expense of plowing up a stand of tall fescue to make limestone applications according to tests made on the plow layer.

TABLE 3. Initial Soil Test Values, 1972.

Depth	om %	P_2O_5 P_1	Lbs/A P_2	E_xK Lbs/A	Ca Lbs/A	Mg Lbs/A	NA Me/100gm	pHs	CEC Me/100gm
0-7"	2.6	22	20	154	2025	161	6.1	4.7	12.0
8-14"	2.0	10	10	135	1200	257	12.9	3.9	17.1

B. Effect of Topdressing Fertilizers on Yields of Blackwell Switchgrass and Caucasian Bluestem.

These studies use the "Feed the Plant" approach to forage production rather than the conventional "Fertilize the Soil" method used for row and rotated crops. Yield data were taken first in 1972 for the switchgrass and in 1973 for the bluestem. Topdressed fertilizers are composed of 3 levels of N, 4 levels of P_2O_5, and 4 levels of K_2O in all combinations making a total of 48 different treatments. Quantities per acre of the three nutrients are: N=0, 60, 120; P_2O_5 = 0, 30, 60, 320 as rock phosphate; K_2O = 0, 50, 100, 150. Yields for 1976 of selected treatments are given in Table 4.

TABLE 4. Yields of Switchgrass and Bluestem as Influenced by Different Rates of N.P.K. 1976.

Yields T/A					
Selected Treatments	Switchgrass	Bluestem	Selected Treatments	Switchgrass	Bluestem
0 + 0 + 0	1.7*	1.0	120 + 30 + 50	4.1	3.4
60 + 0 + 0	2.6	2.2	120 + 30 + 100	4.3	3.7
120 + 0 + 0	2.2	2.4	120 + 30 + 150	4.7	3.7
0 + 30 + 0	2.2	1.0	120 + 60 + 150	3.9	3.6
60 + 30 + 0	2.3	2.1	120 + 320*+ 100	3.7	3.0
120 + 30 + 0	2.7	2.6	120 + 320*+ 150	3.8	2.8
60 + 30 + 50	3.2	2.8	0 + 30 + 50	2.5*	1.2
60 + 30 + 100	2.9	2.5	0 + 30 + 100	2.5*	1.2
60 + 30 + 150	3.4	2.7	0 + 30 + 150	2.9*	1.5

* Yield increase over past years due to red clover planted February 1976.

**Applied as rock phosphate topdressed spring of first production year of each grass.

The data to date show that 120 lbs N will produce more forage than 60 lbs N although in some years there is evidence of some carryover from the 120 lbs rate, indicating that 100 lbs N could be a more suitable rate. P_2O_5 at 30 lbs/A and K_2O at 50 lbs/A annually would be optimum rates for these nutrients on this soil. However, yields are tending to be higher with the 150 lbs/A rate. In these studies all forage is removed. Under pasture conditions considerable amounts of the nutrients would be returned in animal wastes and consequently annual P_2O_5 and K_2O applications would be less. Apparently the rock phosphate is supplying P at a suitable rate for these grasses.

C. Establishing Red Clover in Stands of Warm Season Grasses.

Kenstar red clover seed at 8 lbs/A was drilled into the switchgrass plots receiving no N in late February 1976 and into the bluestem plots in February 1977. Good stands were obtained on all plots. However, different rates of growth were observed depending on the amounts of P_2O_5 and K_2O

that had been topdressed during the previous 4 years. The table below shows the concentrations of P_2O_5 and exchangeable K the seedling red clover plants found in the upper 4 inches of differently treated switchgrass plots in February 1976.

Depth Inches	Topdressed Treatments					
	0 + 30 + 0		0 + 30 + 50		120 + 30 + 50*	
	P_2O_5	E_xK	P_2O_5	E_xK	P_2O_5	E_xK
0-1	154	224	164	405	73	266
1-2	59	145	82	249	27	108
2-3	27	115	17	161	18	96
3-4	22	109	16	130	14	96

*Red clover was not seeded on plots getting this treatment. However, they were sampled to show what the P_2O_5 and ExK concentrations would be in the upper 4 inches of a soil getting a reasonable amount of nitrogen topdressed with an optimum rate of P_2O_5 and K_2O. If red clover were to be seeded on plots getting this treatment 70 lbs of 46% superphosphate banded with the seed with a modified grain drill would insure good growth of the clover seedlings.

The plots of switchgrass into which Kenstar red clover was drilled in February 1976 were harvested for hay May 3, 1977 and again on August 16 for red clover seed. A swarm of honey bees was placed near the plots to aid in pollination.

D. Fertilization of Cool Season Grasses

Results of studies with different topdressed P and K treatments in comparison with "corrective" treatments at the Southwest Center have been mentioned (see Introduction of this section). Results from these studies caused us to concentrate on the warm season grasses at Southwest Center and on the cool season grasses at the North Missouri Center, Spickard, in Grundy County. Our study here at Southwest Center attempting to evaluate the effective nitrogen fixation by birdsfoot trefoil does evaluate 30 and 60 lbs. of P_2O_5 combined with 100 and 200 lbs. K_2O in four separate combinations.

Data showing effects of different rates of N, P, K on yields of tall fescue and reed Canarygrass at the North Missouri Center are given in Table 5. Data from these studies were first taken in 1972.

TABLE 5. Yields of Tall Fescue and Reed Canarygrass Produced by Selected N P K Treatments North Missouri Center 1976.

Yields T/A				
Selected Treatments*	Tall Fescue	Reed Canarygrass	Selected Treatments**	Reed Canarygrass
200 + 0 + 0	0.9	1.7	200 + 0 + 0	2.4
200 + 30 + 0	2.3	2.7	200 + 30 + 0	2.5
200 + 30 + 100	2.8	3.1	200 + 30 + 100	2.9
200 + 30 + 150	2.9	3.1	200 + 30 + 150	3.5
200 + 60 + 0	2.9	2.4	200 + 60 + 0	3.1
200 + 60 + 100	3.5	2.8	200 + 60 + 100	2.8
200 + 60 + 150	3.4	3.3	200 + 60 + 150	3.4

* Treatments topdressed annually in March

**Treatments topdressed annually in March on plots brought up to soil test by basic plow down treatments in April 1971.

Interpretation of the data to date indicates that 80 lbs of N in March and another 80 lbs N in June would be optimum nitrogen management for fescue and reed canarygrass in North Missouri providing summer rains were adequate. In Southwest Missouri times of N application are March and August. Annual topdressing of 40 lbs P_2O_5 and 130 lbs K_2O would probably be optimum where the forage is removed as in our studies. Where the forage in grazed annual rates of P and K would be considerably less. These results are similar to those with warm season grasses at Southwest Center - Table 4. Attention is specifically called to the yields of reed Canarygrass where 200 + 30 + 100 and 200 + 60 + 150 were topdressed on plots receiving no corrective treatment and on plots brought up to soil tests in 1971. These yields show that comparable yields of grasses can be produced by annual topdressings without corrective treatments previous to establishing the stand. The studies at North Missouri Center are to be terminated in the fall of 1977 and comparison of fertilizer amounts, forage yields, and forage composition with soil test values from soil samples taken at one inch depths will give a more refined interpretation of the research data collected over the 5-6 year period of the studies.

E. Birdsfoot Trefoil as a Source of N for Fescue Seed Production

Missouri produces more fescue seed than any other state; 70,560,000 lbs of seed were produced in 1976 and 84,975,000 lbs in 1975. This study was started to evaluate birdsfoot trefoil as a source of nitrogen for fescue seed production and its own contribution as a forage plant grown in combination with tall fescue. Tall fescue seed was drilled into a good stand of Dawn birdsfoot trefoil in the fall of 1973. In addition to evaluating birdsfoot trefoil as a nitrogen fixer the study was designed to evaluate the P and K needs of the fescue-birdsfoot trefoil mixture. Treatments, forage yields in 1976, and seed yields for 1977 are given in Table 6.

TABLE 6. Effect of Commercial Nitrogen and Birdsfoot Trefoil on Tall Fescue Seed Production and Fescue--Trefoil Forage Yields*

Treatment	Forage T/A 1976	Seed Lbs/A 1977
Fescue alone	1.4	250
Fescue + Trefoil	2.5	300
Fescue + Trefoil + 50 lbs N	2.5	490

* Average of all P, K, levels.

Good stands of trefoil were present on all fescue-trefoil plots during the summer and fall of 1976. However, only enough N was added to the soil to produce 50 lbs of fescue seed in 1977. Fifty lbs of N in March produced an additional 190 lbs of seed. The trefoil stands appear to be thinner the summer and fall of 1977. The method of evaluating forage yields by clean cutting with a forage harvester may be reducing the stands. If the fescue-trefoil forage were pastured under managed grazing conditions the trefoil stands could be in a better condition. However, the relatively small amount of nitrogen supplied to the fescue for seed production indicates this fescue-legume combination might not be a good one where fescue seed production is a major item.

CORRECTIVE LIMING OF SOUTHWEST MISSOURI SOILS

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Department of Agronomy

Abstract: Soils found on the Southwest Research Center represent much of this area of the state. Evaluation of 1976 soil test data indicated that over 65% of the samples tested had sufficient acid to receive lime recommendations for the crops generally planted in this region. Further evaluation indicates that a high degree of the samples tested would also receive a suggestion to increase exchangeable magnesium. This data indicates liming is a very necessary practice in Southwest Missouri and that special considerations are necessary when liming these soils.

Correcting soil acidity by liming should be the first step in proper fertility practices to increase profitable crop production. Liming your soil according to soil test recommendations will:

- Decrease soil acidity to desired level
- Improve efficiency of other plant nutrients
- Reduce availability of elements toxic to plants
- Provide a proper cation balance of calcium and magnesium
- Promotes desirable bacterial activity
- Help improve structure and tilth of some soils.

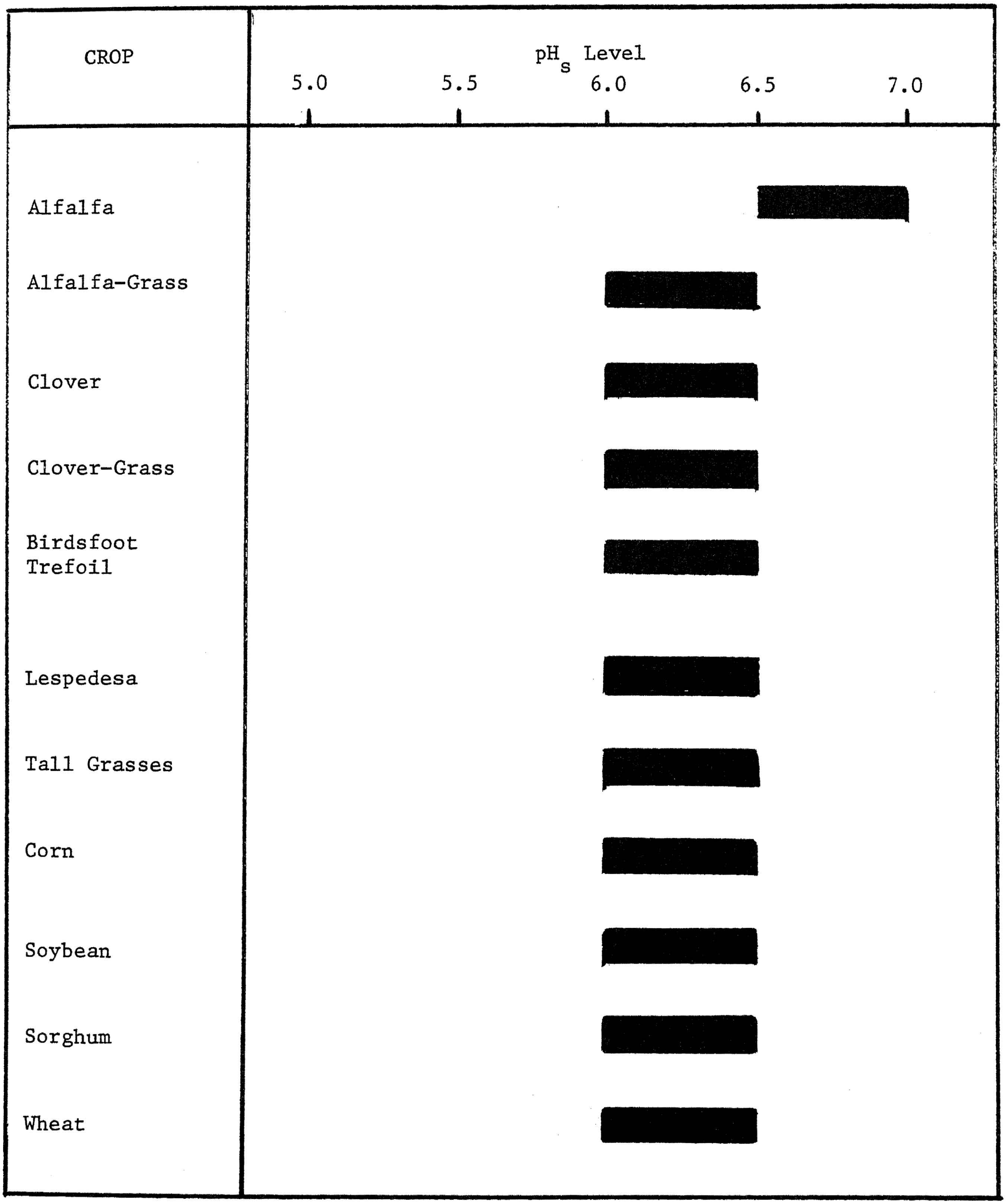
Corrective lime recommendations based on soil test use the following analyses in calculating such recommendations:

- pH_s - acidity in salt solution
- NA - total neutralizable acidity
- Exchangeable calcium and magnesium
- C.E.C. - cation exchange capacity.

Lime requirements are suggested in Missouri by crop and by soil region according to where the field sampled is located in the state. The soils of the University of Missouri Southwest Research Center have features that relate them to a very large area of Missouri. Therefore, corrective liming suggestions for southwest Missouri utilize the same Soil Region criteria.

The most desireable pH_s range for many of the crops in this region is presented in Figure 1. Because the subsoils in this region of the state are extremely acidity, lime suggestions are slightly higher to promote a long term reduction of subsoil acidity to enhance deeper crop rooting.

Figure 1. Recommended soil pH_s for the major crops of the Southwest Missouri Soil Regions.



To illustrate how wide spread liming is in a fertility management program in southwest Missouri some of the 1976 soil test data for this region have been summarized and presented in Figures 2, 3 and 4. These will demonstrate a high degreee of acidity and low calcium and magnesium saturation in southwest Missouri soils.

In Figure 2 is illustrated that of all the samples submitted in southwest and south-central Missouri, more than 65 percent were sufficiently acid to receive a recommendation for lime. A closer evaluation indicates that more than normal liming should be considered. Figure 3 shows that in southwest Missouri, in some counties more than 65 percent of the soil samples tested less than 70 percent calcium saturated and many of the counties 30-65 percent of the samples tested less than 70 percent calcium saturated. As shown in Figure 4, in the far southwest counties, more than 70 percent of the samples tested sufficiently low in exchangeable magnesium to receive a recommendation. In many adjacent counties between 30-65 percent of the samples would receive a suggestion for magnesium correction because of low magnesium saturation.

Some practical significance in proper liming practices are indicated by higher yields and with more desireable calcium and magnesium saturation a possible lower incident of grass tetany.

Figure 2. Southwest Missouri Areas where soil testing indicated corrective liming necessary.

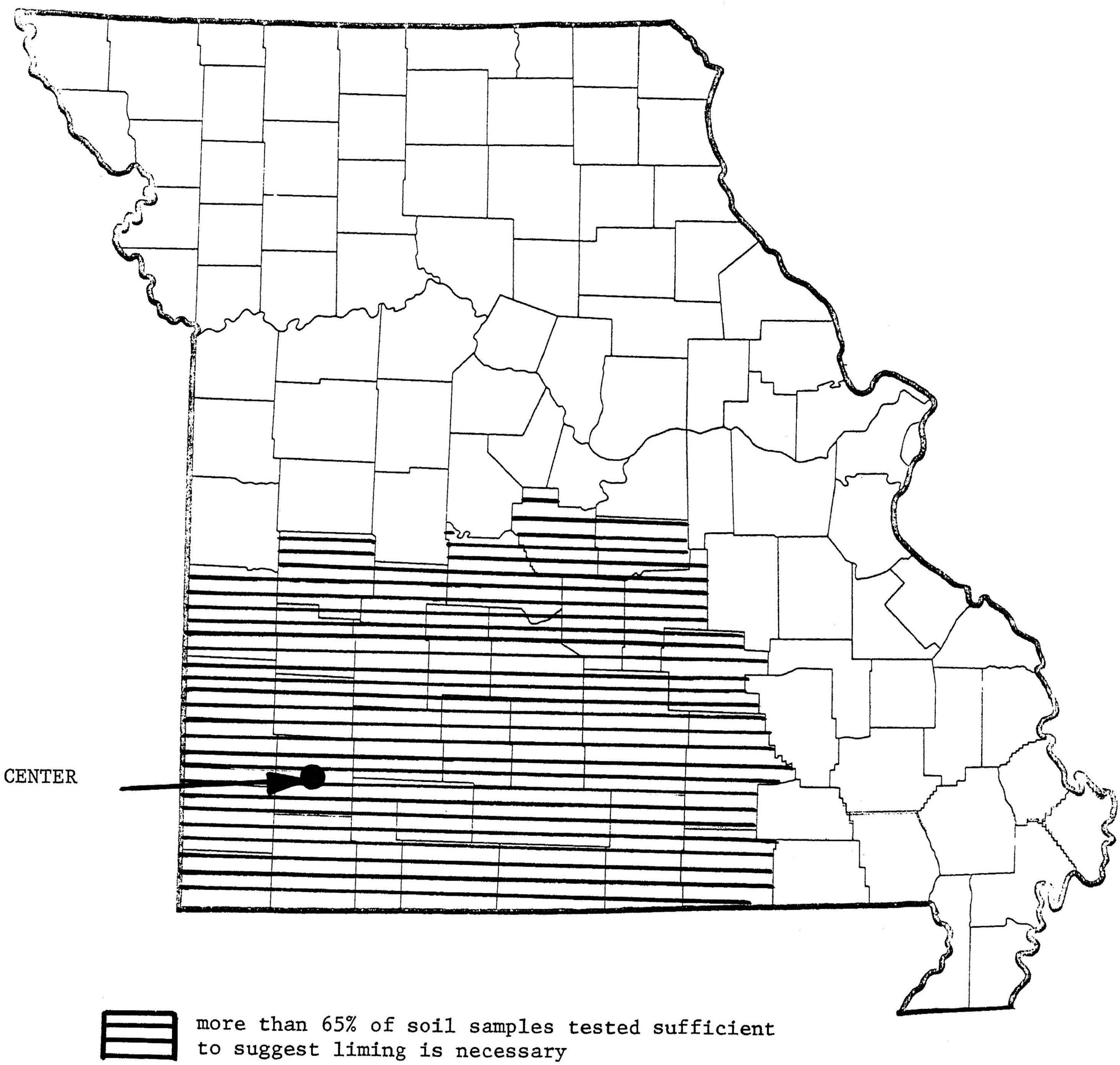


Figure 3. Southwest Missouri Areas indicating the level of exchangeable calcium.

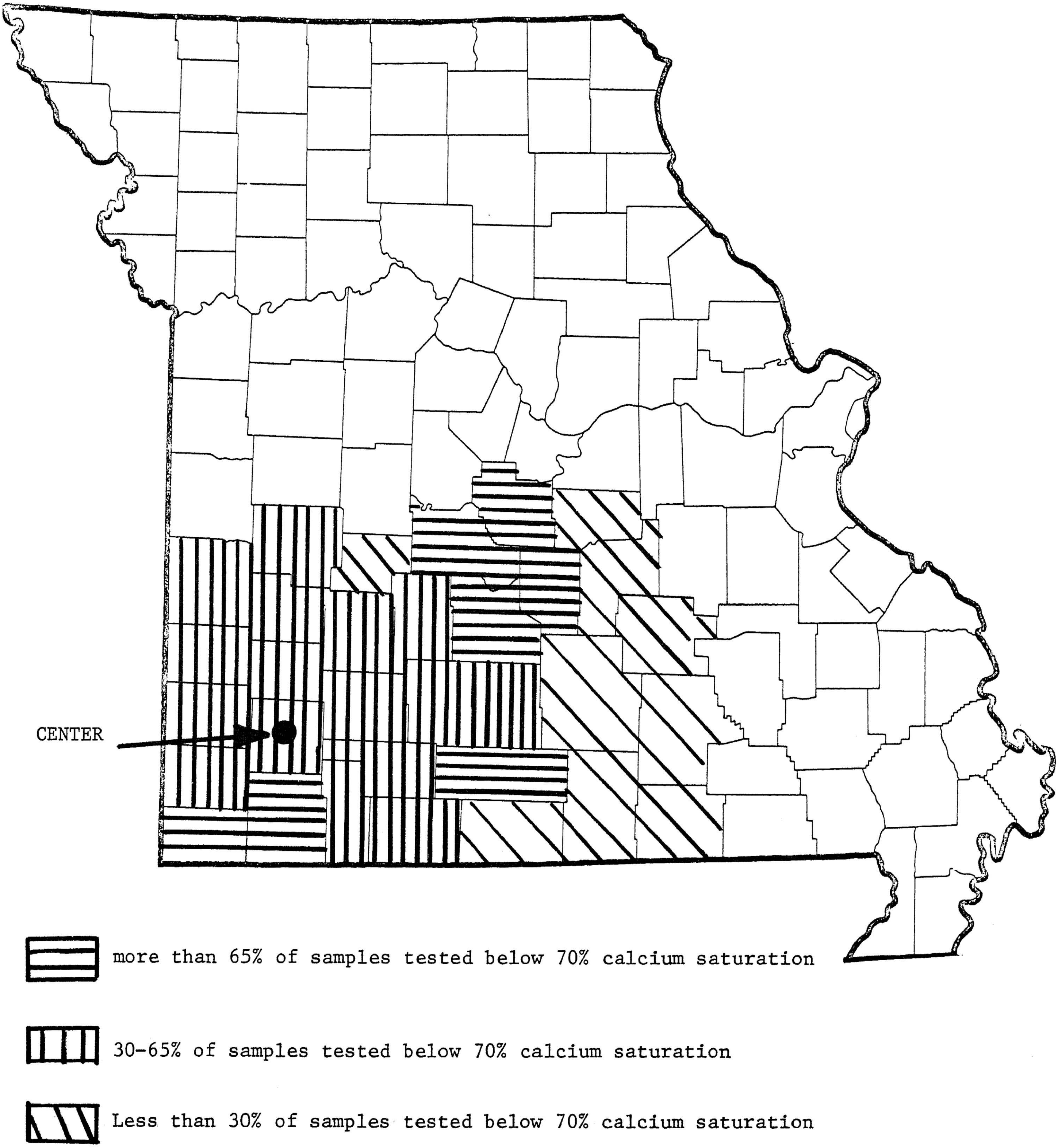
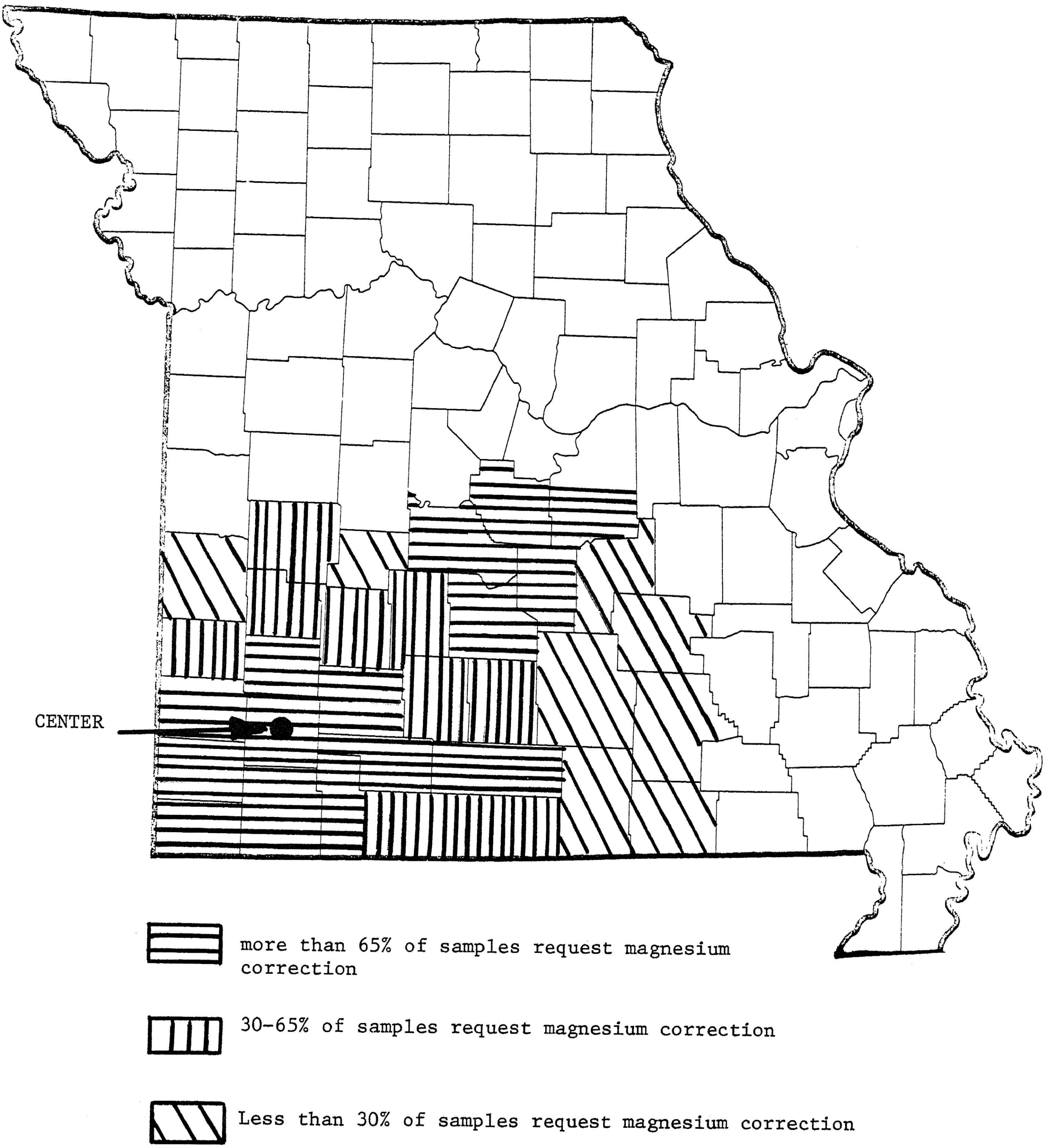


Figure 4. Southwest Missouri Areas indicating magnesium saturation sufficiently low to receive a corrective recommendation.



more than 65% of samples request magnesium correction

30-65% of samples request magnesium correction

Less than 30% of samples request magnesium correction

NON-CONVENTIONAL SOIL AMENDMENTS

Gary W. Colliver, Department of Agronomy - UMC

Soil activators, soil conditioners, plant stimulators, soil surfactants, soil inoculants, "natural" minerals, liquid lime replacement materials, seaweed, fermented manures, crushed mineral (rock) materials, humic materials, and even coal-like materials are among the non-conventional products being offered for sale to farmers. Such products have been around for quite some time but seem to be increasing in numbers in recent years.

The promoters of these products often make fantastic claims for their beneficial effects on soils and crop growth. They are sometimes billed as "cure-alls" which can be good for nearly anything that might ail a soil or plant. They may also be recommended as a livestock feed additive and claims may be made for improving the nutritive value of both feed and food crops. Last winter I read a claim that the use of a seaweed product foliarly on corn in 1976 overcame the effects of drought and tripled corn yield.

Promotional material for one product called a soil conditioner and plant stimulator, claims it will, "--cut the use of fertilizer in half or eliminate it altogether--, revitalize worn out soils and eradicate root rot in such agricultural crops as cotton." It further claims to, "--release nutrients bound in the soil, --reduce caking characteristics in soil and build soil structure, --improve root growth, stimulate circulation in the plant, and provide trace minerals to plants." As if that wasn't enough it is further claimed to, "--adjust soil pH to a favorable range." In my opinion, any product that could do all of these, is truly a miracle!

Sales promotions are usually based largely on testimonials from farmers that supposedly have "successfully" used the product. There is an absence of scientific research to support the claims. If research is quoted, it is often taken out of context, incomplete, and attributed to someone in a distant state. Credibility is sometimes based on quotes from "experts" who probably have no expertise whatsoever in agronomy. Such "experts" may include M.D.'s, veterinarians, lawyers, and even television personalities. Their involvement may be financial backing and are probably well-meaning, but are largely uninformed in the fundamentals of soil chemistry, soil physics, soil fertility, and plant physiology.

When asked how their products can produce the remarkable results they claim, the promoters often answer, "We don't know why, but it works". They may suggest it is due to some "unknown" natural process or ingredient, or perhaps that the ingredients and how they work must be kept secret to protect their investment. Another approach is to use a conglomeration of scientific terms in a sales pitch, which may sound legitimate to laymen not trained in the sciences necessary to fully understand such terminology.

Promoters are usually very vocal critics of agronomic researchers in universities, the U.S.D.A., and large corporations. They will probably tell you, "The university doesn't know it works because they haven't tested our product." Some may also claim universities won't recommend it because they are "controlled" by the large corporations. Another common characteristic of some promoters is the claim that they want to rid agriculture of its dependence on pesticides and inorganic fertilizers, replacing them with their "natural, organic" products.

The "miracle" products are usually used in very small quantities on an acre basis, some as little as 2 ounces per acre. Claims for one product are that 2 to 3 gallons of it will produce the same soil acidity neutralizing benefits as one or more tons of agricultural limestone. This seems rather unlikely. Skepticism is also cast on the claims that these products variously produce the following benefits: chelation of plant nutrients, improve soil water absorptive and holding capacity, increase numbers of earthworms and microbes, increase microbial activity, add beneficial microbes to soil, improve soil organic matter, eliminate crop disease, reduce insect infestation, increase root growth, and improve crop quality.

So-called "proof" of positive results from farmers fields can easily be based on erroneous conclusions. For example, if you have two fields and use a product on one field and not the other and the yield turns out higher where you used it, you might conclude the product produced the benefit. Such, however, is not necessarily the case. There are many other factors which may have caused the difference. Unless the comparison is based on sound scientific principles, the results cannot be considered very reliable. Further, with the normal variations in any field, any series of field trials not properly designed can show what would appear to be a "response" in as many as one-half the trials, regardless of what treatment is applied. This gives the promoters their "ammunition", and they tend to "forget" abount the trials where no response is shown.

A bad crop year, such as the one we had in much of Missouri during 1976, also sets the stage for "proof" that a product works. For example, let's say a farmer used a "miracle" product for the first time in 1977, and gets a very high yield, of course much better than in 1976. It's likely he could be convinced that at least part of that big yield increase was due to the product, when in fact it's more likely due to a better season.

There are too many of these products to conclusively test them all by sound research procedures. The limitations on dollars for agronomic research at the agricultural colleges prevent doing everything that might be needed, and there are higher priorities than testing "miracle" products. Therefore, judgments have to be made based on scientific knowledge and a limited amount of research which has been done on such products. The research which has been done in various states by competent agronomic researchers does not support most of the claims being made for most "miracle" products. Further, the vast amount of scientific expertise available within the ranks of agricultural researchers nationwide, has not found validity in most of the claims for such products.

HERBICIDES FOR SPRING ESTABLISHMENT OF ALFALFA AND BIRDSFOOT TREFOIL

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R. Mattas
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<u>Objective:</u> These experiments were planned to evaluate the effects of herbicides on weeds and seedlings of alfalfa and birdsfoot trefoil.

<u>Methods and Materials</u>: The soil was spring plowed, disked, and harrowed. Herbicides were incorporated into the soil and were applied in 40 gpa of water at a pressure of 40 psi. The herbicides were incorporated into the soil with two harrowings. Preemergent treatments were applied after planting. 'Cody' alfalfa, at 15 lb/A, and 'Dawn' birdsfoot trefoil, at 10 1/2 lb/A, were planted with a cultipacker seeder on April 7.

<u>Results:</u> The numbers of weeds and legume plants present are shown in the tables. The numbers of alfalfa plants increased on plots treated with EPTC, benefin and profluralin and the combination of EPTC and benefin. Control of broadleaf weeds was rather poor on all plots; however, some of the treatments were relatively effective on weed grasses.

With birdsfoot trefoil (Table 2), stands treated with benefin, benefin + EPTC, and profluralin had more birdsfoot trefoil plants than the check. Generally, weed control was poor and yields of birdsfoot trefoil were increased only by treatments with benefin. There were extremely poor stands of birdsfoot trefoil with 1 lb of methazole.

Table 1. Numbers of weeds and alfalfa plants and yields of alfalfa.

Herbicide	Rate	Numbers of plants in 1.5 ft^2			Alfalfa yields tons/acre
		Alfalfa	Broadleaf weeds	Weedy grasses	
EPTC Inc	3	22.4	3.9	4.9	1.42
Benefin Inc	1	21.6	4.4	1.5	1.60
EPTC + Benefin Inc	1 1/2 + 1/2	22.5	4.4	2.4	1.70
Profluralin Inc	1	19.0	3.4	2.1	1.47
Profluralin Inc	2	20.2	4.5	1.1	1.48
Methazole Pre	1	15.2	2.1	4.8	1.55
Methazole Pre	2	16.7	2.9	2.5	1.64
Check		17.1	4.4	5.8	1.63

Weeds were counted on May 26, 1976; and alfalfa was harvested on June 28 and July 30, 1976.

Table 2. Numbers of birdsfoot trefoil plants and weeds and yield of forage

		Numbers of plants in 1.5 ft^2			Yield T/A	
Herbicide	Rate	Birdsfoot trefoil	Broadleaf weeds	Grassy weeds	Weeds	Trefoil
EPTC Inc	3	9.2	7.5	9.8	1.30	.97
Benefin Inc	1	12.4	6.5	3.5	.44	1.30
EPTC + Benefin Inc	1 1/2 + 1/2	11.9	5.2	4.3	.48	1.25
Profluralin Inc	1	11.4	5.8	2.8	.42	1.04
Profluralin Inc	2	13.2	4.2	1.3	.26	1.05
Methazole Pre	1	1.0	4.0	11.5	2.30	.06
Methazole Pre	2	0.2	2.5	5.2	1.80	--
Check		8.9	7.1	9.0	1.33	1.03

Birdsfoot trefoil was harvested on July 8 and August 25, 1976

PASTURE SYSTEMS FOR SEASON-LONG GRAZING

A. G. Matches, Agricultural Research Service,
U. S. Department of Agriculture and Department of Agronomy;
S. Bell and M. Mitchell, Southwest Center;
F. A. Martz, Dairy Husbandry Department

Abstract: The purpose of this research is to develop grazing systems for bridging the summer slump in pasture production.

Pasture systems were grazed from April 6 to November 19 (227 days) during 1976. Average daily gains, gains per acre and gain per tester animal were not significantly different (P = .05) among the four pasture systems (fescue-fescue baled, fescue-legumes, fescue-caucasian bluestem, and fescue-switchgrass). The fescue-legume system had the lowest carrying capacity (animal days and animal unit days per acre), but cattle had the highest average daily gain on this system.

By the third year of production, 'Kenstar' red clover stands were nearly depleted, averaging only 3% of the botanical composition of the sward. Average botanical composition for alfalfa was 32%.

Cattle maintained positive gains over nearly the entire grazing season on all pasture systems.

Introduction: This experiment represents phase II of our research in developing grazing systems for bridging the summer slump in pasture production; phase I experiments were completed in 1972.

Pasture systems consist of tall fescue for spring and autumn grazing and perennial summer grasses ('Blackwell' switchgrass and caucasian bluestem) for summer grazing. Also, pastures of tall fescue cut for hay in May and round baled are grazed (regrowth plus round bales) during the summer slump and again in late autumn. The above fescue pastures received an annual fertilization of 75 lb nitrogen per acre in February and 50 lb again in August. Warm-season grasses are fertilized annually with 60 lb of nitrogen in early May.

Two additional fescue pastures which include legumes make up another system. 'Victoria' alfalfa and 'Kenstar' red clover were seeded into established stands of fescue in early March 1974. These pastures are NOT fertilized with nitrogen.

All pastures in this experiment received an annual application of a 0-60-60 fertilizer in February.

Pasture systems being evaluated are:

1. Tall fescue-switchgrass

2. Tall fescue-caucasian bluestem

3. Tall fescue-tall fescue round baled

4. Tall fescue + red clover -- tall fescue + alfalfa round baled

Each pasture system is handled independently of others. That is, components of each system are grazed according to their particular pattern of growth.

Pastures are grazed with Holstein and Guernsey heifers or steers. Tester animals remain on the same system throughout the season and their weight gain indicates quality of forage consumed. The desired balance of defoliation (differs according to the kind of forage) by grazing is maintained through the addition or removal of "put-and-take" animals from a pasture. Cattle are weighed approximately every 14 days and are shrunk 16 hours before weighing. A three-paddock system of rotational grazing is used in all pastures.

Results for 1976: This is the third year of grazing these pasture systems. During 1976, grazing began on April 6 and ended November 19 for a total of 227 calendar days of grazing. Dates of grazing the summer pastures are shown in Table 1. Caucasian bluestem was grazed 128 days, whereas the baled fescue and switchgrass were grazed 85 days and baled fescue-alfalfa was grazed 71 days.

Hay yields averaged 6857 and 3869 lb of dry matter per acre for the fescue and fescue-alfalfa, respectively (Table 2). Wastage in grazing round bales was nearly the same for fescue and alfalfa and averaged between 22 and 25%. Digestibility of the hay was lower than in past years as a result of heavy rain damage during curing. Hay samples (Table 3) averaged approximately 45% in vitro digestibility (IVDMD) shortly after baling and uneaten hay residue in September averaged approximately 40% IVDMD.

Grazing results for 1976 are given in Table 4. The fescue-legume pastures gave the lowest carrying capacity but had the highest average daily gain (ADG) which averaged 1.33 lb. Carrying capacity of the other three pasture systems were not greatly different. The fescue-fescue baled system had the lowest ADG trends. As in past years, the cattle maintained positive gains over nearly the entire grazing season on all pasture systems.

These experiments will continue through the 1977-grazing season, the fourth year of experimentation. Upon completion, data will be summarized for all years. Future experimental plans include a greater emphasis on the management of the warm-season grasses for higher production per animal and per acre.

Table 1. AVERAGE DAILY GAIN (ADG) OF CATTLE ON SUMMER PASTURE DURING 1976

Species	Dates of grazing	No. of days	ADG lb.
Round baled fescue	7/1 - 9/24	85	0.96
Round baled fescue-alfalfa	7/1 - 9/10	71	1.52
Caucasian bluestem	6/2 - 10/ 8	128	1.00
Switchgrass	5/19 - 7/1	43	1.81
	7/15 - 8/26	42	0.75

Table 2. HAY YIELDS, WASTAGE AND UTILIZATION DURING 1976

Hay	Yield 5/28/76 (lb. DM/A)	% Wastage 9/24/76	Hay utilized (lb. DM/A)
Fescue	6857	25	5143
Fescue-alfalfa	3869	22	3018

Table 3. *IN VITRO* DIGESTIBILITY (IVDMD) OF HAY DURING 1976

Hay	% IVDMD	
	6/10/76[1/]	Residue 9/24/76
Fescue	45.3	40.4
Fescue-alfalfa	44.5	40.9
Average	44.9	40.7

1/ Sampled following baling.

Table 4. GRAZING RESULTS FROM THE PASTURE SYSTEM TRIALS AT THE SOUTHWEST CENTER DURING 1976

Pasture Systems	1976 Grazing Season (April 6 - Nov. 19) Animal Days/A	AU Days/A[1/]	ADG (lb)	Gain/A (lb)	Grain/Tester (lb)
Fescue - Fescue Baled	297	206	1.11	328	253
Fescue + Red Clover -- Fescue + Alfalfa Baled[2/]	178	129	1.33	240	285
Fescue - Caucasian Bluestem	288	207	1.20	347	274
Fescue - Switchgrass	274	198	1.26	346	288
Average	259	185	1.22	315	275
$LSD_{.05}$	34	24	n.s.[3/]	n.s.	n.s.
CV %	6.64	6.61	14	17.4	14

1/ AU Days/A = Animal Unit Days per Acre where a 1000-lb animal equals one animal unit (AU)

2/ Average botanical composition of the legume pastures:
68% fescue = 32% alfalfa
97% fescue = 3% red clover

3/ n.s. = not significantly different at P = .05

RESEARCH WITH WARM-SEASON GRASSES

A. G. Matches, Agricultural Research Service, U. S. Department of Agriculture and Department of Agronomy; Bruce Anderson, Department of Agronomy; and M. L. Mitchell, Southwest Center

Abstract: Four experiments with warm-season grasses are in progress.

In two experiments, five legumes are being interseeded into established stands of switchgrass and caucasian bluestem. The legumes (alfalfa, red clover, ladino clover, and two varieties of birdsfoot trefoil) are broadcast seeded during the winter (February-March). Several more years with additional seedings will be necessary to evaluate the potential success of seeding legumes into stands of these warm-season grasses.

Experiments to determine the yield, quality, and persistence of 'Pathfinder' switchgrass and caucasian bluestem as influenced by cutting height and date of initial harvest will be completed in 1978. Assessment of the long-term effects of defoliation treatments on stand and yield require several years of experimentation. Long-term results will be reported following the completion of these experiments.

Interseeding Legumes: Earlier research (see report on Growing Legumes with Warm-Season Grasses in the 1976 Southwest Center Research Report) indicated that certain legumes are adapted for growing in mixtures with caucasian bluestem and switchgrass. This experiment is an expansion of the previous research.

In this experiment, five legumes were seeded into old established stands of caucasian bluestem and Pathfinder switchgrass. Prior to seeding, the area was fertilized with a 0-60-90 fertilizer and lightly disked. On March 15, 1976, and March 23, 1977, legumes were seeded with a cultipacker seeder. The legumes seeded were:

Treatment	Legume
A	'Dawn' Birdsfoot Trefoil
B	'Cascade' Birdsfoot Trefoil
C	'Victoria' Alfalfa
D	'Kenstar' Red Clover
E	'Arcadia' Ladino Clover

A sixth treatment (F) is grass grown alone.

In 1977, plots overseeded in 1976 are being harvested as follows: (1) harvesting on a hay-cutting schedule, and (2) harvesting on a simulated pasture grazing schedule. Hay plots are harvested whenever the legume reaches 1/10 bloom or the grass reaches the late boot to early heading stage of development. Pasture harvests are taken at 4 to 6 week intervals beginning when grass or legume growth reaches a height of 10 to 18 inches.

Measurements recorded include yield of dry matter, botanical composition, stand changes, plus in vitro digestibility, crude protein and mineral composition of the harvested forage.

Management of Warm-Season Grasses: In the Southern Corn Belt, cool-season grasses such as tall fescue, orchardgrass, and smooth bromegrass produce abundant forage during the spring and autumn, but their summer production is usually very low. As a result, animal performance during the hot, dry summer is usually low. In order to bridge this summer gap in forage production, warm-season grasses, which produce most of their grazeable growth after mid-June, are being used to develop pasture systems for nearly year-long grazing.

Results from previous experiments indicate switchgrass and caucasian bluestem are two grasses with superior summer growth characteristics. However, we do not know how to manage these two species for optimum yield, quality, persistence and animal acceptance.

Experiments were established in the spring of 1975 on blocks of Pathfinder switchgrass and caucasian bluestem to determine the effects of cutting height and time of first harvest. Data from the drier plains states suggest that switchgrass must be managed carefully to avoid loss of stand. Infrequent harvest, tall (8 inches or more) stubble height, or a combination of both have been necessary to maintain switchgrass stands over a number of years. Such management techniques may be impractical in the Southern Corn Belt since alternative species and land use may offer greater returns.

Clipping treatments consist of two cutting heights, high (9 inches) and low (3 inches); and five dates of first harvest. Different plots of switchgrass receive their first harvest on May 29, June 4, June 11, June 18, and June 25. Plots of caucasian bluestem, being later than switchgrass, are first harvested on June 11, June 18, June 25, July 2, and July 9. All switchgrass plots are again clipped around July 30 and all caucasian bluestem plots clipped around August 20. A third cutting is taken of all plots in October.

Since the temperate grasses, such as tall fescue, generally have low production during July and August, special attention is being given to the growth pattern of the warm-season grasses through the summer months.

DRY MATTER LOSSES DURING STORAGE AND FEEDING LARGE BALES

S. Bell, Southwest Missouri Research Center
F. A. Martz, Department of Dairy Husbandry

Abstract: Eleven large orchardgrass bales stored outside nine months lost 14.1% dry matter. Facing the ends of the bales north-south or east-west did not significantly affect the storage or feeding losses. Unrolling the bales on fescue pasture to feed Holstein heifers resulted in 12.2% greater waste than feeding the bales in a circular feeder.

Introduction:

Previous studies here measured waste from big bales fed free choice or in various types of feeders. The primary purpose of this study was to measure dry matter loss during storage, and waste when the bales are unrolled in the pasture or fed in a feeder. Wind damage and hay losses related to direction the ends of the bales faced were also observed and measured.

Procedure:

Orchardgrass hay cut May 25, 1976 received 1.6 inches rain before being baled with a New Holland, Model 850, baler on May 29, 1976. The hay yielded approximately ½ ton/acre, and was of inferior quality due to rain damage and stage of maturity.

The bales were sampled, weighed, and stored outside within ten days after baling. Pounds of dry matter for each bale were recorded at this time. Precipitation from May 29, 1976 until feeding began on February 24, 1977 totaled 23.8 inches. Half of the bales were stored with the ends facing east and west, and half with the bale ends facing north and south. Four bales were stored on 4" x 6" oak posts.

The bales were sampled and weighed again before feeding commenced in late February. Seven bales were fed to twenty-two 845 pound Holstein heifers by unrolling ½ of a bale on each of two consecutive days. Three bales were fed to the same heifers in a circular feeder which served as a control. Hay pulled out of the feeder was picked up each day and any refused hay was weighed back after the second day. Refused hay from unrolling the big bales was raked by hand, weighed, and sampled for moisture the day after feeding.

Results and Discussion:

The bales with the ends facing north and south showed less wind damage than the bales with the ends facing east and west. Wind damage was rated on a scale of 0 to 4, where 0 was no wind damage and 4 was moderate damage on both sides of a bale. Eight north-south orientated bales had an average rating of 1.12 and seven east-west bales had an average rating of 2.14. The north side of the east-west orientated bales took longer to dry between rains.

Eleven bales averaged 982 pounds (864 pounds dry matter) at baling and 884 pounds (742 pounds dry matter) at feeding. This represents a 14.1% dry matter loss during storage. Four of the eleven bales elevated on 6" oak posts had 14.6% dry matter loss compared to 13.8% dry matter loss for seven bales stored on the ground. On a well drained storage site as in this study, bales stored on the ground kept as well as elevated bales.

Five bales stored facing east-west measured 13.8% dry matter loss compared to 14.3% for six bales stored facing north-south. In this study where wind damage appeared to be minimal, these differences seem to be insignificant.

Feeding losses are summarized in Table 1. The data show a 12.2% greater waste from feeding big bales by unrolling than by feeding in a feeder when poor quality hay is fed. A greater amount of waste can be expected from the outside half of the bales compared to the core. This difference indicates that waste would be less for good quality hay than for poor. Also, the feeder saved about 12 pounds of hay from each 100 pounds fed.

Dry matter intake of hay and grain was slightly below the 2.5% of body weight which is normal for the heifers used in this experiment. The poor quality hay may have limited intake, or the heifers may have grazed enough on the pasture to make up the difference. Research reported in last year's Field Day Report showed that using feeders for big bales could limit the waste to 6-8%. The larger waste (12%) observed this year may be a reflection of the poor quality orchardgrass hay.

One of the three bales fed in the feeder was stored on 6" oak posts and refushed hay was only 4%. This advantage of reducing waste by storing bales on posts was not evident with three bales stored on posts that were unrolled for feeding.

Twenty-six good quality orchardgrass-clover bales are now in a barn and outside storage for studies this winter. Four bales will have two years weathering. More conclusive results should be gained from these bales.

Table 1. DRY MATTER HAY LOSSES FOR BALES FED IN A CIRCULAR FEEDER OR UNROLLED IN PASTURE

	Feeder	Unrolled
Number of bales	3	7
Dry matter after storage (lb)	723	753
Dry matter refused (lb)	81	177
Refused (%)	11.2	23.4
Increase waste-unrolled vs feeder (%)		12.2
Waste - outside half of bale (%)		26.0
Waste - core half of bale (%)		19.6
Dry matter intake (% BW)*	1.56	1.48
Dry matter intake (lbs/head)*	13.2	12.5

*Four pounds or 0.47% of the heifers body weight of a 12% grain mix was fed daily.

REGIONAL TEST KENTUCKY BLUEGRASSES IN SOUTHWEST MISSOURI, 1973-1977

John H. Dunn
Department of Horticulture

Abstract: Sixty Kentucky bluegrass turf varieties and experimentals have been under observation at the Southwest Center for five years. Summer quality has generally been rated fair-to-poor. Poor quality of many varieties is believed to be caused by *Fusarium* sp.

We have been studying several turf species in Missouri with emphasis upon Kentucky bluegrass varieties since the late 1950's, when a small number of available types was planted at our New Franklin Horticulture Farm. There were only about a dozen - we didn't have much more to choose from at that time. More recently, 114 varieties were established at the Columbia South Farm Turf Research Area for observation as part of the 1968 and 1972 Regional Variety Studies which originated in the North-east and which now involve several midwestern universities. The regional approach allows us to study varieties in different environments but with similar management from state to state. We routinely observe the bluegrasses during summer (they are well adapted to spring and fall conditions) then compare notes with our colleagues to determine which varieties are generally adapted and which are best adapted to specific uses or locations. (A case in point: Nugget Kentucky bluegrass has performed poorly in tests at Missouri, but quality at more northerly experiment stations has sometimes been excellent.)

The 1972 Regional Study includes sixty entries and some fine products of years of turfgrass improvement by several out-standing breeders. We established this study at Columbia, Port-ageville and Mt. Vernon, Missouri, to learn more about how the varieties adapt to different environments within our state. Generally, the bluegrass varieties have fared better during summers at Columbia where they receive a higher level of maintenance than in the southern regions of the state under less intensive maintenance. Fair to poor quality of varieties during summers at the Southwest Center especially in 1976-77, can usually be traced to outbreaks of disease, tentatively, identified as a *Fusarium* species (Tables 1 and 2). Rankings of the bluegrasses for summer quality have changed little over five summers.

Our observations of the 1972 Regional Test varieties will continue for several more years. We are making good progress in the sorting-out process, and we expect some of these varieties to prove useful in Southwest Missouri.

Table 1. Average quality (9=best) of Regional Kentucky bluegrass varieties and blends for five summers 1973-1977. Southwest Center.

P-140	4.8	Galaxy	4.2	Merion	3.8
Fylking + Biljart[1]	4.7	Rugby	4.2	Touchdown	3.8
KI-157	4.7	Parade	4.2	KI-131	3.8
Brunswick	4.6	Adelphi	4.2	P-154	3.7
Victa	4.6	Windsor	4.2	KI-132	3.7
Plush	4.5	Adelphi + Nugget	4.1	Ram I	3.6
P-143	4.5	P-59	4.1	Fylking + Jamestown[1]	3.6
Brunswick + P-59	4.4	Enoble	4.1	Merion + Kenblue	3.6
Park	4.4	Delft	4.1	Enita	3.5
Cheri	4.4	Bonnieblue	4.0	KI-143	3.5
KI-158	4.4	Majestic	4.0	Nugget + Pennstar	3.5
Monopoly	4.4	Fylking	4.0	Campina	3.4
Vantage	4.3	Pennstar	4.0	KI-133	3.4
Vantage + Victa	4.3	Blend 38	4.0	Entopper	3.3
Pennstar + Merion	4.3	Enmundi	4.0	Kenblue	3.2
Merion + Baron	4.3	Glade	4.0	Fylking + Pennlawn[1]	3.2
BA 6191	4.2	Nugget + P-59	4.0	Fylking + Pennfine[2]	3.2
BA 6255	4.2	Nugget + Park	4.0	KI-187	3.2
Baron	4.2	Geronimo	3.9	Nugget	3.0
Sydsport	4.2	Sodco	3.9	KI-138	3.0
				LSD .05	.8

[1]Fine-leaf Fescue [2]Perennial ryegrass

Table 2. Disease* (9=most severe) ratings for Regional Kentucky bluegrass varieties and blends, July 19, 1977. Southwest Center.

Nugget	6.7	Merion + Baron	4.3	Brunswick	3.0
Adelphi + Nugget	6.7	Delft	4.3	Nugget + Park	3.0
Nugget + Pennstar	6.7	P-140	4.0	Ram I	3.0
Glade	6.3	Baron	4.0	KI-187	3.0
Nugget + P-59	6.0	Plush	4.0	P-154	2.7
Fylking	6.0	Cheri	3.7	Brunswick + P-59	2.7
Merion + Pennstar	5.7	Fylking + Jamestown	3.7	Vantage	2.7
Galaxy	5.7	P-59	3.7	Campina	2.7
Enita	5.3	Rugby	3.7	KI-138	2.7
Entopper	5.3	Merion	3.7	Monopoly	2.7
KI-133	5.0	Majestic	3.7	Sodco	2.7
BA 6191	5.0	KI-132	3.7	Touchdown	2.3
Enmundi	5.0	Parade	3.7	Park	2.3
Blend 38	5.0	Fylking + Pennfine	3.7	Fylking + Pennlawn	2.3
Pennstar	4.7	Adelphi	3.3	Windsor	2.0
Victa	4.7	KI-143	3.3	P-143	2.0
BA 6255	4.3	Geronimo	3.3	Kenblue	2.0
Enoble	4.3	Sydsport	3.3	KI-157	2.0
Bonnieblue	4.3	Vantage + Victa	3.0	KI-158	2.0
KI-131	4.3	Merion + Kenblue	3.0	Fylking + Biljart	1.3
				LSD .05	1.8

* Tentatively identified as _Fusarium_ sp.

SOILS OF SOUTHWESTERN MISSOURI

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Department of Agronomy

ABSTRACT: Three soils, Gerald, Creldon and Keeno, make up a large portion of the gently sloping uplands of the Southwest Research Center. Similar Soils are distributed over a wide area of Southwestern Missouri. The soils have special features that influence plant rooting and yield. All three soils have fragipans (dense layers) in the lower subsoils that are extremely acid. Root penetration is believed to be restricted by such layers. Cherty (stony) layers in the Creldon and Keeno soils result in low volumes of available moisture storage in subsoils.

Soils of the University of Missouri Southwest Research Center have features that relate them to a large area of Missouri delineated on the map in Figure 1. Claypan horizons in some soils relate them to many soils to the west and north of the center. Underlying limestones, contents of chert fragments and fragipans in other soils relate them to many soils east and north of the center.

There are more than 20 different kinds of soils on lands of the Southwest Research Center. They may be grouped into three topographic units: (1) the alluvial lands along Spring River; (2) the sloping, formerly forested lands bordering the Spring River Valley; and (3) the gently sloping prairie uplands.

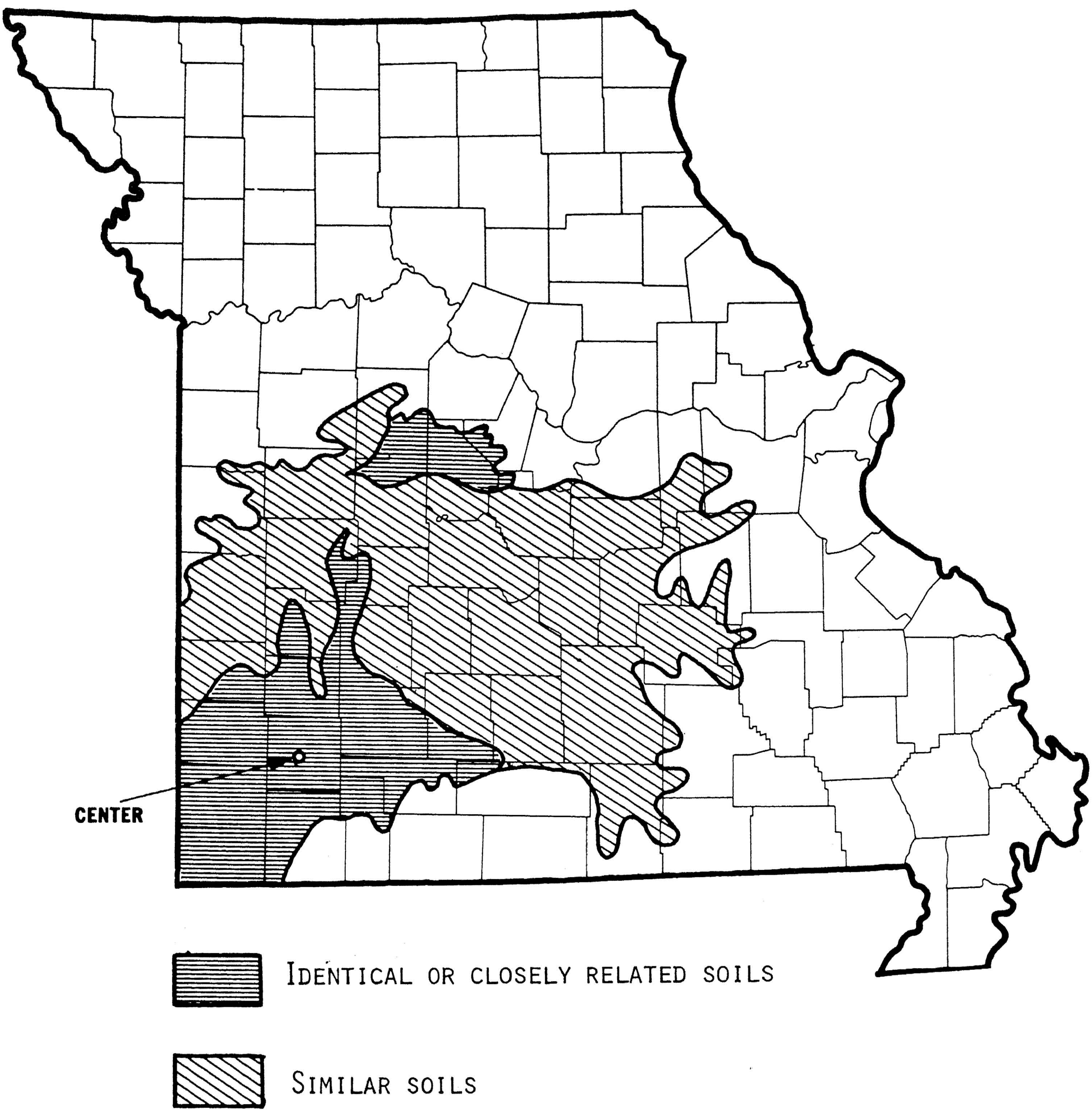
Three soils of the gently sloping prairie uplands were studied in detail. Those soils, named the Gerald, Creldon and Keeno form most of the landscape on the western portion of the lands of the Center. Those same soils are prominent parts of the landscape in that part of Missouri shown in Figure 1 to have identical or closely related soils.

Gerald, Creldon, Keeno Soils

This group of soils forms a pattern (called a soil association) in which the Gerald is positioned on nearly level to depressional parts of the landscape. The Creldon and Keeno soils are on slopes with gradients of 2 to 12 percent. Within the association there are several features that are important in soil-plant relationships. Those special features are:

Figure 1.

Missouri Areas with Similar Soil Conditions to Those of the University of Missouri-Columbia Southwest Center.



Claypans	-	Subsoils with high clay content - a feature of Gerald soils.
Fragipans	-	Dense and compact layers in lower subsoils - a feature in all three soils
Cherty Layers	-	Layers with 10 to 80 percent of the volume made up of coarse chert - a feature of Creldon and Keeno.
Acid, Infertile Subsoils	-	pH of 4.0 or less; low phosphorus and potassium - a feature of all three soils.

Plant root penetration and function may be affected by the special soil features in three ways; (1) water storage capacities are affected, (2) densities of fragipans are great enough to retard root penetration and (3) the pH of the subsoils is low enough to suggest a possible interference from aluminum, manganese and other elements in the chemical nutrition of the roots.

Plant Available Water Storage Capacities

The amount of water which the soils can store and release to growing plants is greatly affected by volumes of coarse chert which retain little or no water and by fragipans which have low pore volumes for water retention. Volumes of available water for the different soil layers are tabulated in Table 1. The volumes vary from 3 percent to 20 percent of the soil volume. When those volumes are converted to inches of water in given depths of soils they are as follows:

Soil	Plant Available Water Storage	
	(in 3 ft soil)	(in 4 ft soil)
Gerald	5.4 inches	6.9 inches
Creldon	4.8	5.5
Keeno	3.5	3.9

The estimates of available water are based upon the assumption that roots can penetrate and function well to depths of three and four feet. It may be that the physical and chemical nature of the fragipan prevents some penetration and thus not all of the water may be truly available.

Densities of Fragipans

Data included in Table 1 show that the fragipan layers are compacted to densities of 1.55 grams/cc. Some more strongly expressed fragipans in the Missouri Ozarks may have densities as high as 1.8 grams/cc. Thus the fragipans are not as dense in the Gerald, Creldon, Keeno soils as they are in some soils in Missouri. Even so a density of 1.55 indicated a soil with only 40 percent pore space for retention of water and for root penetration. Root penetration is generally believed to be retarded at densities greater than 1.5.

Subsoil pH or Acidity

Data included in Table 1 show that minimum pH values exist in the fragipans of the Creldon and Keeno soils where minimum values are pH 3.65 and pH 3.95. Such values are extremely low. Research has not been performed to demonstrate impeded root growth in these soils associated with low pH. However, they are in the range at which aluminum and manganese toxicities are possible.

Phosphorus levels of the subsoils are extremely low. Test values of 6 to 18 pounds per acre 7 inches of soil are common. Similar depths in many northern Missouri soils have phosphorus test values of over 200 pounds per acre seven inches of soil. Potassium and calcium levels are also low.

Possible Remedies for Subsoil Features

Research may be needed to determine the effects upon root penetration that will result from physical and chemical alterations of the fragipan. Conventional methods cannot be employed. However, the fragipan layers could be mechanically broken by chiseling or they could be mechanically mixed with overlying or underlying horizons having more clay. For example, if the claypan horizon of the Gerald could be mechanically mixed with the upper one foot of the underlying fragipan, the resulting mixture would have a clay content of 36 percent. Swelling and shrinking of the clay would prevent reformation of the dense fragipan. The available water holding capacity of the upper 3 feet of soil would be increased by about ten percent.

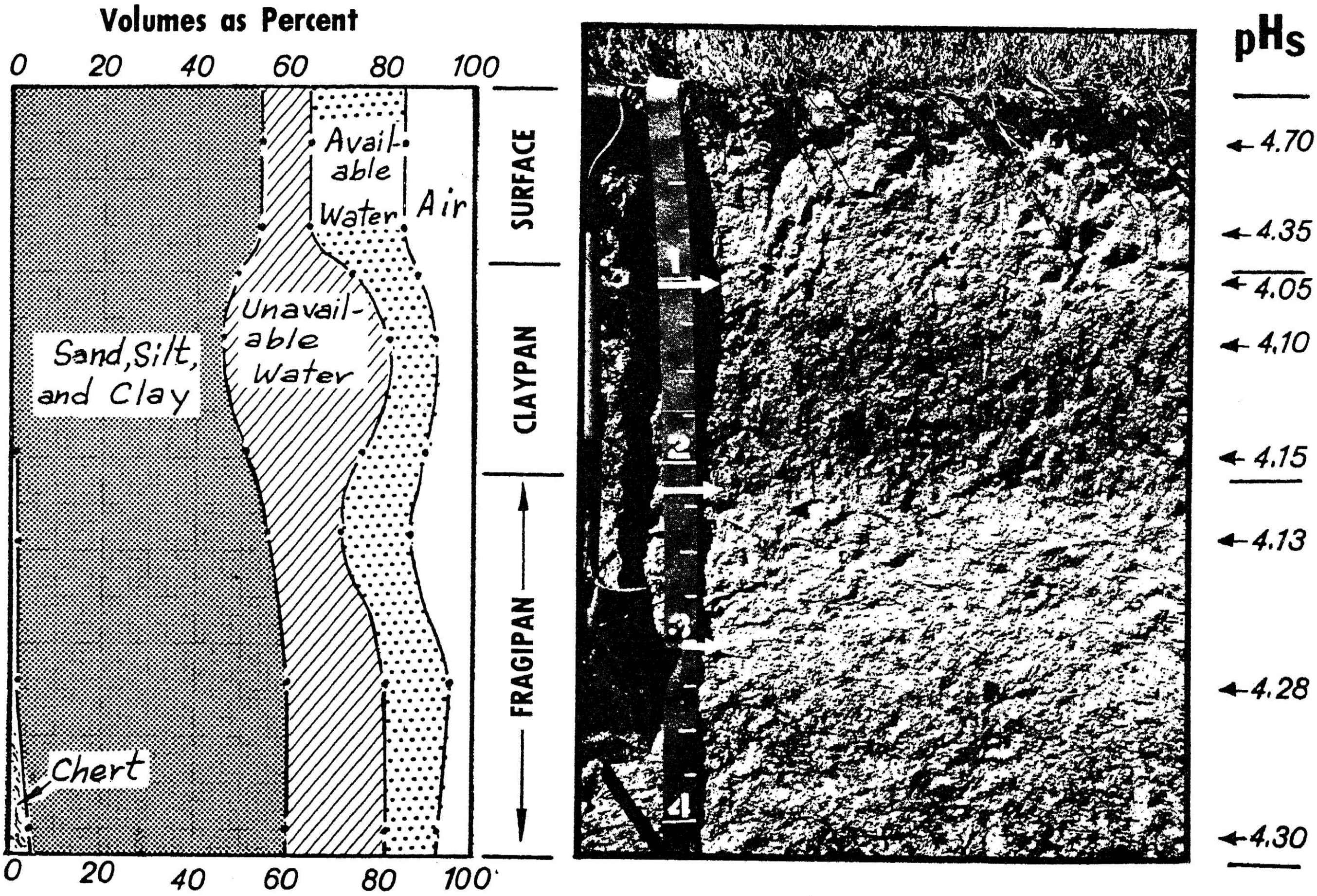
Liming of the subsoils concurrent with mechanical mixing or chiseling might raise the subsoil pH above a critical level and thus encourage root penetration.

The Creldon and Keeno soils could possibly be greatly charged by the above procedures. The fragipans are thin the underlying materials have low densities and slightly higher pH's. Thus the destruction of the rooting barrier presented by the fragipan might result in a greatly enlarged rooting volume extending well below the present bottom of the fragipan.

Figure 2.

GERALD SOIL

UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Gerald soils have dark colored, silty surface horizons underlain by claypan horizons which have as much as 50 to 60 percent clay sized particles. They have fragipans (dense acid layers) below the claypan. Some small chert fragments are scattered throughout materials below the claypan and at some depth (usually over four feet) red cherty clay materials are found. The silty surface soil and the claypan are thought to have formed in a silty, wind laid deposit called loess. The cherty materials formed as the result of weathering of cherty limestones which underlay the soil areas.

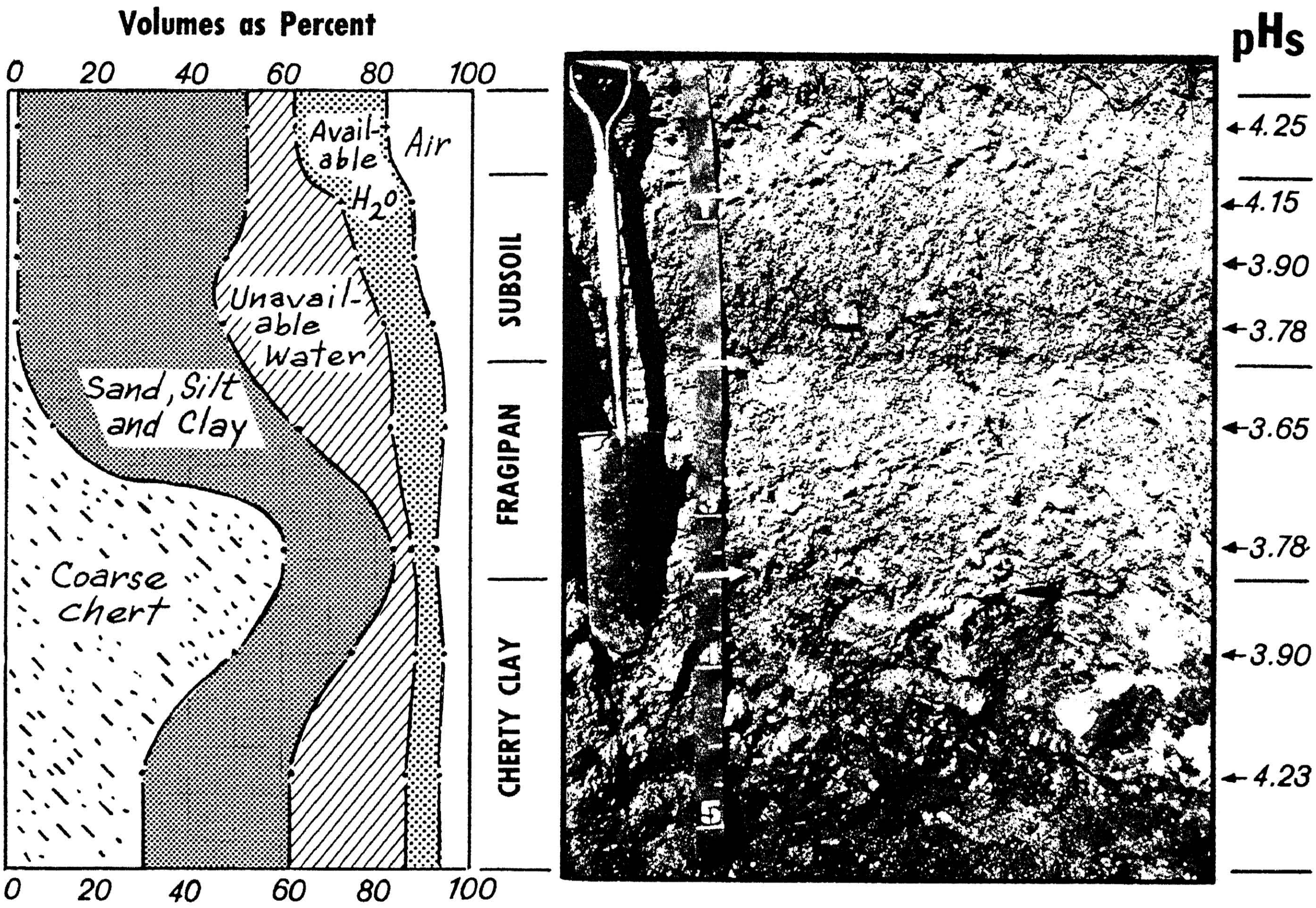
The claypan horizon retains large volumes of unavailable water and causes some restriction in drainage and aeration in spring months. The fragipan horizon is not as dense as those of the central and eastern ozarks. However, density of 1.55 grams/cc. is enough to impede root penetration. The fragipan horizon is not present in other claypan soils north of the Gerald areas.

Available water storage capacities are moderate, being 5.4 inches in 3 feet of soil or 6.9 inches in 4 feet of soil.

Figure 3.

CRELDON SOIL

UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Creldon soils have dark silty surface soils and brown, silty clay subsoils that are underlain by dense, cherty fragipan layers. Volumes of coarse fragments and the dense fragipan, severely limit volumes for penetration of air, water and roots below two feet depth.

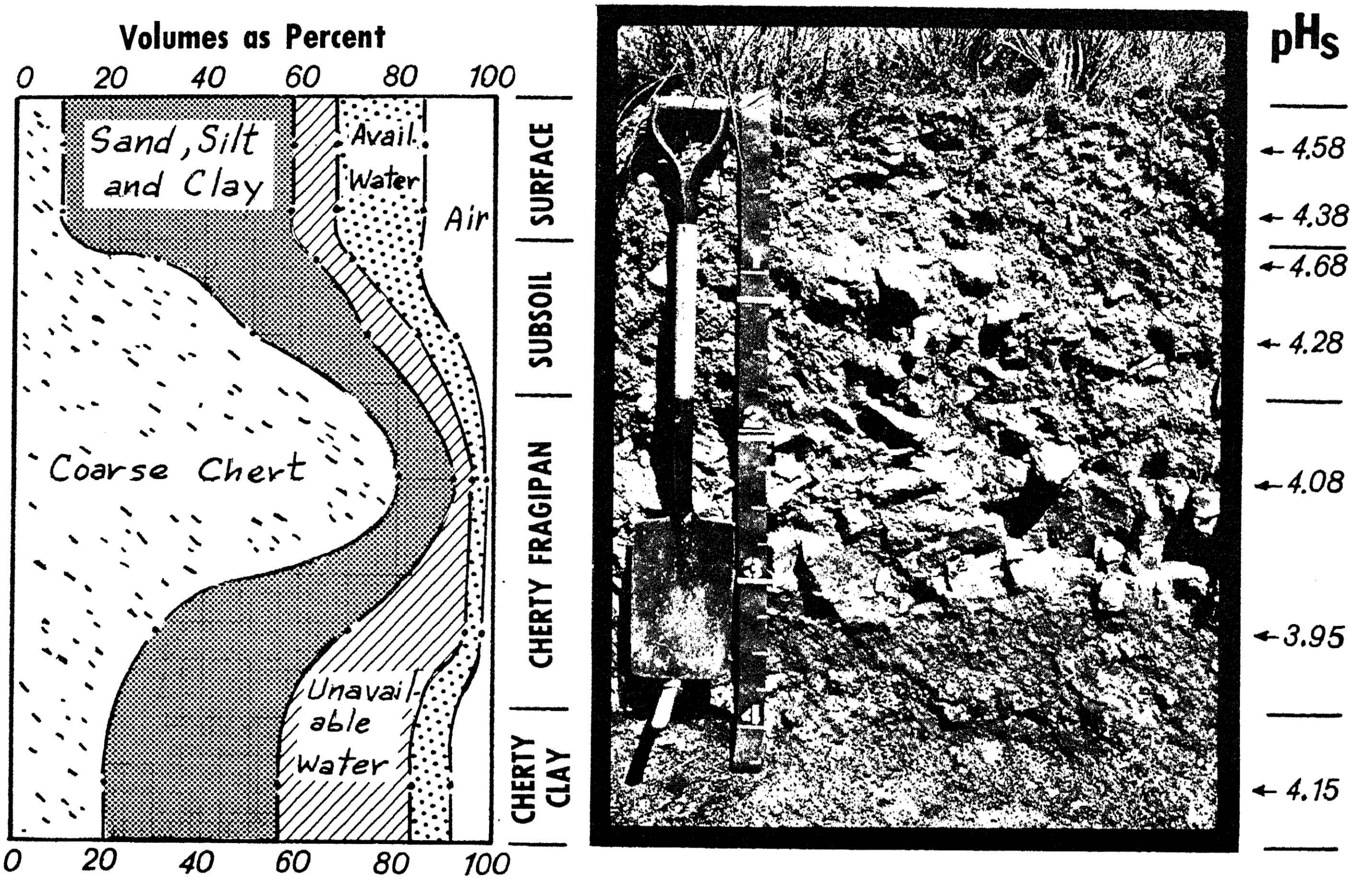
Available water storage capacity is 4.8 inches of water in 3 feet of soil and 5.5 inches of water in 4 feet of soil. These low capacities result in early drought damage to crops during periods of rainfall shortage.

The fragipan and subsoil are extremely acid and may present chemical barriers to root penetration.

Some of the Creldon soils on Southwest Research Center lands are slightly less well drained than is typical for the soil in other parts of Missouri.

Figure 4.

KEENO SOIL
UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Keeno soils are characterized by large volumes of chert. They have dark-colored cherty silt loam surface horizons and have cherty fragipans at two to three feet depth.

Available water storage capacities are low being 3.5 inches of water in 3 feet of soil and 3.9 inches of water in 4 feet of soil.

The cherty fragipan is extremely acid and the root environment in that layer is poor both chemically and physically. Materials below the fragipan are red cherty clays with moderate to low densities and they are less acid than the overlying fragipan.

Cherty limestone underlies the soil at variable depths.

Table 1. Some characteristics of Three Soils - University of Missouri Southwest Center

Soil Name	Depth (inches)	Nature of Fine Earth (Total Soil Minus Coarse Chert)			Volumes of Solids and Water (Percent of Total Soil)				
		pH_s	Clay Content (%)	Bulk Density (%)	Coarse Chert (%)	Sand, Silt and Clay (%)	Water 1/3 Atm.* (%)	Water 15 Atm.* (%)	Water Avail.* (%)
Gerald	0- 7	4.70	13	1.44	0	54	30	10	20
	7-11	4.35	15	1.42	0	54	30	10	20
	11-13	4.05	39	1.30*	0	49	38	24	14
	13-22	4.10	55	1.21	0	46	45	35	10
	22-25	4.15	35	1.32	1	50	38	24	14
	25-33	4.13	19	1.46	2	54	30	15	15
	33-44	4.28	29	1.55	2	58	34	21	13
	44-52	4.30	27	1.53	5	55	32	21	11
	52-62	4.40	32	1.51	10	51	28	20	8
Creldon	0- 7	4.25	15	1.36	2	50	30	10	20
	7-12	4.15	33	1.34	2	50	36	20	16
	12-16	3.90	40	1.24	2	46	40	28	12
	16-22	3.78	53	1.22	2	45	45	35	10
	22-34	3.65	32	1.55	10	53	32	20	12
	34-41	3.78	24	1.55*	60	24	9	4	5
	41-51	3.90	50	1.30*	50	25	20	14	6
	51-62	4.23	88	1.21	30	32	32	25	7
Keeno	0- 7	4.58	20	1.40*	10	48	27	9	18
	7-11	4.38	24	1.40*	10	48	27	9	18
	11-14	4.68	23	1.24*	30	33	21	7	14
	14-23	4.28	29	1.24*	50	24	18	10	8
	23-35	4.08	27	1.55*	80	12	7	4	3
	35-47	3.95	65	1.50*	30	40	28	25	3
	47-58	4.15	73	1.20*	20	36	36	28	8

*Estimated values

WALNUT MULTI-CROP DEMONSTRATION

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Missouri is a leading state in the production of black walnut wood and nut products. Much of this production has come from prarie and row-crop situations. With increasing demands for walnut and decreasing supplies, black walnut values have risen and offer opportunities for supplemental farm income. Management systems are being developed to allow management of walnut trees in conjunction with other cropping systems.

In a cooperative project, the Hammons Walnut Products Company of Stockton, Missouri, the Forestry Division of the Missouri Department of Conservation and the University of Missouri School of Forestry, Fisheries and Wildlife established a 160 tree demonstration planting, in fescue pasture, on the Southwest Missouri Center in the spring of 1975.

The planting was made with tree rows spaced 35 feet apart and with the trees 12.5 feet apart within the row. This spacing allows some future selectivity among trees but allows haying or future grazing between the rows.

Genetically superior walnut seed sources were used, chemical weed and grass control was applied around the seedling and a fescue hay crop will be periodically removed from the demonstration area.

In addition to the demonstration value of the project the area will serve to provide data about the compatibility of walnut and fescue and on the survival and growth of the superior seed sources.

In spite of a very dry period during the summer and moderate defoliation by grasshoppers, survival on the plantation at the end of the first growing season was 96 percent.

On April 25th 1976 (second growing season) a killing frost destroyed most of the leaves on all the seedlings. The trees made a good recovery and at the end of the second growing season the plantation still had 87 percent of its trees surviving. As a result of the freeze many multiple stems occurred and the need for corrective pruning is developing. Also some evidence of saprophytic fungi have appeared on the stems of some of the walnut seedlings.

Chemical weed control was applied around the seedlings in late April 1977 (third growing season). The plot was also fertilized in March. The first cutting of fescue hay yielded 135 bales on 1.6 acres.

VARIATION IN SUSCEPTIBILITY TO NEEDLECAST DISEASE AMONG PONDEROSA PINE PROVENANCES

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Abstract: In a 79-origin provenance test of ponderosa pine, trees grown from Northern Rocky Mountain and Northwestern seeds are being severely damaged or destroyed by needlecast disease. Trees of Southwestern origin are displaying high resistance. More erratic results are being obtained with seeds collected in other parts of the natural range of this racially diversified pine.

Numerous plantings of ponderosa pine (*Pinus ponderosa* Laws.) in Missouri, dating back into the 1930's, have produced highly variable results. One striking difference among plantations has been the degree of susceptibility to needlecast disease. Contrasts in morphological traits between susceptible and resistant trees suggest strong racially based differences within the ponderosa pine species, but these early planting trials were not designed to provide valid evidence in this direction. Any one test did not include seedlings from more than one lot of nursery stock. Also, seed origin, if known, was not recorded.

The ponderosa pine planting at Southwest Center and a similar one in central Missouri are parts of a widespread interstate study in the North Central Region. For the first time a broadly based experiment is providing ample opportunity to determine the extent to which genetics and environment, acting separately or in concert, contribute to the variable results that have been obtained with ponderosa pine in Missouri during a span of four decades.

Establishment details have been given in an earlier report. Briefly, the plantation includes stocks representing 79 provenances (locales of natural seed origin). Fourteen western states are represented in the collection. Each seed source is amply replicated in a completely randomized block comprised of 648 plots of four trees each. An additional 164 plots make up a border that isolates the main block from edge effects. Date of planting was April, 1968.

After ten growing seasons in the field, there is a strong contrast among the plots (and to a less degree within plots) in the severity of needlecast damage. Careful study of this problem was begun in March, 1977, and will continue into at least 1978.

What had been considered the inroads of a single pathogen has been found to be a more complex problem. From damaged needle tissues have been cultured three needlecast fungi: *Scirrhia acicola* (Dearn.) Siggers, brown spot; *Lophodermium pinastri* (Schrad.) Chev., Lophodermium needlecast; and a *Naemacyclus* sp. tentatively identified as *N. niveus* (Pers. ex Fr.) Sacc., Naemacyclus needlecast. These have been listed in what appears to be a decreasing order of severity.

Naemacyclus injury appears to be of inconsequential proportions. At mid-season it was difficult to assess the relative levels of attack by the Scirrhia and Lophodermium organisms. A sudden increase in damage since early July, however, has been shown through repeated cultures to be attributable to brown spot. Moreover, this recent attack has been on the current year (1977) crop of needles of the more vulnerable provenances. This is needlecast disease in its most serious dimensions. As long as damage is restricted to foliage developed two and three seasons back (presently the extent of attack on most provenances at Southwest Center), mortality will not result.

Some trees have already been killed among the most sensitive origins -- those from Montana, Idaho, Oregon, and Washington. At the other end of the spectrum, high levels of resistance that approach complete immunity are being realized among sources from Arizona and New Mexico. Materials from elsewhere are producing erratic results with a range in damage from serious to very light but mostly intermediate.

Although there is obviously a wide range of genetic variation in susceptibility to needlecast injury, it is equally clear that the extent of damage can be tempered or accentuated in varying degree through genetic-environment interaction. Trees that are resistant in one environment may be susceptible in another and vice versa. Prevailing weather is a factor. The problem has been observed to flare up during periods of prolonged wetness and then virtually disappear during times of drouth. In a given climatic zone, however, it seems highly improbable that sources (races) remaining healthy when grown amid severely infested trees will become vulnerable in a serious degree. Selection for resistance, environmental interaction notwithstanding, can be very effective in eliminating the needlecast problem.

SOUTHWEST CENTER SWINE EVALUATION STATION

by
John C. Rea, Keith Leavitt, Department of Animal Husbandry,
and Eldon Cole, Area Extension Livestock Specialist

In 1977, 188 boars were tested through the facility at the Southwest Center Swine Evaluation Station. Since the establishment of the swine test station, 570 boars have been evaluated.

The evaluation station was established through the efforts of concerned swine producers in the area in cooperation with Agri-Businesses throughout Southwest Missouri. It includes 30 pens, with a lagoon, service building and boar testing equipment. The day-to-day management of the test station is under the supervision of Don Kleiboecker of the Southwest Center staff, with consultation from Keith Leavitt of the University of Missouri-Columbia.

Sales in 1977 were held on January 15, February 19, July 22, and August 18. Animals meeting the standards set up by an advisory group are eligible for sale. About 70% of the boars that go on test, qualify for sale. Boars are rated on the traits of average daily gain and feed efficiency and must meet certain criteria on carcass measurements which include backfat and lioneye area. The average performance and range for each trait for the 570 boars that have been on test are included in the following table.

Boar Data for Southwest Center Swine Evaluation Station (1975-1977)

Trait	Average	Range
Av. daily gain (lbs)	2.01	1.40-2.60
Feed/lb gain (lb)	2.66	2.35-3.18
Backfat (in)	.78	.60-1.07
Loineye area (sq in)	5.86	5.00-6.86

There have been eleven performance tested sales held since the test station was built. Four-hundred five boars have been sold for a total of $115,721, for an average of

$286 per head. A high percent of boars sold stayed in Southwest Missouri. Slightly over 10% of the boars have been going out of state. Some of these have been top sellers in the sales. Prices have ranged from $150 to $700 per boar. All costs of the test are paid by the breeders.

In addition to the individual data on boars, a pen index system has been used this year. The index places approximately equal emphasis on feed efficiency, backfat, and rate of gain. Buyers can use the index as one method of evaluating a pig. The index is calculated as follows:

Index - 100 + 60 (DG-ADG) - 75 (FG-AFG) - 70 (BF-ABF)

In addition, a ratio is calculated to allow buyers to determine the performance of an individual boar in relation to the average of all boars on the test.

A top health program is in effect at the Southwest Center. Boars are vaccinated for Erysipelas and Leptospirosis. Boars prior to sale have been blood tested and found to be negative for Brucellosis, Pseudorabies, and Leptospirosis. Sanitation is stressed at the testing station with foot baths and other means to cut down on chances of boars contacting a disease.

The central test station in this area continues to be of value, both to breeders and buyers. It allows breeders to obtain an evaluation of their animals under a standard environment. It also provides a regulated source of tested boars for Southwest Missouri commercial producers to use in improving performance of both feeder pigs and slaughter weight hogs.

FESCUE FOOT RESEARCH

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Shelly Yates
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Toxic fall grown fescue hay has been routinely produced by applying 300# Nitrogen per acre in Aug-Sept. and harvesting in December. Extracts of the toxic hay have been chemically fractionated and the fractions infused into cattle. One fraction, the acid portion (anions), has caused fescue foot symptoms in the cattle. Further chemical fractionation is underway to identify the toxic principle and the source of production.

"Fescue foot" was reported in New Zealand scientific journals in 1949. It was identified in Missouri in 1954. Since the symptom in cattle are similar to ergot poisioning both farmers and scientist have thought the cause to be due to a fungus growing on the plant. A systemic fungus, Epichloe typhina, is under investigation in Georgia and Kentucky, however, it has not been directly associated with cattle trials to date. We will be checking our experimental pastures this fall to see if the fungus is present and if it is present, in only toxic pastures. To date there is no definitive research data proving a fungal cause.

If fungi are not responsible for Fescue Foot, then we are faced with the fact that the causative agent is plant produced. Several years ago, we decided to attempt the chemical isolation of the toxin and then search for the site of production (fungus or plant). Our procedure is briefly described in the next two paragraphs. The reader will appreciate the fact that large amounts of hay & extracts of large volume are necessary for cattle trials since all attempts to use laboratory animal assays have failed.

Fescue pastures are fertilized with 150# N/A in early August and again in early September. The fall growth is harvested as hay in December, dried in a wagon dryer, baled and shipped to the Northern Regional Laboratory, USDA, Peoria, Ill. for extraction. Extraction is carried out by soaking 200# of chopped hay in 80% alcohol. This requires a 800 gal. fermentor with an agitator. After 24-36 hours of soaking, the alcohol is removed and the process repeated on the hay residue. The alcohol from both extractions are combined and diluted to 50-55% alcohol with water. The alcohol is returned to a clean fermentor where it is mixed with a cation exchange resin to remove the mineral, some amino acids and alkaloids. In this step the chlorophyl is precipated or floculated. The resulting clear liquid (after filtration) is passed thru an anion exchanger. The sugars pass thru and the acid portion is retained on the column of anion exchanger. After washing, the anion column is eluted with formic acid. The formic acid solution is evaporated in a manner that both concentrates and removes the formic acid. The anion (acid) concentrate is adjusted to a pH 7.2, sterilized and bottled in daily dose amounts for the infusion into cattle.

Experimental cattle are from the Forage System Research Center and weigh about 450#. They are acclimated to an alfalfa wafer diet and to restraint in stanchions. Surgically a catheter is inserted into the peritoneal cavity to allow the infusion of 1 liter of extract or saline solution per day. This infusion requires about two hours each day. Animals are observed daily for signs of lameness, roughened hair, coat, rectal temperature and tail necrosis. By using thermography (infra-red pictures of the hoof region), we have a more objective measure of the effect of the extracts and a permanent record (picture) is made. Affected cattle are necrospied and the tissues examined.

Results of 1976-77 trial:

Extract Infused	Fescue Symptoms	Comments
Saline Control	Negative	
Total Anion		
Ky - 31	Positive	Hay grown in Columbia
Kenhy	Positive	Hay supplied by Dr. Robert Buckner, Univ. of Ky.
Gradient Elution of Anions		
0.1N Formic Acid	Positive	Hay grown in Columbia
1.0N " "	Positive (less than 0.1N)	" " " "
6.0N " "	Negative	" " " "

In previous years, we have shown the toxin which produces fescue foot in cattle is in the anion fraction. The significance of this years results is the new variety "Kenhy" being released by Kentucky has the potential to produce "fescue foot" as measured by the infusion method described. We will be field testing "Kenhy" with winter grazing here at Southwest Center this winter (Jan. '78) and next year at Columbia.

The gradient elution results are of importance to us in chemical fraction as we try to identify the chemical cause. For more details and practical recommendations, see UMC Guide 2100, "Fescue Foot".

BIRDSFOOT TREFOIL MANAGEMENT

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Department of Agronomy

Abstract: Trefoil produced more forage and was more persistent at pHs levels above 5.3 than at pHs 4.7. Raising pHs with lime did not improve establishment, however, and also did not affect the amount of phosphorus available for plant growth. Trefoil reached 95% of maximum yield at soil phosphorus levels of about 60 lbs/A. Increasing phosphorus level above 100 lbs/A tended to decrease trefoil persistence due to increased competition from invading weeds.

Trefoil has persisted satisfactorily in mixtures with orchardgrass, but cutting frequency affects productivity of the mixture and the amount of trefoil present. Cutting trefoil during the critical fall period appears to decrease the following spring yield.

An experiment was established in the spring of 1972 to determine levels of lime and phosphorus that are necessary for successful establishment and growth of trefoil. Other research has shown that trefoil does not require as much lime (to raise pHs) as alfalfa for optimum growth. Upland soils in Southwest Missouri naturally have a low pHs and often are very low in phosphorus. While many grasses may grow fairly well with low levels of phosphorus, legumes usually have higher requirements. We were hopeful that our data would give insight into the necessary soil treatments for interseeding or renovation of grass pastures with trefoil. The first data was taken in 1973 and is being continued at present.

Different pHs levels (Table 1) were achieved by adding 0, 2, or 4 tons/A of dolomitic limestone. Within each pHs level eight phosphorus (P) levels (Table 2) were established. Phosphorus was plowed down in spring, 1972, and starter treatments were banded at seeding on April 12. Phosphorus topdressing treatments began in late summer, 1972, and have been repeated annually. All plots also received 100 pounds of potash (K) in late summer annually, beginning in 1972. Plots were harvested three times during each of 1973, 1974, 1975, and 1976.

Table 1. Effect of soil acidity (pHs) on soil test levels (lb/A) of K and yield (T/A) of birdsfoot trefoil. P_2 was not affected by pHs and averaged 178, 165, and 139 lb/A for 1973, 1974, and 1975 respectively.

	1973		1974		1975		1976	
pHs	K	Yield	K	Yield	K	Yield	K	Yield
4.7	187	2.45	211	2.48	250	1.39	310	1.36
5.3	181	2.58	189	2.62	225	1.47	272	1.55
5.7	167	2.61	183	2.66	220	1.46	259	1.59
L.S.D.*0.1	14	0.10	17	0.11	20	ns	28	.13

*For statistical purposes values exceeding this level are considered to be significantly different. ns means not significant.

Table 2. Soil test values following phosphorus treatments. Plowdown and starter were begun in spring, 1972, and annual topdressing treatments were begun in fall, 1972.

Treatments Lbs P/Acre			P_2 Soil Test Level Lbs/Acre			
Plowdown	Starter	Topdress	1973	1974	1975	1976
0	0	0	37	33	33	22
0	0	50	46	70	77	83
0	50	0	51	42	33	26
0	50	50	76	110	112	96
150	50	0	151	143	92	59
150	50	50	200	249	233	213
300	50	0	270	316	170	154
300	50	50	289	361	364	319

Excellent stands of Dawn birdsfoot trefoil were obtained under all fertility and lime treatments. Apparently birdsfoot trefoil may be established under considerably lower soil pHs and phosphorus levels than alfalfa.

There was no pHs by phosphorus interaction on total yield per season or on Bray's P_2 test, so data were averaged over pHs levels. Table 1 shows that lime applications significantly raised pHs, but did not significantly change the P_2 test. Even so, yield at pHs 4.7 was significantly lower in 3 of 4 years than at the higher pHs levels. These data suggest that trefoil responds to lime applications up to pHs levels of 5.3 to 5.4.

Lime applications significantly affected the K test level in all 4 years (Table 1). Original K level in the soil was 195 lbs/A and pHs was 4.6.

K level is tending to increase with time at all pHs levels indicating that the 100 lb/A topdressing is greater than the amount removed by the crop. Trefoil yields were probably not limited by K level as Dr. T. R. Fisher (Mo. Agr. Exp. Sta. Bull. 1007) reported that an alfalfa-grass mixture reached 100% of yield potential at K levels of about 160 lbs/A.

Phosphorus soil test levels were greatly affected by P applications (Table 2). Even those plots receiving no P treatment are testing higher now than the 13 lbs/A before the native vegetation was plowed. Except where high rates of plowdown P were used, soil test value for Bray's P_2 test are decreasing when no annual topdressing is added. Topdressing annually with P has caused an increased soil test level in all cases which suggests that annual removal was less than 50 lbs/A.

Forage yield was related to Bray's P_2 soil test level and is shown in Figure 1. For more accurate interpretation all data within each year was transferred to a percentage basis. Using combined data, 95% of maximum yield level occurred at a P_2 level of about 60 lbs/A. Yield levels of 95% of maximum are more economic than 100%, as it would take almost 50 lbs/A more on the P_2 test to produce the last 265 lbs/A of forage to achieve the 100% yield.

First harvests for 1975 and 1976 were taken about May 15. We were particularly interested in weed invasion into the plots, and so separated harvested samples into trefoil and weed components. Interactions between soil pHs and P_2 level were not significant for yield or botanical composition so data for each factor were averaged over the other variable. However, P_2 levels up to about 100 lbs/A increased the trefoil component (Figure 2).

Weed invasion was significantly higher at pHs 4.7 as 51% of the yield consisted of winter annual weeds and cool-season grasses while both of the other lime levels had only about 41% of invading species. Evidently lime treatment increased vigor of trefoil enough to offer more competition to invading weeds and grasses. This was apparently also reflected in higher seasonal yields (Table 1) when lime was added to raise pHs.

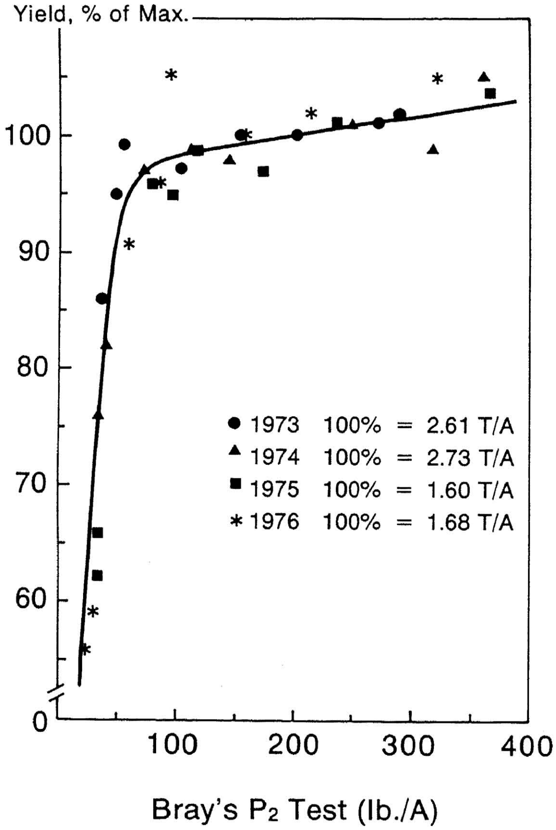

Figure 1. Forage yield of birdsfoot trefoil as affected by soil level of P.

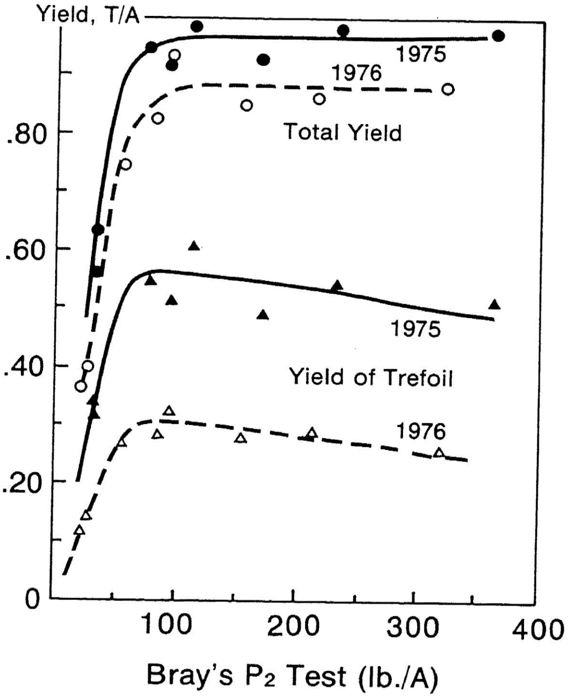

Figure 2. Yield of total forage and trefoil only in first cutting as affected by soil level of P.

Another experiment was designed to measure the ability of Dawn birdsfoot trefoil to yield and persist under different cutting managements. It is recognized that trefoil is much better adapted to frequent defoliation (similar to continuous grazing) than is alfalfa or other upright legumes providing some green leaf area remains to provide photosynthate to support the plant during regrowth. This characteristic, coupled with a natural reseeding habit, makes trefoil one of the best adapted legumes available for grass mixtures in pastures.

Stands of trefoil and trefoil-orchardgrass were established in April, 1972, and treatments were imposed beginning in spring 1973. Plots were topdressed annually with 0-75-240 to insure that adequate P and K were available. Orchardgrass was seeded in half the plots as grasses may actually aid persistence of legumes by providing a mulch-like canopy in winter and also aid in preventing weed invasion.

Cutting treatment and forage yields of trefoil grown alone are shown in Table 3. A wide range in yield occurred in 1973 which often happens during the first treatment season. Weed invasion was minimal, the trefoil plants were young and vigorous, and the effects of the treatments had not begun to have a great effect.

Table 3. Cutting frequencies and yield response of birdsfoot trefoil seeded in spring, 1972.

Cutting Treatment	Code	Forage yield T/A 1973	1974	1975	1976
May 1, then every 15 days to Sept. 1	15 - FC	1.98	2.18	1.30	1.24
May 1, then every 15 days to Oct. 15	15 + FC	2.32	2.22	1.22	1.17
May 15, then every 30 days to Sept. 1	30 - FC	2.08	2.58	1.70	2.31
May 15, then every 30 days to Oct. 15	30 + FC	2.70	2.67	1.67	2.11
May 30, then every 45 days to Sept. 1	45 - FC	2.64	2.45	1.88	2.17
May 30, then every 45 days to Oct. 15	45 + FC	3.68	3.13	2.36	2.34
L.S.D. (0.05)		0.17	0.15	0.13	0.31

In general, plants cut less frequently had the highest yield as less time was spent in the slower growth rate periods following cutting. Fall cutting in 1973 during the normal critical period of September 1 to October 15 increased yield in all three basic cutting managements. During 1974, treatment effects began to show up as the range in yield was decreased and particularly at frequent cutting. During 1975 and 1976 yield was lower where cutting occurred during the critical fall period. Previous research by Dr. A. G. Matches, ARS, USDA, and the University of Missouri has shown that vigor and persistence of trefoil cut infrequently is often reduced. In our experiments treatments cut every 15 days or 30 days retained their productivity indicating that birdsfoot trefoil is adapted to more frequent defoliation. During 1975 we noticed a great deal of weed invasion into plots cut infrequently where trefoil was seeded alone.

Table 4 shows the effects of the same treatments as in Table 3 on a birdsfoot trefoil mixture with orchardgrass. Orchardgrass has many desirable features for growing in mixtures with trefoil, and especially its upright growth habit and lessened sod-forming characters. Yields of the mixture were slightly lower than for trefoil grown alone (Table 3) but showed a similar relationship between 1973 and 1974. During 1975 and 1976 the mixture outyielded trefoil alone in most treatments.

Of greater interest though is the persistence of trefoil in the mixture. Herein both the natural ability of trefoil plants to avoid stress and their reseeding ability are of concern. During 1973, those plots cut every 15 days retained a high level of trefoil in the mixture (near 60%) while under the 30 day management the percentage was reduced. Trefoil percentage was highest in the 45 day treatment. During 1974, the trefoil component was reduced to about 35% of the mixture under the 15 day treatment, but remained higher (40-45%) in other treatments. Even though trefoil is more tolerant of frequent cutting than many other legumes the 15 day

Table 4. Response of birdsfoot trefoil-orchardgrass mixture to cutting treatments. Percentage trefoil in mixture was calculated from botanical separations for each cutting throughout the growing season.

	Yield (T/A)				% Trefoil			
Treatment	1973	1974	1975	1976	1973	1974	1975	1976
15 - FC	1.56	1.89	1.37	1.49	60.3	35.4	46.6	45.4
15 + FC	1.92	2.10	1.25	1.38	60.5	34.8	43.5	44.5
30 - FC	2.04	2.03	2.21	2.60	53.8	40.9	44.9	49.9
30 + FC	2.50	2.40	1.82	2.50	51.4	40.4	47.2	45.7
45 - FC	2.76	2.38	2.61	3.38	67.5	45.8	41.0	53.6
45 + FC	3.51	2.57	2.80	2.74	65.3	45.1	49.0	51.3
L.S.D. .05	0.17	0.15	.32	.60				
$\bar{x}$	2.38	2.23	2.01	2.35				

frequency was apparently affecting productivity. However, by 1975 when persistence was more dependent on reseeding, the trefoil percentage actually increased again with little difference between cutting treatments. That percentage trefoil also remained in 1976.

The natural reseeding habit of trefoil will have to be evaluated over several years. In order to get new seedlings established it is generally recognized that competition will need to be kept to a minimum. In that case once the original plants die, which may be sooner in the frequent cuttings, persistence will be totally dependent on getting some seed produced and having competition decreased enough to make natural reestablishment possible. In the latter case the more frequent cutting may compensate by allowing easier establishment to perpetuate the stand, even though seed yield may be lower than for other treatments.

The influence of fall management on ability to overwinter and subsequent spring production is of major concern in legume persistence. Table 5 shows the response of the trefoil-orchardgrass mixtures to fall cutting and yield the following spring. Comparisons should be made only for the influence of fall cutting within each cutting frequency. No management differences occurred during 1972, so spring 1973 yields as affected by fall cutting were not significantly different (ns). Even though half the plots were cut during fall, 1973 they still performed at the same level in spring, 1974, as their uncut counterparts. Treatments of cutting every 15 days gave three extra cuts during the critical fall growth period adding 0.29 T/A to the 1973 yield. The 30 day treatment was cut twice and added 0.31 T/A, and the 45 day treatment was cut only on October 16 and gave 0.72 T/A additional yield.

Table 5. Response of birdsfoot trefoil-orchardgrass mixture to fall cutting and subsequent spring cutting. Spring cuttings were on May 1-8, May 15, and June 1-3 of 15, 30, and 45 day treatments respectively. Yields are given in tons per acre.

Treatment	Fall 1973	Spring 1974	Fall 1974	Spring 1975	Fall 1975	Spring 1976	Fall 1976	Spring 1977
15 - FC	0	0.68	0	0.47	0	0.47	0	.53
15 + FC (3)	0.29	0.66	0.18	0.35	.18	0.26	0.02	.39
30 - FC	0	1.11	0	1.59	0	1.03	0	1.25
30 + FC (2)	0.31	1.04	0.24	1.02	.12	0.82	0.03	1.12
45 - FC	0	1.59	0	1.89	0	2.11	0	1.66
45 + FC (1)	0.72	1.54	0.16	1.86	.25	1.38	0.04	1.47
L.S.D. (0.05)	0.12	ns	0.06	0.20	.02	0.48	0.01	.31

Cutting during fall, 1974, also increased yield for the 1974 growing season with only a moderate effect on spring, 1975, growth. No significant difference occurred in the least or most frequent cutting, but spring yield was reduced by fall cutting in the 30 day frequency treatment. Contribution of fall growth to yield in 1976 was very small due to the dry weather. Even so, cutting had a detrimental effect on productivity in spring, 1977.

At each cutting the plants are not completely defoliated and leaf area was left to carry on photosynthesis to give the plant energy for regrowth. Again, the long range response of repeated cutting during the fall hardening period is not yet established. The influence of cutting on seedling development as the stands become more dependent on new seedlings will be critical. Therefore, these studies will become more valuable as dependence on reseeding for plant perpetuation becomes greater.

These data suggest that trefoil is adapted to more marginal soils in terms of pHs and phosphorus levels than we had anticipated and that both minimum and maximum phosphorus levels are experienced. If management systems for establishment and maintenance of trefoil in the stand are accepted, this legume could make an important contribution to the forage supply of South Missouri.

NITROGEN ASSIMILATION OF FORAGE LEGUMES

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Abstract: The nitrogen sources of field grown forage legumes were studied during two years. Red clover, white clover, alsike clover, ladino clover, birdsfoot trefoil, and alfalfa were established in the field and sampled during the seedling and second year of growth. Activity of nitrate reductase enzyme in leaves and roots, which is associated with nitrate uptake from the soil, and nitrogen fixation (acetylene reduction) from the air by nodules was measured. During the establishment year there was little difference between species except for birdsfoot trefoil which had about double the nitrogen fixation rate of the others throughout the season. There was an inverse relationship between activity of nitrate reductase and nitrogen fixation by nodules. Nitrogen fixation was reduced at high temperatures. Activity of nitrate reductase, which indicates uptake of nitrate from the soil, was high following rains in summer.

Nitrogen is an important part of protein, which is needed by both plants and animals. Air consists of 78% nitrogen, 21% oxygen, and about 1% of other gases including carbon dioxide. Forage legumes obtain a large portion of their nitrogen from the air. Nitrogen is fixed by an association between legumes and special bacteria called rhizobia which transform the inert nitrogen gas in the atmosphere into forms the plant can use. Inoculating legumes with rhizobia eliminates the need for nitrogen fertilization in legumes. In contrast forage grasses need manufactured nitrogen fertilizer. Using more legumes and legume-grass mixtures would save on cost of forage production to the farmer, as well as saving energy that would be used for manufacturing nitrogen fertilizer.

There are specific Rhizobium bacteria for each legume. Seeds of the legume crop to be planted are "inoculated" by coating the seed with a slurry or powder, containing rhizobia specific for that species. In order to fix nitrogen the bacteria first enter the small root hairs on the plant roots and form nodules. The nodule is a small sphere ranging in size from a pinhead to a small pea, and it is made of a root-like, callus material. The rhizobia then use energy from the plant to transform atmospheric nitrogen to a useable form.

Similar to other crop plants, forage legumes are able to utilize nitrates from the soil in addition to the nitrogen fixed from the air. Nitrate reductase is the plant enzyme which causes the first step in a chain of metabolic events by which nitrate from the soil is altered in the plant to make it useful for protein synthesis. The activity of the nitrate reductase enzyme is an indicator of the amount of nitrate taken up from the soil.

Both the reduction of nitrate from the soil and nitrogen fixation from the air are important systems for meeting the nitrogen needs of legume plants. If legume plants absorb enough nitrogen from the soil, they will more readily use the nitrate reductase system and will not fix very much from the air.

The data in table 1 are from an experiment in North Carolina where ladino clover was fertilized with several rates of nitrogen on February 24. The amount of nitrogen in the herbage harvested on March 17 that was obtained by fixation by nodules was decreased as N rate increased. This trend continued in the April 21 and May 16 harvests, but the influence of fertilizer application became less and less as that source of nitrogen was nearing depletion.

Table 1. Effect of applied nitrogen (N) upon N fixed from atmosphere in established ladino clover, North Carolina Agric. Exp. Sta. Bull. 383. Remainder of N was assumed to come from soil nitrate.

N applied Feb. 24 (lbs/acre)	Percent of total N in herbage fixed from air		
	March 17	April 21	May 16
25	65	91	92
50	42	87	87
100	25	75	87
200	10	43	75

The balance in the plant between nitrogen fixation from the air and nitrate utilized from the soil also depends on soil moisture content, and temperature. This study was designed to determine how soil moisture content and temperature affected the two nitrogen systems in six forage legumes.

Plants were established in two replications on a Mexico silt loam soil at the Agronomy Research Center near Columbia. Wheat had been grown the previous year with no fertilizer application. White clover, red clover, ladino clover, alsike clover, alfalfa, and birdsfoot trefoil were inoculated with their specific Rhizobium and planted on May 10, 1975. Seeds were planted in 18 cm (6") rows on conventional tilled soil. Plants were sampled beginning May 28 to study both nitrogen fixation from the air and the activity of nitrate reductase enzyme in the roots and leaves.

Nitrogen fixation was estimated by incubating roots that had been removed from the soil with nodules intact with acetylene gas in pint jars. In this technique acetylene gas is converted to ethylene gas by the rhizobia in the nodules at a rate proportional to that of nitrogen being fixed. Working with acetylene is cheaper, faster, and easier than with the special nitrogen gas that would be needed, and at the same time is very accurate. Therefore "acetylene reduction" has become a standard assay for estimating nitrogen fixation. Units of nitrogen (acetylene) fixed were expressed on both a per unit weight of tissue sampled and per unit volume of soil sampled basis.

Activity of nitrate reductase enzyme was estimated separately on roots and leaves. Tissue was diced and placed into solutions containing nitrate. In this assay the enzyme in the diced tissue converts the nitrate in the solution into nitrite. After 1 hour at 25 C the reaction was stopped and the concentration of nitrite was measured. Activity was expressed as units of nitrite produced per unit dry weight of tissue.

RESULTS

<u>Seedling Year</u>

During the seedling year there was little difference in activity of nitrate reductase (N.R.) among species, and thus for both roots and leaves the data were combined over species (Figure 1). The highest activity was during spring and fall, while activity was low when growth was slow during summer. A small increase in activity also occurred following cutting in mid-July. Activity of N.R. in roots and leaves increased after rains in June and August which indicated that the plants were using nitrogen from the soil during that time.

During July and August when air temperature were high, the activity of N.R. in leaves was low suggesting that nitrate utilization from the soil was lower when temperatures were high and growth was slow.

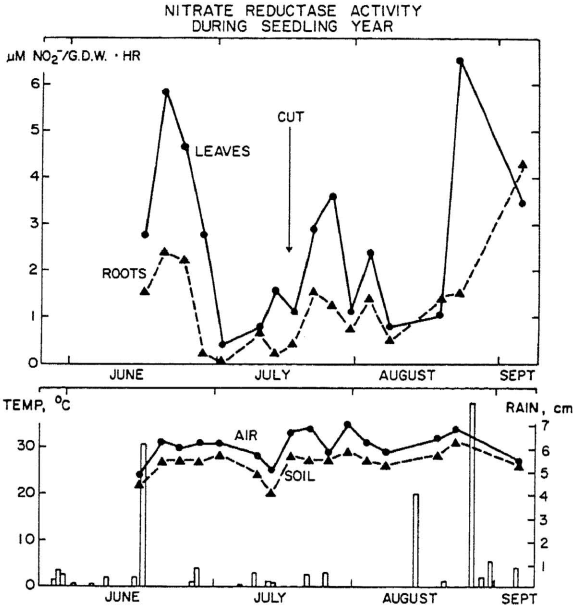

Figure 1. Units of nitrate reduced in leaves and roots of six forage legumes during the seedling year. Units per hour are expressed on a dry weight of tissue basis. Air and soil temperatures at sampling and rainfall data are also shown for the sampling period.

Nitrogen fixation was measured on all species, but data are not presented. All species had approximately the same activity except for birdsfoot trefoil which was about double that of the others.

No forage yields were taken during the seedling year because it was dry and there was little growth. The plots were clipped again during the first week in September, but for either harvest there was not enough material for an accurate yield determination.

Second Year

During the second year of growth the only significant difference detected among species in activity of N.R. occurred during the first two sampling dates. These two dates were before and after the first harvest on May 28. Ladino clover was the highest in activity, and white clover and alfalfa were the lowest. Activity of N.R. in both roots and leaves (Figure 2) followed a pattern similar to the seedling year with increased activity following rains during spring and fall. This year, however, activity of N.R. in both the leaves and roots was lower than during the seedling year.

Activity of N.R. in roots was very high after the first cutting in the spring (Figure 2) with activity of N.R. in leaves following a similar pattern. The rapid response of the roots was probably due to the increased rainfall following cutting and to the fact that the leaves, which are the major site for nitrate reduction, had been removed by cutting. Later peaks of root N.R. activity were less distinct (Figure 2). Activity of N.R. in both the roots and leaves was low following the second cutting when growth was slow. However, in fall, leaf N.R. activity increased and root N.R. activity decreased as drought stress was relieved.

Effects of rain and air temperature on N.R. activity were similar to the seedling year (an inverse relationship to temperature and increased activity after rains.) During August, even though there was little rain, when soil and air temperatures decreased N.R. activity increased indicating that the optimum temperature for nitrate utilization had been surpassed.

Nitrogen fixation (labelled as C_2H_2 in Figure 3) decreased after the first cutting except for red clover, which doubled its activity. No explanation is known for this response. In summer and fall nitrogen fixation decreased as activity of N.R. in roots increased (Figure 3) indicating again that when one system was operating at a high rate, the other system was operating at a low rate. Activity of N.R. in leaves did not appear to be related to nitrogen fixation or activity of N.R. in the roots.

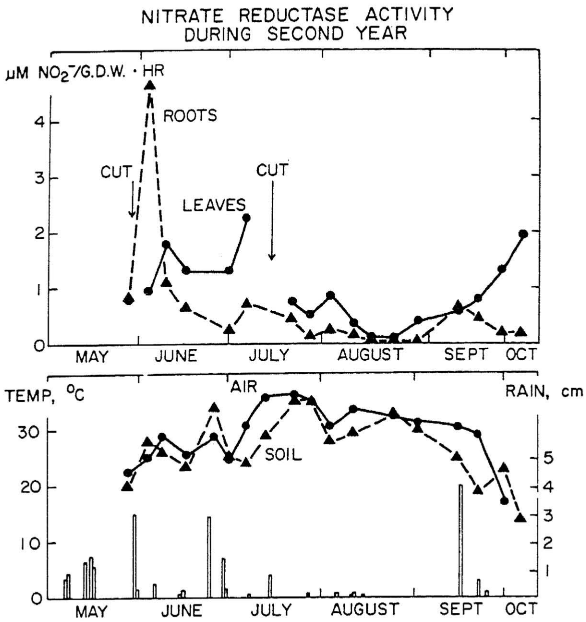

Figure 2. Units of nitrate reduced by the enzyme nitrate reductase in leaves and roots of six forage legumes during the second year. Units per hour are expressed on a dry weight of tissue basis. Air and soil temperatures and rainfall data are also shown for the sampling period.

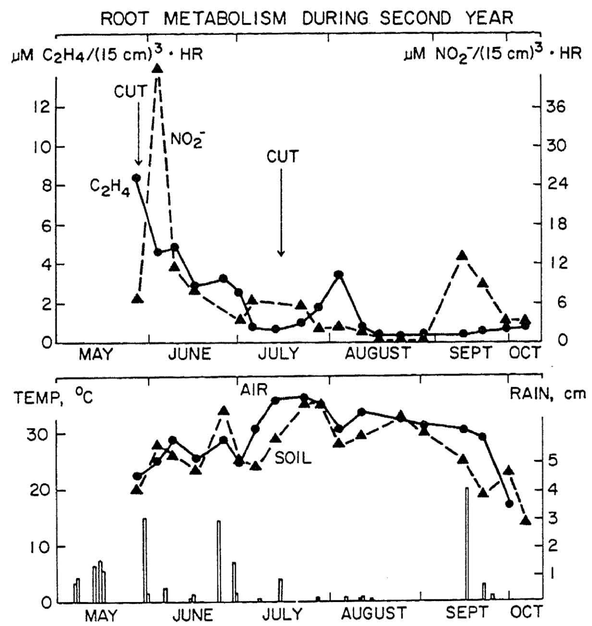

Figure 3. Acetylene reduction (estimate of nitrogen fixation from air) and nitrate reduction by forage legume roots. Data are expressed as units per 15 cm cube of soil area. Note that when nitrate uptake from soil (NO_2^-) was high, fixation of nitrogen from soil (C_2H_4) was low and vice versa. Temperatures and rainfall data are also shown for the sampling period.

We recalculated the N.R. data from Figure 2 for root tissue to make it on a unit soil volume basis as shown in Figure 3. This allows a better comparison of the relative responses of the two nitrogen metabolism systems as the environment changed. After the first cutting, root N.R. activity increased as acetylene reduction decreased (Figure 3), and this inverse relationship continued throughout the season. Nitrogen fixation by nodules, in general, decreased after rain, possibly because of less soil aeration and the increased amount of nitrate utilization from the soil. Peaks in nitrogen fixation during the first of August and middle of September coincided with decreases in soil temperature, again indicating a cooler environment was helpful for optimum nodule activity.

Red clover was the highest yielding species in this trial, but yield was not a primary objective of the study. Alfalfa and birdsfoot trefoil were the only species that survived the dry weather past the second year.

CONCLUSIONS

From our data and that of others it appears that legumes are not able to fix their entire amount of nitrogen needed for growth. In addition, when nitrate from the soil is utilized, the rhizobia are less effective in fixation. During the seedling year and second year most of the nitrate was reduced in the leaves. We were not able to compare directly the actual amounts of nitrogen fixed from the air to the amount absorbed and reduced from the soil.

Environmental conditions have been known to be a determinant of how much nitrogen is fixed by legumes. During drought stress, as indicated by the second year data, little nitrogen was fixed. When rains relieved the stress nitrate utilization directly from the soil was the earliest response. When high air and soil temperatures occurred nitrogen fixation was slowed. Other researchers have also shown that nitrogen fixation has an optimum temperature range, and that above or below that range nitrogen fixation is slowed.

Nitrate reduction takes place mostly in the leaves of forage legumes until they are cut, then the plant is dependent on the root system for reduction of nitrate as well as for nitrogen fixation. Fortunately, forage legumes store carbohydrates in their root systems which can be used to provide energy to the metabolic systems. That way nitrogen can continue to be absorbed or fixed until the topgrowth becomes reestablished and begins to provide photosynthate.

The hot, dry environments of summer also probably reduced photosynthate production of the topgrowth which indirectly would reduce nitrogen metabolism as well as growth. More information is being obtained on how nitrogen metabolism in forage legumes is affected by short-term drought exposure.

It is apparent from our studies that forage legumes do not obtain all of their nitrogen by fixation from the air. Even so forage legumes seldom give a yield response to nitrogen fertilizer applications. However, properly inoculated forage legumes can support rhizobia to provide a high proportion of the nitrogen they need. Researchers at Missouri and other institutions are trying to develop superior bacteria, and more specific bacteria to eventually provide an even greater percentage of the nitrogen requirements of legumes. New varieties and management systems also need to be developed that will exploit this resource. Other studies need to be conducted to determine responses of grasses grown in association with the legumes, and in turn, the influence of the grass on rhizobia activity.

IRRIGATED FORAGE GRASSES

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ABSTRACT: An experiment to compare productivity of 8 forage species under irrigation and dryland from 1974 through 1976 has shown that tall fescue, Caucasian bluestem, Bermudagrass, and alfalfa have given the best response from irrigation. Caucasian bluestem and alfalfa were the most productive species under irrigation, as well as on dryland. The importance of alfalfa as a nitrogen fixing species for the following crop, such as oats, was well illustrated.

The experiment was initiated in 1974 on 8 forage species to compare producitivity under dryland and irrigated conditions. Fertilizer treatments applied during 1974 and 1975 are shown in the 1975 and 1976 Southwest Missouri Center Research Reports, respectively. Total amounts of nitrogen applied during 1976 are shown in Table 1. Due to the 1976 drought conditions, 2 inches of water were applied on each of the following dates: June 18, July 16, July 28, August 27, and September 8.

Forage yields obtained during 1974-76 are shown in Table 1. Results show that irrigation water primarily increased forage yields of tall fescue, Caucasian bluestem, and Bermudagrass. Responses among the other species were less pronounced during the 1976 crop year.

TABLE 1. Tons dry matter per acre of several forage species grown on dryland and under irrigation at the Southwest Missouri Center during 1974-1976.

Entry	#N/A-1976		Tons DM/A 1976		Tons DM/A 1974-76	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
Kentucky 31 tall fescue	105	160	3.51	4.57	3.43	4.51
Hallmark orchardgrass	105	160	3.54	3.80	3.45	3.89
Southland bromegrass	105	160	1.15	1.24	2.15	2.37
Rise reed canarygrass	105	160	1.02	1.57	2.21	2.83
Caucasian bluestem	105	135	3.83	5.44	3.80	4.98
Midland Bermudagrass	105	135	2.57	3.57	2.79	4.53
Greenfield Bermudagrass	105	135	2.70	3.54	2.69	4.55
Cody alfalfa	0	0	4.11	4.38	3.89	4.81

During 1977 spring oats were seeded on the experimental site and grown for forage yield to determine fertility residue and/or irrigation effects of the previous 3 summer. Harvest at the milk stage was made on June 2. Forage yields are shown in Table 2.

TABLE 2. Tons dry matter per acre of spring oats grown on land previously cropped with several forage species on dryland and under irrigation at the Southwest Missouri Center, 1977.

	Tons DM/A	
Previous Species	Dryland	Irrigated
Kentucky 31 tall fescue	.88	1.15
Hallmark orchardgrass	.90	1.41
Southland bromegrass	.87	1.17
Rise reed canarygrass	.87	1.03
Caucasian bluestem	.71	.98
Midland Bermudagrass	.60	.82
Greenfield Bermudagrass	.68	.66
Cody alfalfa	2.56	2.47

BERMUDAGRASS - LEGUME MANAGEMENT

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Abstract: An experiment to compare productivity of Bermudagrass in pure stand at 3 levels of nitrogen and with alfalfa, red clover, and Ladino clover has shown after 1 year of study that (1) Bermudagrass responded to increasing levels of nitrogen, (2) alfalfa and red clover alone and in mixture with Bermudagrass were the most productive of all entries, and (3) alfalfa showed little response to nitrogen. Bermudagrass contributed very little to total yield in mixture with red clover and alfalfa.

The experiment was established from seed and sprigs (Midland Bermudagrass) on May 9, 1975. Seeding rates used were 10 pounds per acre of Cody alfalfa and Kenstar red clover and 2 pounds per acre of Merit Ladino clover. Sprigs of Midland Bermudagrass were spaced approximately 18 inches apart in two 2-foot spaced rows through the middle of the 10' X 20' plots. Plots were replicated 4 times.

Entries consisted of Bermudagrass at 3 levels of nitrogen fertility (0, 100, and 200 pounds per acre); Ladino clover, alfalfa, and red clover with and without Bermudagrass; and alfalfa with 50 pounds nitrogen per year. Prior to establishment, 0 + 40 + 80 pounds of fertilizer per acre were applied as plowdown to bring soil fertility up to soil test. During 1976 nitrogen was applied to the Bermudagrass in split applications on May 28 and July 9. Nitrogen on alfalfa was applied also on May 28. All plots were fertilized with 0 + 60 + 252 pounds of fertilizer on August 18.

Yields in 1976 are shown in Table 1.

TABLE 1. Tons per acre of dry matter of several forage species grown in pure stand and mixture with Bermudagrass at the Southwest Missouri Center during 1976.

Entry	% Legume	% Grass	Tons DM/A[1]
Bermudagrass + 100# N/A	--	--	2.44
Bermudagrass	--	--	.75
Bermudagrass + 200# N/A	--	--	3.60
Bermudagrass + alfalfa	90	10	6.62
Bermudagrass + red clover	95	5	6.96
Bermudagrass + Ladino clover	70	23[2]	3.93
Alfalfa	--	--	6.17
Red clover	--	--	6.84
Ladino clover	--	--	3.43
Alfalfa + 50# N/A	--	--	6.50

[1] Harvest dates: Bermudagrass - July 7, August 4, and September 10; Alfalfa - Bermudagrass and alfalfa - May 21, June 28, August 4, and September 10; Red clover - Bermudagrass and red clover - June 3, July 7, and August 17; and Ladino clover - Bermudagrass and Ladino clover - June 3, July 7, August 4, and September 10.

[2] Seven % weeds estimated in the Bermudagrass - Ladino clover.