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ARTICLES

Factors Affecting Income Over Feed Cost by County on Northeast Texas Dairies

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ABSTRACT

Using Dairy Herd Improvement Association (DHIA) records on Northeast Texas farms, this study develops a predictive model of Income Over Feed cost (IOFC) for the region as a whole and for individual counties. Emphasis is placed on factors under a manager's regular control, as opposed to long run structural changes or investments. The findings present quantitative estimates of the influence of various factors on IOFC; e.g. each hour between milkings from a.m. to p.m. tended to reduce IOFC per cow by $0.47 to $0.51 per day, whereas the pounds of concentrate fed, Holstein breed and month of March raised IOFC by $0.38, $4.16 and $0.95 per day, respectively.

INTRODUCTION

In addition to monitoring and considering the latest technological developments and capital investments available to Texas dairies, dairymen need to manage their current assets as efficiently as possible. Though much concern in agriculture has lately focused on aspects of making a transition to the long run (Richardson 1984; Schwart 1985), a need remains to help managers make better short run decisions; otherwise, adoption of expensive technologies and sophisticated management practices may not be possible.

The Dairy Herd Improvement Association (DHIA) record keeping system was developed to create a data base on individual farms to enhance productivity (Voelker 1981). A key short run variable related to profitability is Income Over Feed Cost (IOFC) (Shumway et al. 1982). this study develops a predictive model of IOFC for the Northeast Texas region as a whole and for selected individual counties. Emphasis is placed on factors under a manager's regular control, versus long run structural changes or investments. With the goal of aiding short run decision making, the study presents quantitative estimates of the influence of various factors on daily IOFC.

Though Texas dairies produce only about 2.8% of total U.S. milk (ERS 1985), Texas ranks ninth among the states in quantity produced (Knutson et al. 1981). Whereas approximately

aiding short run decision making, the study presents quantitative estimates of the influence of various factors on daily IOFC.

Though Texas dairies produce only about 2.8% of total U.S. milk (ERS 1985), Texas ranks ninth among the states in quantity produced (Knutson et al. 1981). Whereas approximately
30% of the total U.S. dairy herd is enrolled in the DHIA, 23% of Texas dairy cows are enrolled (TCLRS 1982). The Northeast Texas study area has approximately 114,000 dairy cows which produce around 1.3 billion pounds of milk annually, both of which represent approximately 34% of their respective state total (TCLRS 1982).

Little comprehensive work has been done on predicting dairy IOFC. Several linear programming models have been developed to maximize IOFC using nutrient and price data for various feed ration formulations, but with only a few cow and herd specifications (Bath and Bennett 1980; Bath et al. 1972; Dean et al. 1969; Jones et al. 1980; Reyes et al. 1981). Dairy profit functions have been developed, but their meaning and purpose, i.e. to include fixed expenses and enhance genetic evaluation, are different from predicting IOFC (Andrus and McGilliard 1975; Balaine et al. 1981; Blaine et al. 1981; Norman et al. 1981; Pearson and Miller 1981; Tigges et al. 1984). Two studies have conducted simple correlation, but not multiple regression, analysis on IOFC (Grisley 1985; Williams 1985).

Several studies have estimated the impact on IOFC of a few of the factors examined in this analysis. Increasing herd life from 2.8 to 3.3 lactations was found to increase annual income by $30/cow (Congelton and King 1984). Each additional day open from 40 to 140 reduced daily IOFC by $0.71 and $1.18 for first and later lactation cows, respectively (Olds et al. 1979). Three studies indicated that extending the calving interval for high-producing cows from 13-15 months did not decrease IOFC (Reyes et al. 1980; Reyes et al. 1981; Shumway et al. 1982), but two other studies found a negative impact of approximately $7/cow/year for every three days beyond thirteen months (Gibson 1984; Holman et al. 1984). Bakker et al. (1980) argued that assessment of sire profitability requires information beyond the impact on first lactation, an aspect examined in this study.

DATA

The variables of interest are reported monthly to the farmer on the DHI-202 Herd Summary Form. Table 1 defines the two dependent and 146 independent variables and presents a corresponding acronym for each one for the purposes of this report.

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Table 1. Variables Examined in Economic Model of Income Over Feed Costs (IOFC)

Dependent:		
Y1. $IOFCACTD	=	Mean daily IOFC per cow, all cows (milking and dry)
Y2. $IOFCACAA	=	Rolling annual average IOFC per cow, all cows (milking and dry)
Independent:		
		Test Day Data
1. #COWSNTLHDTA	=	Total # of cows in herd
2. #COWSNMKTD	=	# of cows in milk
3. %COWSNMKTD	=	% of cows in milk
4. PDSMKACTD	=	Lbs. of milk per cow per day, all cows

Table 1., cont.

5. PDSFATACTD	=	Lbs. of butterfat per cow per day, all cows
6. %FATACTD	=	% of butterfat per cow per day, all cows
7. PDSPTNACTD	=	Lbs. of protein per cow per day, all cows
8. %PTNACTD	=	% of protein per cow per day, all cows
9. PDSMKMCTD	=	Lbs. of milk per cow per day, milking cows
10. PDSSLGACTD	=	Lbs. of silage consumed per cow per day
11. SLGENGVALTD	=	Net energy value of the silage
12. PDSOTSCLACTD	=	Lbs. of other succulents consumed per cow per day
13. OTSCLENGVAL	=	Net energy value of other succulents
14. PDSDRYFRGACTD	=	Lbs. of dry forage consumed per cow per day
15. DRYFRGENGVALTD	=	Net energy value of the dry forage
16. PDSOTFDSACTD	=	Lbs. of other feeds consumed per cow per day
17. OTFDSENGVALTD	=	Net energy value of the other feeds
18. PTRQUALRAT	=	Pasture quality rating
19. PDSCNTACTD	=	Lbs. of concentrates consumed per cow per day
20. CNTENGVALTD	=	Net energy value of the concentrates
21. CNTCSTPCTD	=	Cost of concentrates per cow per day
22. TFDCSTPCTD	=	Total feed costs per cow per day
23. FDCSTPCWTMK	=	Feed costs per cwt. of milk produced
24. #COWSBRHDTD	=	# of cows in breeding herd
25. #BDSOP>100BRDH	=	Mean # of breedings for cows open > 100 days, breeding herd
26. %BDSSVDBRHD	=	% of possible breedings that were serviced, breeding herd
27. DYSFSTBDGBRHD	=	Mean # of days to first breeding, breeding herd
28. #OP<60BRHDNDP	=	# of cows in breeding herd currently open < days, not diagnosed pregnant
29. %OP<60BRHDNDP	=	% of cows in breeding herd currently open < 60 days, not diagnosed pregnant
30. #OP60-100BRHDNDP	=	# of cows in breeding herd currently open 60-100 days, not diagnosed pregnant
31. %OP60-100BRHDNDP	=	% of cows in breeding herd currently open 60-100 days, not diagnosed pregnant
32. #OP101-140BRHDNDP	=	# of cows in breeding herd currently open 101-140 days, not diagnosed pregnant
33. %OP101-140BRHDNDP	=	% of cows in breeding herd currently open 101-140 days, not diagnosed pregnant
34. OP>140BRHDNDP	=	# of cows in breeding herd currenty open > 140 days, not diagnosed pregnant
35. %OP>140BRHDNDP	=	% of cows in breeding herd currently open > 140 days, not diagosed pregnant
36. #OP<60BRHDTED	=	# of cows in breeding herd currently open < 60 days, too early to diagnose
37. %OP<60BRHDTED	=	% of cows in breeding herd currently open < 60 days, too early to diagnose
38. #OP60-100BRHDTED	=	# of cows in breeding herd currently open 60-100 days, too early to diagnose
39. %OP60-100BRHDTED	=	% of cows in breeding herd currently open 60-100 days, too early to diagnose
40 #OP101-140BRHDTED	=	# of cows in breeding herd currently open 101-140 days, too early to diagnose
41. %OP101-140BRHDTED	=	% of cows in breeding herd currently open 101-140 days, too early to diagnose
42. #OP>140BRHDTED	=	# of cows in breeding herd currently open > 140 days too early to diagnose
43. %OP>140BRHDTED	=	% of cows in breeding herd currently open > 140 days, too early to diagnose
44. #BRD>3BRHD	=	# of cows in breeding herd bred > 3 times
45. %BRD>3BRHD	=	% of cows in breeding herd bred > 3 times
46. #OP50-80TLHDFSTBDG	=	# of cows in total herd open 50-80 days at first breeding
47. %OP50-80TLHDFSTBDG	=	% of cows in total herd open 50-80 days at first breeding
48. #OP81-100TLHDFSTBDG	=	# of cows in total herd open 81-100 days at first breeding
49. %OP81-100TLHDFSTBDG	=	% of cows in total herd open 81-100 days at first breeding
50. #OP>100TLHDFSTBDG	=	# of cows in total herd open > 100 days at first breeding
51. %OP>100TLHDFSTBDG	=	% of cows in total herd open > 100 days at first breeding
52. %PBLMCOWSNTLHD	=	% problem cows in total herd
53. DYSOPLSTCLVDT	=	Mean # of days open per cow since last calving date
54. #PGNTTLHD	=	# of cows in total herd currently pregnant
55. #COWSCDPTLHD	=	# of cows in total herd with complete dry periods
56. #DYSDRYCDP	=	Mean # of days per cow in 55
57. DRY<40CDP	=	# of cows in 55 dry < 40 days
58. #DRY40-70CDP	=	# of cows in 55 dry 40-70 days
59. #DRY > 70CDP	=	# of cows in 55 dry > 70 days
60. #SVCSRS	=	# of service sires currently used
61. $PDSVCSRS	=	Mean $PD of current service sires
62. #FSTCLFHFRTLHD	=	# of first calf heifers, total herd
63. #>1LCTNTLHD	=	# of cows in second and later lactation, total herd
64. AVGAGEMOSTLHD	=	Mean age of cows, in months, total herd
65. #MKG>305	=	# of cows currently milking > 305 days
66. %MKG>305MKHD	=	% of milking herd currently milking > 305 days
67. AVGWGTPDSTLHD	=	Mean body weight of cows, total herd
68. #HRSBTWNMKGSAM-PM	=	# of hours between milkings, a.m. to p.m.

Monthly Data

69. $BLDPRCCWTMK	=	Milk blend price per cwt.
70. %FATBLDPRCCWT	=	Blend price base % butterfat
71. %<200KSCCTLHD	=	% of total herd with < 200 KSCC
72. %2-400KSCCTLHD	=	% of total herd with 200-400 K SCC
73. %4-800KSCCTLHD	=	of total herd with 400-800 K SCC
74. %>800KSCCTLHD	=	% of total herd with > 800 K SCC

Table 1., cont.

Rolling Annual Average Data

Variable		Definition
75. #COWSNTLHDAA	=	Total # of cows in herd
76. #COWSNMKAA	=	# of cows in milk
77. %COWSNMKAA	=	% of cows in milk
78. PDSMKACAA	=	Lbs. of milk per cow per year, all cows
79. PDSFATACAA	=	Lbs. of butterfat per cow year, all cows
80. %FATACAA	=	%of butterfat per cow per year, all cows
81. PDSPTNACAA	=	Lbs. of protein per cow per year, all cows
82. %PTNACAA	=	%of protein per cow per year, all cows
83. PDSSLGACAA	=	Lbs. of silage consumed per cow per year
84. SLGENGVALAA	=	% energy from silage
85. PDSOTSCLACAA	=	Lbs. of other succulents consumed per cow per year
86. OTSCLENGVALAA	=	% energy from succulents
87. PDSDRYFRGACAA	=	Lbs. of dry forage consumed per cow per year
88. DRYFRGENGVALAA	=	% energy from dry forage
89. PDSOTFDSACAA	=	Lbs. of other feeds consumed per cow per year
90. OTFDSENGVALAA	=	% energy from other feeds
91. #DYSPTRPCAA	=	# of days per year on pasture, any cows
92. PTRENGVALAA	=	% energy from pasture
93. PDSCNTACAA	=	Lbs. of concentrates consumed per cow per year
94. CNTENGVALAA	=	% energy from concentrates
95. CNTCSTPCAA	=	Cost of consentrates per cow per year
96. TFDCSTPCAA	=	Total feed costs per cow per year
97. FDCSTPCWTMK	=	Feed costs per cwt. of milk produced
98. $AVGBLDPRCCWTMK	=	Mean milk blend price per cwt.
99. %AVGFATBLDPRCCWT	=	Mean blend price base % butterfat
100. PRJMINCLVITVLMOS	=	Projected minimum calving interval
101. #BDSLST12MOS	=	# of breedings in last 12 months
102. %SCFLBDSLST12MOS	=	% of successful breedings in last 12 months
103. #BDSPCNPN	=	# of breedings per conception
104. FSTBDGCNPNRT	=	First breeding conception rate
105. PRJ305DYMKMETLHD	=	Projected 305 day milk ME, all cows
106. PRJ305DYFATMETLHD	=	Projected 305 day fat ME, all cows
107. $PDSVCSRSFSTCLFHFR	=	Mean $ PD of current and former sires first calf heifers
108. $PDSVCSRS>1LCTN	=	Mean $ PD of current and former sirez, second and later lactations
109. $PDSVCSRSTLHD	=	Mean $ PD of current and former sires, all lactations
110. #COWSLFTHDLST12MOS	=	#of cows that left herd in last year
111. %COWSLFTHDLST12MOS	=	% of cows that left herd
112. #COWSLFTLOWPDTN	=	# that left due to low production
113. #COWSLFTREPROBLM	=	# that left due to reproductive problems
114. #COWSLFTDIS/INJ	=	# that left due to disease/injury
115. #COWSDIED	=	# that left due to death
116. #COWSLFTMSTS/UDR	=	# that left due to mastitis/udder problems
117. #COWSLFTFEET/LEG	=	# that left due to feet/leg problems
118. #DYSNMKLST12TSTSMC	=	Mean # days in milk, last 12 test days, milking cows
119. PDSMKLST12TSTSMC	=	Mean lbs. of milk per milking cow per day, last 12 test days
120. PRSTCYNDXLST12TSTS	=	Mean test period Persistency Index, last 12 test days
121. PDSMKLST12TSTSAC	=	Mean lbs. of milk per cow per day, all cows, last 12 test days
122. %FATLST12TSTSAC	=	Mean % of butterfat per cow per day, all cows, last 12 test days
123. %PTNLST12TSTSAC	=	Mean % of protein per cow per day, all cows, last 12 test days
124. %<200KSCCLST12TSTS	=	Mean % of herd with < 200 K SCC, last 12 test days
125. %2-400KSCCLST12TSTS	=	Mean % of herd with 200-400 K SCC, last 12 test days
126. %4-800KSCCLST12TSTS	=	Mean % of herd with 400-800 K SCC, last 12 test days
127. %>800KSCCLST12TSTS	=	Mean % of herd with > 800 K SCC, last 12 test days
128. AVGSCCLST12TSTS	=	Mean weighted average SCC, nearest 1,000, entire herd, 12 test days.

Dummy Variables (1 = true, 0 = false)

129. HOHD	= Holstein herd	132. BSHD	= Brown Swiss herd
130. JEHD	= Jersey Herd	133. AYHD	= Ayrshire herd
131. GUHD	= Guernsey herd	134. MXHD	= Mixed breeds herd
135. JAN	= Jan. test month	141. JUL	= Jul. test month
136. FEB	= Feb. test month	142. AUG	= Aug. test month
137. MCH	= Mch. test month	143. SEP	= Sep. test month
138. APR	= Apr. test month	144. OCT	= Oct. test month
139. MAY	= May test month	145. NOV	= Nov. test month
140. JUN	= Jun. test month	146. DEC	= Dec. test month

Data were collected through the DHIA on 126 farms in 19 counties for the two most recent years available, 1982-83. With a total of 749 monthly observations, the data are distributed by county in Table 2.

Table 2. Distribution of Data by County

County	Number of Farms Observed	Number of Total Monthly Observations
Camp	5	42
Franklin	8	61
Henderson	1	7
Hopkins	73	366
Hunt	1	6
Nacogdoches	8	58
Rains	3	28
Rusk	1	5
Smith	1	10
Upshur	12	96
Wood	7	37
Van Zandt	3	21
? *	3	12
Total . . .	126	749

* Cass, Harrison, Houston, Marion, Norris, Panola, or Shelby. Unknown due to similar DHI County codes.

Sample farms ranged in size from 18 to 384 head. The highest daily herd average for milk production per milking cow was 65.9 lbs. Daily IOFC per cow ranged from – $0.08 to $6.21, with a mean of $2.70. The minimum projected calving interval was 11.8 months, with a mean of 13.7. Average days open ranged from 80 to 275, with a mean of 137. Average days dry ranged from 45 to 124, with a mean of 74. the average first breeding conception rate was 59.8%. Eighty-nine percent of the herds were Holstein, 5% were Jersey, 5% were mixed herds, 1% were Guernsey or Brown Swiss, and none were Ayrshire. The mean numbers of hours between milkings was 11.4 from a.m. to p.m. Average somatic cell count (SCC) ranged from 7,000 to 984,000 with a mean of 334,335.

METHODOLOGY

Simple correlation analysis based on Pearson's sample correlation coefficient was conducted to identify those independent variables most linearly correlated with IOFC. Stepwise regression at the 0.05 level was then conducted to search for the best set of independent variables. Multiple linear regression models were then estimated for the nineteen-county area collectively, then separately for the seven counties with twenty-eight or more monthly observations, and once for the remaining twelve counties.

FINDINGS

No theoretically or statistically satisfactory model could be found to predict the annual measure of IOFC : Y2. $IOFCACAA. This is not surprising since the majority of variables on the DHI-202 Form are monthly data. Suitable models were found for the monthly measure of IOFC : Y1. $IOFCAACTD. Table 3 presents two overall models for the nineteen-county area.

Table 3. Multiple Linear Regression Models of Y1. $IOFCACTD

Independent Variable	Beta Coefficient	T Value
(Model 1 : With the "Big 3")		
Constant	0.72	3.84[b]
3. %COWSNMKTD	0.01	3.99[b]
4. PDSMKACTD	0.04	13.23[b]
5. PDSFATACTD	0.95	13.82[b]
20. CNTENGVALTD	0.01	7.25[b]
21. CNTCSTPCTD	-0.20	-5.85[b]
23. FDCSTPCWTMK	-0.26	-24.43[b]
R^2 = 0.85	Sig. F = 0.0000	Entire Sample
(Model 2 : Without the "Big 3")		
Constant	-2.42	-6.39[b]
3. %COWSNMKTED	0.05	15.05[b]
17. OTFDSENGVALTD	-0.02	-3.40[b]
20. CNTENGVALTD	0.02	5.16[b]
21. CNTENGVALTD	-0.31	-4.73[b]
66. %MKG>305MKHD	-0.02	-5.38[b]
74. %>800KSCCTLHD	-0.01	-3.19[b]
118. #DYSNMKLST12TSTSMC	0.00	3.91[b]
128. AVGSCCLST12TSTS	-0.00	-2.92[b]
R^2 = 0.38	Sig. F = 0.0000	Entire Sample

[a]Denotes significance at 0.05 level
[b]Denotes significance at 0.01 level

Model 1 illustrates the positive effects of the percent of the herd in milk, milk and fat production, and the energy value of concentrates, plus the negative effects of concentrate costs and feed costs per cwt. of milk produced.[2]

The model's accuracy, as measured by the R^2 ratio, is 85%. However, in this Model, as well as in all preliminary estimates of the county models, the regression procedure relied on milk and fat production and feed costs per cwt. of milk produced for most of its predictive power. These three independent variables, i.e. the "Big Three," were omitted from the remainder of the analysis in order to search for less obvious determinants of IOFC.

Model 2, with 38% predictive power, indicates positive impacts from the percent of herd in milk and concentrate energy value, and negative impacts from the energy value of other feeds, concentrate cost, percent herd milking more than 305 days, percent of herd with more than 800,000 SCC, and the average SCC from the last twelve tests. The mean number of days in milk for milking cows from the last twelve tests has a positive, albeit very small, effect on daily IOFC.

Table 4 presents the county models of daily IOFC. The equations do not utilize any of the "Big Three" factors. With the exception of Hopkins County, the predictive power of the equations is generally high. In Camp County (Model 3), Holstein herds are relatively more lucrative and March and April are the most prosperous months in terms of daily IOFC. For each

[2]The beta coefficient reflects the change in the dependent variable associated with a **one unit change** in that independent variable, holding the values of the other independent variables fixed. The R^2 statistic measures the percent of variation in the dependent variable accounted for by the independent variables, the significance of the F statistic states the likelihood that there is no relationship between the dependent variable and **any** of the independent variables, and the significance of the T statistic states the likelihood of no relationship between the dependent variable and **that** independent variable.

hour from a.m. to p.m. between milkings, daily IOFC/cow drops by $0.47. In Franklin County (Model 4), Holstein herds tend to increase IOFC and the number of hours between milkings has a markedly negative effect. In Hopkins County (Model 5), a major dairy center, the leading predictors are the percent of herd in milk and the mean test period persistency index from the last twelve tests, the latter of which corresponds to an increase of $0.09 in daily IOFC/cow for each unit increase in the index. The cost of concentrates in Nacogdoches County (Model 6) has a pronounced negative effect. The persistency index, percent of herd in milk and concentrate energy value are correlated with enhanced IOFC.

Table 4. Multiple Linear Regression Models Of Y1. $IOFCACTD by County

Independent Variable	Beta Coefficient	T Value
(Model 3 : Camp County)		
Constant	-7.78	-2.76[b]
20. CNTENGVALTD	0.18	4.77[b]
68. #HRSBTWNMKGSAM-PM	-0.47	-3.62[b]
110. #COWSLFTHDLST12MOS	0.03	2.76[b]
128. AVGSCCLST12TSTS	-0.01	-4.77[b]
129. HOHD	4.16	5.94[b]
137. MCH	0.95	4.05[b]
138. APR	1.07	4.49[b]
R^2 = 0.71	Sig. F = 0.0000	No. of Obs. = 42
(Model 4 : Franklin County)		
Constant	3.06	4.26[b]
3. %COWSNMKTD	0.05	9.65[b]
19. PDSCNTACTD	-0.08	-8.01[b]
66. %MKG>305MKHD	-0.01	-2.97[b]
68. #HRSBTWNMKGSAM-PM	-0.51	-10.55[b]
118. #DYSNMKLST12TSTSMC	0.01	4.46[b]
129. HOHD	0.69	5.43[b]
R^2 = 0.82	Sig. F = 0.0000	No. of Obs. = 61
(Model 5 : Hopkins County)		
Constant	-12.06	-5.14[b]
3. %COWSNMKTD	0.05	10.57[b]
27. CYSFSTBDGBRHD	0.00	2.26[a]
66. %MKG>305MKHD	-0.01	-2.50[a]
67. AVGWGTPDSTLHD	0.00	2.67[b]
110. #COWSLFTHDLST12MOS	-0.00	-2.34[a]
118. #DYSNMKLST12TSTSMC	0.00	2.83[b]
120. PRSTCYNDXLST12TSTS	0.09	3.73[b]
R^2 = 0.32	Sig. F = 0.0000	No. of Obs. = 363
(Model 6 : Nacogdoches County)		
Constant	-36.46	-5.83[b]
3. %COWSNMKTD	0.08	8.03[b]
20. CNTENGVALTD	0.05	3.44[b]
21. CNTCSTPCTD	-0.87	-5.66[b]
67. AVGWGTPDSTLHD	0.00	4.00[b]
120. PRSTCYNDXLST12TSTS	0.23	5.07[b]
R^2 = 0.67	Sig. F = 0.0000	No. of Obs. = 58
(Model 7 : Rains County)		
Constant	-0.85	-1.88
19. PDSCNTACTD	0.38	8.86[b]
21. CNTCSTPCTD	-2.04	-4.64[b]
R^2 = 0.80	Sig. F = 0.0000	No. of Obs. = 28
(Model 8 : Upshur County)		
Constant	-1.57	-3.25[b]
3. %COWSNMKTD	0.05	11.96[b]
53. #DYSOPLSTCLVDT	0.00	2.57[a]
128. AVGSCCLST12TSTS	-0.00	-0.42
R^2 = 0.67	Sig. F = 0.0000	No. of Obs. = 96
(Model 9 : Wood County)		
Constant	-10.56	-4.92[b]
3. %COWSNMKTD	0.08	4.29[b]
20. CNTENGVALTD	0.02	4.97[b]
118. #DYSNMKLST12TSTSMC	0.03	3.49[b]
128. AVGSCCLST12TSTS	0.00	3.65[b]
R^2 = 0.78	Sig. F = 0.0000	No. of Obs. = 37
(Model 10 : All Other Sample Counties)		
Constant	-0.59	-1.00
3. %COWSNMKTD	0.05	6.25[b]
53. #DYSOPLSTCLVDT	0.01	2.04[a]
66. %MKG>305MKHD	-0.04	-3.55[b]
128. AVGSCCLST12TSTS	-0.00	-3.91[b]
142. AUG	-0.48	-2.73[b]
R^2 = 0.60	Sig. F = 0.0000	No. of Obs. 61

[a] Denotes significance at 0.05 level.

[b] Denotes significance at 0.01 level.

In Rains County (Model 7), 80% of the variation in IOFC is associated with changes in the quantity used and cost of concentrates, positively and negatively, respectively. Both of the coefficients are significantly different from zero at the 0.01 level. The most powerful predictor in Upshur County (Model 8) is percent of herd in milk. The number of days open since last calving date and the mean SCC from the last twelve tests have marginally positive and negative impacts, respectively. In Wood county (Model 9), the percent of herd in milk, concentrate energy value and mean number of days in milk from the last twelve tests have important positive effects. Lastly, the key positive factor in the remaining twelve sample counties (Model 10) is percent of herd in milk, while the percent of cows in the milking herd currently milking over 305 days and the month of August have notably negative effects on daily IOFC/cow.

It may be of interest to note that the age of the herd, first breeding conception rate and the percent of possible breedings that were actually serviced are some typically key factors that did not enter any of the models. Neither did the size of the herd, implying that a positive flow of IOFC can be achieved at any farm size, as measured by herd size.

CONCLUSIONS

It is possible to anticipate the direction and magnitude of change in IOFC from changes in many of the feeding, breeding, genetic, health and management factors reported on the monthly DHI-202 Herd Summary Form. This applied study developed models capable of predicting IOFC on Northeast Texas dairies. For the nineteen-county region, the following factors contributed positively to IOFC: percent of herd in milk, concentrate energy value, Holstein breed, the months of March and April, mean test period persistency index, and mean number of days in milk. Important negative factors were: concentrate costs, percent of energy from other feeds, percent of herd milking over 305 days, percent of herd with more than 800,000 SCC, mean SCC from the last twelve tests, the number of hours from a.m. to p.m. between milkings, and the month of August. The beta coefficients, which reflect the change in IOFC from a one unit change in that particular factor, presented in Tables 3 and 4 are offered in the hope of helping producers improve short run financial returns during this period of uncertainty and transition.

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Production of Cash Market Grain Sorghum Versus Contracting Hybrid Seed

Richard T. Schad and R. Terry Ervin[1]

ABSTRACT

The profitability of producing irrigated sorghum for the cash market is compared to producing two types of irrigated hybrid sorghum seed for sale to seed companies. Partial enterprise budgets are used to estimate profit rates for the three types of sorghum production activities. During the study period hybrid sorghum seed averaged 75.1 and 56.2 percent, respectively, greater revenue per acre than commercial grain sorghum.

INTRODUCTION

Texas' agricultural economy has long recognized sorghum as an important crop. Ranked as the top sorghum producing state in the nation, the value of sorghum production in Texas reached $472.5 million in 1983 (USDA 1984). Because sorghum's primary use is in cattle feed, producers are limited in their marketing alternatives. Producers must accept prices offered by grain elevators or commercial feedlots. With the exception of target prices all of the price risk involved in sorghum production is assumed by producers because no sorghum futures are traded. Although the plant is easily grown and bears high yields, profits from sorghum production may be small to nonexistent due to the unstable agricultural market.

Past studies of identifying profitable alternative crops for the Texas sorghum producer have considered such diverse crops as sunflower and guayule. Harman, Unger, and Jones (1982) developed production functions for sunflowers and grain sorghum in the Texas High Plains to estimate the yield response to different irrigation levels. Another study compared the profitability of sunflower production to grain sorghum and cotton production in the High and Rolling Plains of Texas (Moore, Lacewell, and Griffin, 1982). Collins, Lacewell, and Heilman (1979) performed a study comparing the profitability of irrigated corn to irrigated and dryland grain sorghum. Cornforth, Lacewell, Collins, Whitson, and Hardin (1980) compared the production of guayule, cotton, and grain sorghum in the Trans Pecos and Winter Garden regions of Texas. Diversifying production enterprises through the introduction of any of these alternative crops, or totally shifting to alternate cropping systems may decrease the price risk carried by sorghum producers.

The capability of a sorghum producer to set a harvest price before or during the growing season would decrease the price risk and uncertainties involved. An alternative to shifting to substitute cropping systems is to obtain a contract to grow hybrid sorghum seed for a seed company. A pricing system is agreed upon by the producer and the seed buyer before production begins. A hybrid seed enterprise can be readily implemented into an existing sorghum producer's operation with minimal cost and few changes in production technique, thus broadening the producer's options and decreasing the risk inherent in farming during depressed economic periods.

In this paper we compare the profitability of producing irrigated sorghum for the cash market (delivered to Continental Grain Company of Gruver, Texas) to producing two types of irrigated hybrid sorghum seed for sale to a seed company (delivered to Dekalb-Pfizer, Moore County, Texas). Our data for the hybrid sorghum were received from Dekalb-Pfizer with no names other than Types I and II. Hereafter, the irrigated sorghum for the cash market is referred to as grain sorghum, while the hybrid sorghums are referred to jointly as hybrid seed, and individually as Hybrid I and Hybrid II. The study uses production and marketing conditions during a four year period (1981-84) in Hansford County, Texas (the center county on the northern border of the Texas Panhandle).

METHODS AND PROCEDURES

A comparison of the profitability of producing grain sorghum and hybrid seed was accomplished by constructing partial budgets and identifying the profit rate for each enterprise on a per acre basis (profit rate was defined as total revenue divided by total variable costs). Determination of total variable costs and total revenue for each production enterprise provided the intermediate results required to identify the respective profit rates. The assumptions made within the study were: a) fixed costs were identical for each enterprise; b) land and climatic conditions were equal for production goals; c) isolation required to insure genetic purity for hybrid seed was accomplished; e) production inputs such as water, fertilizer, seeding rates, and herbicide and insecticide applications were equal between production goals; f) produced grain sorghum met the quality standards of moisture, foreign material, test weight, and damage required to grade number 2; and, g) produced hybrid seed met the contract specified standards of moisture, foreign material, test weight, damage, and germination.

Total Variable Costs

Variable costs were developed for irrigated grain sorghum and modified as needed for the hybrid seed enterprises. Because fixed costs were assumed to be identical for each enterprise they were not included in the analysis. Although some of the variable costs were equal between enterprises they are presented in the budgets to enable the profit rate to be defined. Nitrogen level was set at 180 pounds per acre. Production inputs provided by the seed company for the hybrid seed enterprise were 100 percent of the cost of seed and 50 percent of the herbicide and insecticide costs (these values vary among seed companies.)

Total variable costs were:

$$TVC_i = \sum_{t=1}^{n=9} P_t X_t \qquad t = 1, 2, 3, \ldots, 9 \qquad (1)$$

where TVC_i represented variable costs for year i, P_t represented the price for the appropriate input, and X_t represented inputs seed, fertilizer (N), herbicide, insecticide, irrigation, fuel and lube, repair, labor, and harvest costs.

Total Revenue: Hybrid Seed Enterprise (HSE)

Total revenue per acre of each hybrid seed enterprise was calculated by multiplying the weighted average yield per acre by the average price of the product. Hybrid seed is typically grown with a male pollinator band of four rows to every eight rows of hybrid, or a 1:2 pollinator-hybrid per acre ratio. Because the pollinator was specifically designed for pollination rather than yield, it was expected to produce substantially

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less than the hybrid. A weighted average per acre yield for each hybrid was calculated by summing the pollinator yield and twice the hybrid yield and dividing by three. Likewise, the average per acre product price for each hybrid was calculated by summing the products of the prices and yields received for the male and the hybrid crops, and dividing by the total average per acre production.

Total revenue for a hybrid seed enterprise was calculated as:

$$TR_{HSE_i} = A(DAP_i + PP_i) + (1 - A)(MY_i \times CP_i) \quad (2)$$

where TR_{HSE_i} = total revenue received for a hybrid seed enterprise in year i.

A = Ratio of female rows to all rows (ie. 2:3).

DAP_i = Designated acre payment ($) for year i.

PP_i = premium pounds of female hybrid payment ($/cwt.) for year i.

MY_i = average male yield per acre (cwt.) was obtained from seed company records for each period.

CP_i = average cash price for November ($/cwt.) calculated by averaging the cash prices for number 2 yellow grain sorghum ($/cwt.) during the month of November of each specified year offered by Continental Grain Company in Gruver, Texas

The designated acre payment (DAP) was calculated as:

$$DAP = .5(RF \times NP) + .5(RF \times FP) \quad (3)$$

where RF = regional factor determined by seed company for each sorghum producing region (88 for the study area in year 1981 and 91 in years 1982-84.)

NP = average daily settle price ($/bu.) of the May (March) corn futures contract price for the month of November, calculated by averaging the settle price of the May corn futures contract for the year 1981 and the March corn futures contract for the years 1982-84 using Chicago Board of Trade prices (Futures Prices 1981-84). The strategy used by Dekalb-Pfizer to price hybrid sorghum seed is based on corn futures prices.

FP = average daily settle price ($/BU.) of the May (March) corn futures contract price for the month of February, calculated as for NP except the prices used are those reported in February of the given year.

Premium pound payments are designed to reward a grower for superior yields. A grower receives this payment for each hundredweight quantity produced above the target yield established by the seed company. The premium pound payment (PP) is a function of the premium pounds coefficient (PF) defined in the contract by the seed company for each year, and was calculated using:

$$PP = .5((PF \times NP) \times (Y - TY)) + .5((PF \times FP) \times (Y - TY)) \quad (4)$$

where Y = average hybrid yield in cwt.; values obtained from seed company yield records for each period (Howitt 1985).

TY = hybrid target yield (cwt.) determined by seed company, based on expected yield of each hybrid.

The target male yield for each hybrid was multiplied by the average cash price to obtain the revenue for the acres devoted to growing the male pollinator. The revenue associated with the male pollinator acres was multiplied by (1-A) or .33 to develop a weighted revenue value based on the ratio of two female acres to one male acre.

Total Revenue: Grain Sorghum (GS)

The net returns over variable costs for each enterprise were calculated by subtracting the total variable costs from the corresponding total revenues for each year. Net returns from grain sorghum were compared to each of the net returns associated with the two hybrid seed varieties. Total revenue for the grain sorghum enterprise was calculated as:

$$TR_{GS_i} = SY_i \times CP_i \quad (5)$$

where TR_{GS_i} is the total revenue received for the grain sorghum enterprise in year i, SY_i the average yield of grain sorghum (cwt.) for specified years in Hansford County, Texas (Texas Crop and Livestock Reporting Service, 1982-85), and CP_i the cash price paid by Continental Grain Company in year i.

To compare over time, net returns were converted to constant 1984 dollars.

RESULTS

Table 1 summarizes total revenue, variable costs, and net returns (in nominal dollars) on a per acre basis for each of the enterprises considered.

Table 1. Revenues, Variable Costs, and Net Returns (in nominal dollars) Per Acre for Hybrid Seed and Grain Sorghum Production

	Year				
Enterprise	1981	1982	1983	1984	Average
Hybrid I					
Revenue	402.80	364.49	398.44	371.14	384.02
Var. Costs	142.63	177.38	177.97	201.72	174.93
Net Returns	260.17	187.11	220.47	169.42	209.09
Hybrid II					
Revenue	340.15	371.80	344.87	313.94	342.69
Var. Costs	142.63	177.38	177.97	201.72	174.93
Net Returns	197.52	194.42	166.90	112.22	167.77
Grain Sorghum					
Price/Cwt.	4.58	4.51	5.22	4.60	4.73
Revenue	199.19	213.45	221.68	243.13	219.36
Var. Costs	151.78	192.49	193.07	216.82	188.54
Net Returns	47.41	20.96	28.61	26.31	30.82

Revenues produced by Hybrids I and II were consistently higher than those associated with grain sorghum. Over the four year period, Hybrids I and II averaged 75.1 and 56.2 percent greater revenue per acre than grain sorghum, respectively. Variable costs per acre for the hybrid enterprises were slightly below the grain sorghum enterprise because of the shared expenses the seed company assumed. During the four years under study, variable costs of the hybrid enterprises averaged 7.3% less per acre than grain sorghum.

The profit rates averaged 120% for Hybrid I; 96% for Hybrid II; and 16% for grain sorghum. The large rate was due chiefly to the higher value of the hybrid. Net returns for Hybrids I and II in constant dollars (1981 prices = 100) averaged 6.75 and 5.43 times, respectively, greater net returns than grain sorghum.

Table 2. Net Returns in Constant (1981) Dollars

	Year				
Enterprise	1981	1982	1983	1984	Average
Hybrid I	260.17	176.30	201.26	147.98	196.43
Hybrid II	197.52	183.19	152.36	98.26	157.83
Grain Sorghum	47.41	19.75	26.12	23.04	29.08

CONCLUSIONS

The principal objective of this project was to compare the net returns of two hybrid seeds and irrigated grain sorghum production. This study shows that the hybrid seed enterprises result in considerably higher net returns per acre than the grain sorghum enterprise.

An initial conclusion is that a producer would wish to divert all acres under his/her control to hybrid seed production. The limiting factor on hybrid seed production is the isolation requirement. Realistically, isolation becomes difficult due to the barrier distances required around the perimeter of a field to insure genetic purity. Unless a producer could devote the surrounding acreage to a genetically dissimilar crop which produces acceptable net returns per acre, the barrier acres would become unproductive. Consequently a producer must control a large block of land to grow even a small field of hybrid seed. However, this study indicates that producers in such a situation would find hybrid sorghum production economically advantageous if arrangements with seed companies are available.

The analysis considered only average or typical conditions for yields, input levels, climatic conditions, quality standards, and prices. Changes from these conditions over time or across farms will alter the results obtained in this study. Other limiting factors in the study are that government deficiency payments were not included, and only the policies of a single seed company were used.

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Ordination Analysis of Ant Faunae along the Range Expansion Front of the Red Imported Fire Ant in South-Central Texas

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ABSTRACT

The red imported fire ant (RIFA), *Solenopsis invicta*, is expanding its range into western Texas. Although few native ant species have been found to be either directly or indirectly competitive with the RIFA, collectively or individually native species may offer some resistance, resulting in a decrease in the rate of RIFA infestation. The objective of the present study was to characterize the predominant ant species at the westernmost edge of RIFA infestation and to determine through niche overlap which native ants may be in competition with the RIFA.

Ants from four habitats (juniper, oak, cypress, and pasture) were sampled monthly with pitfall traps in Kerr and Bandera Counties, Texas, for one year. A total of 27,683 individuals representing five subfamilies and at least 37 species was collected. The most commonly collected ants from all habitats were *Solenopsis invicta* (RIFA), *Solenopsis geminata, Pheidole* spp., *Monomorium minimum, Forelius pruinosus,* and *Paratrechina terricola.*

Data analysis by Wisconsin/polar ordination distinctly separates the several habitats in space through time (seasons); whereas, quartile analysis of the prominant ant species emphasizes habitat-season interactions. Factor gradients that determine species prominance within and among habitats are strongly indicated. However, our data indicate that native species may offer only little resistance to the RIFA.

INTRODUCTION

The red imported fire ant (RIFA), **Solenopsis invicta**, is a pest in the southern and southeastern United States, and 12 states have recorded this pest within their borders. The red imported fire ant now infests at least 110 Texas counties and is extending its range westward (Francke et al., 1983).

The geographical distribution of the RIFA and the biotic/abiotic factors affecting its range have been reviewed by Buren et al. (1974), Hung et al. (1977), and Hung and Vinson (1978). Buren et al. (1974) stated that the northward expansion of the RIFA will be limited by winter kill. In fact, the 0° F isoline in the USDA Plant Hardiness Zone Map was originally proposed as the ecological range limit for the RIFA (USDA, 1972). Hung and Vinson (1978) stated that the RIFA may eventually extend its range beyond this proposed limitation and infest most of Texas and Oklahoma. However, Pimm and Bartell (1980) developed a statistical model for predicting range expansion of the RIFA and stated that the 0° F isoline proposed by the USDA is probably accurate for Texas but may not be accurate for Oklahoma. Finally, Francke et al. (1986) stated that the RIFA exhibits only limited physiological adaptations toward coldhardiness, and that nest construction may be more significant in explaining the northward distribution of this species.

Although several native ant species have been reported as either predators or competitors of the RIFA (Bhatkar et al., 1972; Whitcomb et al., 1973; Hung, 1974; O'Neal, 1974; Nickerson et al., 1975), these species appear to have little effect on halting or delaying the range expansion of the RIFA (Hung and Vinson, 1978). In fact, the RIFA seems to be displacing and thus eliminating the native fire ants, **Solenopsis geminata**, and **Solenopsis xyloni** from eastern Texas (Hung and Vinson, 1978).

The major objective of our study was to characterize the predominant ant species with respect to four habitats at the westernmost edge of RIFA infestation in Texas. An additional objective was to quantitatively compare the foraging activities of the RIFA with the other major associated species. From these comparisons, similarities or dissimilarities in activity could lead to the formulation of hypotheses with respect to niche overlap and subsequent competitive displacement involving the RIFA and native ants of Texas.

MATERIALS AND METHODS

Four study sites were demarked in Kerr and Bandera Counties (Fig.1), which are located on the Edwards Plateau in south-central Texas at the western edge of RIFA infestation (Francke et al., 1983). Vegetational communities and site locations were established as follows: juniper (**Juniperus ashei** Buchholz) - grassland community, 0.7 miles SSE of Center Point, along Elm Pass Road; live oak (**Quercus virginia** Miller) - grassland community, 1.5 miles S of Center Point adjacent to Elm Pass Road; southern cypress [**Taxodium distichum** (L.)] - grassland community, 0.9 miles W of Bandera, southwest of State Highway 16 and Farm Road 470 intersection; and Bermuda pasture [**Cynodon dactylon** (L.)] - grassland community, located 0.1 miles SW of State Highway 16 on Farm Road 470.

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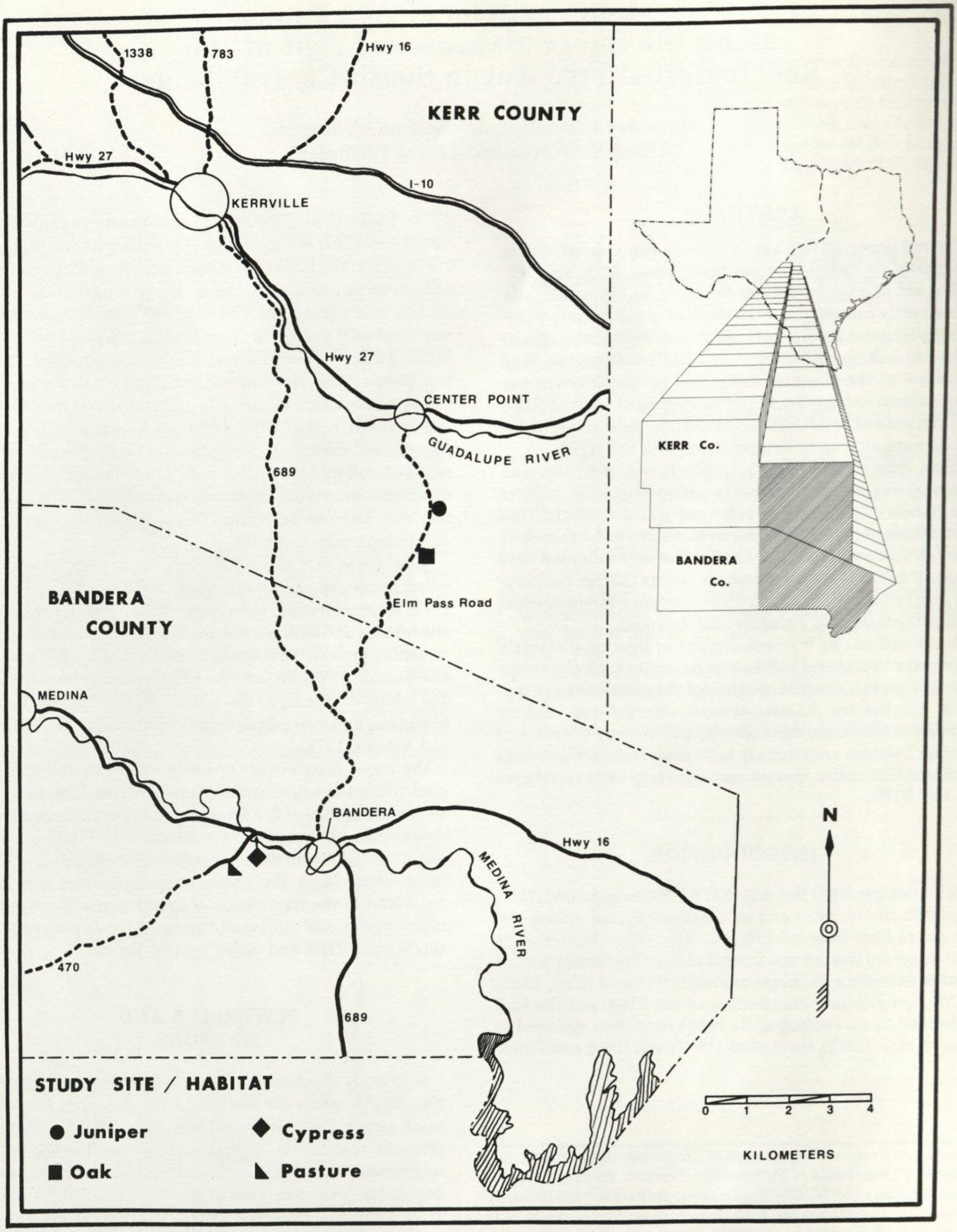

Figure 1. Location of study sites in Kerr and Bandera Cos., Texas. Dotted line on Texas map depicts western edge of RIFA infestation.

A line transect of 20 pitfall traps (16 oz. plastic cups containing ethylene glycol placed approximately 15 ft. apart) was established in each site. An asphalt roofing shingle was secured above each trap to form a protective cover. Traps were placed in the field the beginning of each month, and were left for a period of 7 days from May 1983 through April 1984. All ant specimens trapped were identified and tallied. Identifications were verified from determined specimens in the Entomological Collection, The Museum, Texas Tech University.

Although problems are associated with interpreting the results of pitfall trap sampling, Adis (1979) contends that this method does indicate temporal patterns of dispersal and annual periodicities of activity. Pitfall trapping can also reveal the composition of different habitats through time. In addition, pitfall traps are commonly used to monitor ground foraging arthropod populations.

Data were analyzed by the Wisconsin/polar ordination technique (Bray and Curtis, 1957; Beals, 1960; Burlington, 1962; Della Lûcia et al., 1982). The method is valuable in the analysis of ant activity in selected habitats (Munsee, 1966; Lawson, 1974; Della Lucia et al., 1982). Some of the data collected during this study could not be analyzed because: 1) the pasture did not form an "activity continuum" with the other three habitats; 2) the first three collections in the cypress habitat were negated by a change in study site; and 3) the winter collections in the juniper habitat were considered to be zero (one individual of **Pachychondyla harpax** was taken). The large number of **S. geminata** taken during the summer was the major difference between the pasture and other sites. Secondarily, the pasture exhibited an internal difference among seasons of greater magnitude than the other three habitats; and, the pattern of activity is one of continuous decline, unlike that of the other habitats.

RESULTS

Thirty-seven species representing five subfamilies were detected in the study (Table 1). The subfamily Myrmecinae contained the largest number of species (19), whereas Ponerinae contained the smallest number of species (3). The most commonly occurring myrmecines in descending order were **Solenopsis geminata, Solenopsis invicta** (RIFA), **Monomorium minimum** and **Pheidole** spp. These species were most prevalent in the pasture and cypress habitats. Although the numbers of individuals were small, the most commonly detected species of Ponerinae were **Leptogenys elongata** and **Pachycondyla harpax**. The most commonly occurring species of Dolichoderinae were **Forelius pruinosus** and **Forelius foetidus**. Few dolichoderines were taken in the cypress habitat. **Labidus coecus** was the most commonly collected species of Dorylinae, and it was most prevalent in the pasture habitat. Finally, the most commonly detected member of Formicinae was **Paratrechina terricola**. This species was quite common in the juniper and pasture habitats.

Table 1. Number of individuals/taxa collected from each of four study sites in Kerr and Bandera Counties, Texas, during 12 monthly sampling periods from May 1983-April 1984.

	No. of individuals by study site			
Taxa	Juniper	Oak	Cypress	Pasture
DOLICHODERINAE				
Conomyrma bicolor (Wheeler)	63	0	0	87
Conomyrma spp.	0	0	0	7
Conomyrma insana (Buckley)	20	0	0	11
Forelius pruinosus (Roger)	185	233	2	189
Forelius foetidus (Buckley)	77	8	3	70
DORYLINAE				
Labidus coecus (Latreille)	53	7	0	178
Neivamyrmex nigrescens (Cresson)	0	2	0	0
Neivamyrmex opacithorax (Emery)	1	12	1	27
Neivamyrmex spp.	9	4	0	43
FORMICINAE				
Paratrechina terricola (Buckley)	203	70	52	309
Brachymyrmex depilis Emery	1	0	2	0
Camponotus spp.	2	7	0	1
MYRMICINAE				
Atta texana (Buckley)	0	0	134	57
Crematogaster laeviuscula Mayr	10	136	24	1
Crematogaster minutissima Mayr	1	0	0	0
Crematogaster punctulata Emery	4	11	3	0
Strumigenys louisianae Roger	0	2	3	3
Xiphomyrmex spinosus Wheeler	0	0	14	1
Trachymyrmex turrifex (Wheeler)	3	0	0	0
Myrmecina americana Emery	0	0	1	0
Monomorium minimum (Buckley)	219	311	338	1,197
Pheidole spp.	268	253	500	300
Pogonomyrmex barbatus (Smith)	1	1	1	124
Solenopsis invicta Buren	8	298	1,238	1,369
Solenopsis geminata (F.)	3	32	22	18,669
Solenopsis molesta (Say)	15	9	30	12
Leptothorax schaumi Roger	2	0	1	0
Leptothorax spp.	2	0	1	0
Cyphomyrmex rimosus (Spinola)	0	0	1	0
PONERINAE				
Leptogenys elongata (Buckley)	1	8	18	0
Pachycondyla harpax (F.)	9	20	0	55
Hypoponera punctatissima (Roger)	0	0	6	1
TOTAL	1,160	1,424	2,395	22,704

Ordination showed (prominence values given in Table 2) the cypress, juniper, and oak habitats to be very dissimilar with respect to major species activity (Fig. 2). This dissimilarity or partitioning of habitats may indicate moisture gradient differences in the three vegetational communities. However, ordination indicated both similarities and dissimilarities in the six most predominant taxa, based on major species activity (Fig. 3).

Table 2. Coefficients of similarity and dissimilarity as based on prominence values obtained from numbers of individuals and frequency of occurrence of each ant species detected seasonally in each habitat. Codes are as follows: 0 = oak, J = juniper, C = cypress; S = summer, F = fall, W = winter, SP = spring.

	OS	OF	OW	OSP	JS	JF	JSP	CS	CF	CW	CSP
OS	-	68.3	85.0	67.1	62.7	88.0	75.1	85.8	88.6	74.9	85.2
OF	31.7	-	76.3	87.7	71.7	90.8	94.9	96.7	92.9	88.5	95.0
OW	15.0	23.7	-	95.9	94.3	81.0	97.0	98.1	93.3	90.1	96.7
OSP	32.9	12.3	4.1	-	75.0	97.3	29.6	51.3	80.0	72.5	70.0
JS	37.3	28.3	5.7	25.0	-	93.9	53.8	85.9	95.7	87.0	90.3
JF	12.0	9.2	19.0	2.7	6.1	-	96.1	98.3	40.0	88.3	96.0
JSP	24.9	5.1	3.0	70.4	46.2	3.9	-	57.2	97.0	90.5	82.6
CS	14.2	3.3	1.9	48.7	14.1	1.7	42.8	-	66.6	80.1	45.3
CF	11.4	7.1	6.7	20.0	4.3	60.0	3.0	33.4	-	44.2	30.9
CW	25.1	11.5	9.9	27.5	13.0	11.7	9.5	19.9	55.8	-	55.2
CSP	14.8	5.0	3.3	30.0	9.7	4.0	17.4	54.7	69.1	44.8	-

SIMILARITY

DISSIMILARITY

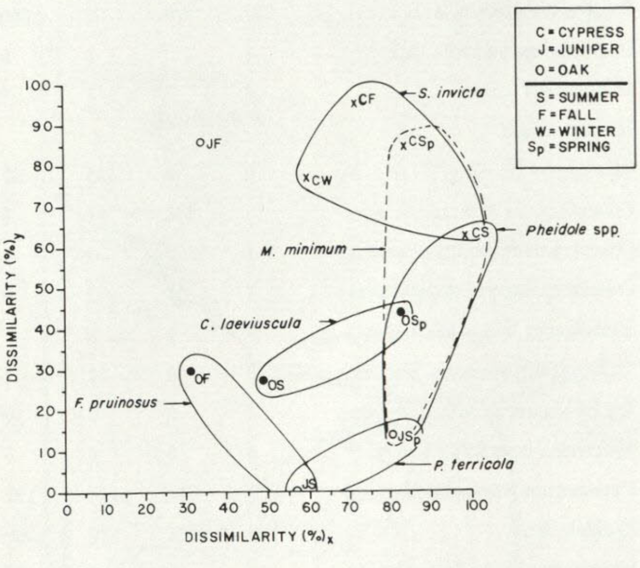

Figure 2. Major ant species activity of three vegetational communities in Kerr and Bandera Cos., Texas (May 1982-April 1983), as plotted by Wisconsin/polar ordination. Data plotted from Table 2.

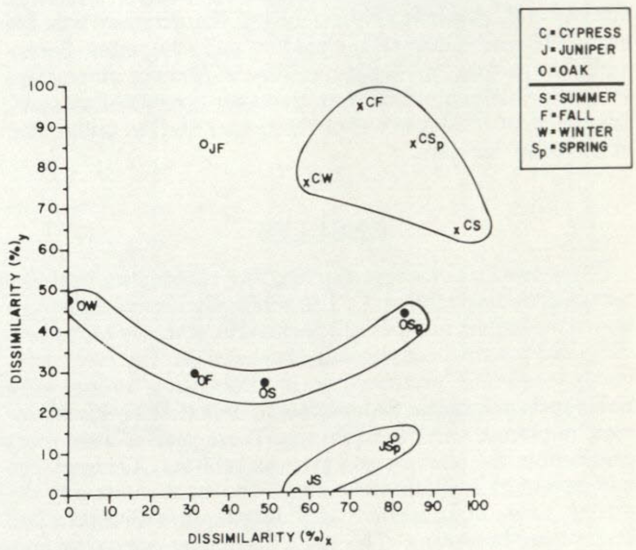

Figure 3. Seasonal activity of major ant species of three vegetational communities in Kerr and Bandera Cos., Texas (May 1982-April 1983), as plotted by Wisconsin/polar ordination. Data plotted from Table 2.

DISCUSSION

Although **Conomyrma insana** reportedly preys on dealated RIFA queens (Nickerson et al., 1975; Hung, 1974), this species is not well represented from our sampling (less than 0.5% of the ant faunae). Also, **S. geminata**, which has been reported to offer some resistance to range expansion by the RIFA (Hung and Vinson, 1978), comprised a large portion of the ants trapped in our study; however, a major habitat separation exists between it and the RIFA. Two other species which reportedly prey on the RIFA, **P. terricola** and **F. pruinosus** were well represented in our study. However, both of these species and the RIFA were very dissimilar in activity. This finding is in agreement with that of Claborn (1985) in which he found a significantly negative association between **F. pruinosus** and the RIFA in a study conducted during the summer using pitfall traps. The only species in our study that overlaps in activity with that of the RIFA are **M. minimum and Pheidole** spp. Although never observed preying on the RIFA, **M. minimum** has been reported to successfully compete with the RIFA (Baroni-Urbani and Kannowski, 1974). In addition, **M. minimum was well represented by our sampling in the juniper, oak, and cypress habitats. Pheidole** spp., which in our study does not overlap in activity with the RIFA as much as **M. minimum,** is stated to be negatively impacted by the RIFA (Whitcomb et al., 1972).

CONCLUSION

Of the five most frequently detected, and therefore predominant, sympatric species found in association with the RIFA, only two overlap in activity. Of these species, **Pheidole** spp. may be negatively impacted by the RIFA. However, **M. minimum** may offer some resistance to RIFA spread. Two other species, **F. pruinosus** and **P. terricola**, prey on RIFA queens; however, our data suggest a lack of niche overlap with the RIFA, indicating either that their impact would be minimal, or that they are preventing niche overlap by preying on founding RIFA queens. **Crematogaster laeviuscula** has not been reported as a factor in RIFA range expansion.

In conclusion, several known ant predators and competitors of the RIFA were detected in the westernmost infested counties of Texas. However, their apparent lack of dominance make them suspect with respect to their potential impact on the RIFA in this region. In fact, the RIFA may be adversely affecting the native ant faunae of Texas through indirect competition, perhaps for limited resources such as food. Therefore the population dynamics of the native species and the interaction of these species with the RIFA should be monitored on a continual basis to determine the impact the RIFA is having on the native ant funae at the westernmost edge of infestation in Texas.

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Effects of Simulated Browsing on Spiny Hackberry after Top Removal

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ABSTRACT

Spiny hackberry (*Celtis pallida*) regrows readily after top removal. Our objective was to determine effects of various simulated browsing intensities in fall and early winter on regrowth and nutritional quality of spiny hackberry after top removal. Spiny hackberry plants were cut to a 10-inch stump height in June 1984 and regrowth was removed either once (6 months after top removal) or twice (3 and 6 months after top removal) at intensities of 0, 25, 50, 75, and 100%. Standing crop and number of sprouts per shrub were measured 13 months after top cutting to determine recovery. Crude protein (CP), neutral detergent fiber (NDF), *in vitro* organic matter digestibility (IVOMD), calcium (Ca), potassium (K), and phosphorous (P) content of regrowth subjected to 0 and 100% defoliation (3 and 6 months after top removal) was determined at 3, 6, and 13 months after top cutting. Defoliation at the intensities and frequencies tested had no significant ($P > 0.05$) effect on standing crop or number of sprouts per plant. Crude protein content, P content, NDF, and IVOMD of regrowth exceeded that of controls (not subjected to top removal) at 3 and 13 months after top removal. Calcium content was lower in regrowth than in controls 3 and 6 months after treatment. Regrowth and controls had similar K levels. Fall and early winter browsing of plants subjected to summer top removal may have little effect on nutritional quality and vigor of regrowth the following growing season.

INTRODUCTION

Browse is a major component of white-tailed deer (**Odocoileus virginianus**) diets in south Texas (Arnold and Drawe 1979, Meyer et al. 1984). Powell and Box (1966) found that top removal by shredding and roller chopping increased utilization of woody plants by white-tailed deer. Regrowth after top removal is more available to deer and higher in nutritional quality than mature plant parts (Powell and Box 1966, Everitt 1983). Everitt (1983) suggested shredding brush in the summer to provide nutritious regrowth during the summer and fall when forbs are less available.

Utilization of regrowth by range animals affects recovery and the ability of the plant to continue growth (Cook and Stoddard 1953). Knowledge of the effects of various levels of regrowth utilization will aid in management of treated areas.

Meyer et al. (1984) reported that spiny hackberry (**Celtis pallida**) was the most preferred browse plant for white-tailed deer during late summer and fall in honey mesquite (**Prosopis glandulosa**) - mixed brush rangeland of south Texas. Our objective was to determine effects of various simulated browsing intensities in fall and early winter on recovery and nutritional quality of spiny hackberry after top removal.

MATERIALS AND METHODS

Study area

The study was conducted at the Texas A & I Range and Wildlife Research Area 7 miles south of Kingsville, Texas, from June 1984 to July 1985. The study area was surrounded by a fence that excluded cattle (**Bos** sp.), deer, and javelina (**Dicotyles tajacu**). Vegetation of the area was described by Ham (1979) and Meyer and Brown (1985) as a honey mesquite-mixed brush association. Soil is Willacy fine sandy loam, a fine-loamy mixed, hyperthermic Udic Argiustoll. The climate is subtropical with hot, humid summers and mild winters. During the study rainfall at the study area totaled 38 inches and varied from trace rainfall in September to 9 inches in May 1985.

Effects of top removal and simulated browsing on regrowth

Spiny hackberry plants 6.5 - 16.4 feet in height were cut to a stump height of about 10 inches above ground level with a chain saw in June 1984. Remaining stems per shrub were recorded. Regrowth was removed either once (January 1985) or twice (October 1984 and January 1985). Height of regrowth from the stump was measured and either 0, 25, 50, 75, or 100% of the regrowth was removed with forage clippers to simulate various browsing intensities. Ten plants were randomly assigned to each treatment. All regrowth was harvested in July 1985, dried at 105°F for 3 days, and weighed. Samples were separated into woody and leaf material by shaking dry leaves from the plants.

Statistical analyses utilized SAS (1982) procedures. Analysis of variance was used to compare treatment effects, and Tukey's test (Kleinbaum and Kupper 1978) was used to identify significantly differently means.

Statistical analyses utilized SAS (1982) procedures. Analysis of variance was used to compare treatment effects, and Tukey's test (Kleinbaum and Kupper 1978) was used to identify significantly different means.

Effects of top removal and simulated browsing on nutritional quality

In a second experiment, all regrowth of 10 randomly selected plants was removed in October 1984 and in January 1985 to simulate repeated heavy browsing. Regrowth of ten other randomly selected plants did not receive simulated browsing. Ten additional plants were randomly selected as controls (i.e., not subjected to top cutting). Browse samples (leaves and green non-lignified twigs) from each treatment were clipped in October 1984, January 1985, and July 1985. Samples were oven-dried 3 days at 105°F, ground to pass through a 0.25-inch screen with a Wiley mill, and stored in polyethylene bags before analysis. Samples were analyzed for crude protein (CP), neutral detergent fiber (NDF), **in vitro** organic matter digestibility (IVOMD), calcium (Ca), potassium (K), and phosphorus (P).

Crude protein (%N × 6.25) was determined by the micro-kjeldahl procedure (A.O.A.C. 1970). Neutral detergent fiber was determined by procedures described by Goering and Van Soest (1970). **In vitro** organic matter digestibility was analyzed by the Tilley and Terry (1963) two-stage technique as modified by Moore et al. (1972). Rumen inoculum was obtained from a Jersey cow (**Bos indicus**) on a roughage diet and forages with known **in vivo** digestibility were included in the **in vitro** digestion. Samples for CP, NDF, and IVOMD were digested in duplicate. Calcium and potassium were determined using a Perkin Elmer Model 2903 atomic absorption spectrometer (Jones 1972). Phosphorus was analyzed by the colorimetric method using a phosphomolybdate reduction with ascorbic acid (Murphy and Riley 1962). Digestion for mineral analysis was done by the nitric acid procedure of Havlin and Soltanpour (1980) with citrus samples included in the digestion.

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Data for each nutrient were analyzed by analysis of variance (SAS 1982). Tukey's test was used at the 0.05 level to identify significantly different means when F values were significant (Kleinbaum and Kupper 1978).

RESULTS AND DISCUSSION

Effects of top removal and simulated browsing on regrowth

Standing crop of spiny hackberry regrowth 13 months after top removal was not affected ($P > 0.05$) by the various simulated browsing treatments (Table 1). Leaf standing crop was similar for all treatments. These findings are similar to those of Trlica (1977), Neff (1978), and Cisse (1980) in which short-term defoliation of shrubs did not reduce growth.

Table 1. Mean standing crop (leaves and stems) and leaf standing crop (ounces/shrub) 13 months after top removal for spiny hackberry regrowth subjected to simulated browsing treatments of 0, 25, 50, 75, and 100% at either 6 months or 3 and 6 months after top removal.

Simulated browsing frequencies	Simulated browsing intensities (%) 25	50	75	100
Once (6 months after top removal)				
Standing crop	10±1.5[1]	9±2.3	4±1.5	6±1.1
Leaves Only	3±0.6	3±0.3	2±1.1	2±0.6
Twice (3 and 6 months after top removal)				
Standing crop	4±1.7	4±1.1	5±2.2	6±1.4
Leaves only	2±0.3	1±0.3	2±1.0	3±0.6
No simulated browsing (0%)				
Standing crop	4±1.1			
Leaves only	2±0.5			

[1]Mean ± standard error, n = 10.

Top removal of spiny hackberry plants stimulated profuse sprouting from the base (Table 2). The number of sprouts per shrub were significantly ($P < 0.01$) higher 13 months after top removal at all simulated browsing intensities compared to original number of stems per shrub. There was no significant ($P > 0.05$) difference in the number of sprouts among the various treatments 13 months after top removal.

Table 2. Average original number of stems and number of stems per shrub about 13 months after top removal for spiny hackberry plants subjected to simulated browsing treatments of 0, 25, 50, 75, and 100% at 6 months or 3 and 6 months after top removal.

Simulated browsing frequencies	Simulated browsing intensities (%) 25	50	75	100
Once (6 months after top removal)				
Original no. stems	7±3[1]	7±5	7±4	6±4
Sprouts/shrub	35±5**	43±10**	27±9**	39±7**
Twice (3 and 6 months after top removal)				
Original no. stems	4±3	5±3	6±5	7±3
Sprouts/shrub	28±5**	30±5**	40±14**	32±5**
No simulated browsing (0%)				
Original no. stems	4±2			
Sprouts/shrub	32±13**			

**Significantly ($P < 0.01$) different from the original number of stems.
[1]Mean ± standard error, n = 10

Effects of top removal and simulated browsing on nutritional quality

Crude protein content, NDF, and IVOMD of spiny hackberry regrowth exceeded ($P < 0.05$) that of control plants in October and July, but not in January (Table 3). No significant ($P > 0.05$) difference in CP, NDF, and IVOMD existed between simulated browsing treatments. The minimum CP requirement for white-tailed deer is 13% (French et al. 1956, Verme and Ullrey 1972). Crude protein content was above this requirement on all sampling dates.

Table 3. Mean percent crude protein, percent neutral detergent fiber and percent *in vitro* organic matter digestibility of spiny hackberry browse from control (i.e., no top removal or simulated browsing) plants, plants subjected to top removal only, and top-removed plants with regrowth clipped in October 1984 and January 1985.

Chemical analyses	Sampling date October 1984	January 1985	July 1985
Crude protein (%)			
Control	23.4a[1]	23.7a	18.2a
Top removal only	26.8b	26.7a	23.8b
Top removed and clipped	26.4b	25.9a	24.2b
Neutral detergent fiber (%)			
Control	29.4a	25.6b	36.9a
Top removed only	21.0b	25.8b	28.8b
Top removed and clipped	24.2b	23.4b	29.3b
In vitro organic matter digestibility (%)			
Control	49.6a	55.7a	46.3a
Top removed only	59.0b	57.3a	51.8b
Top removed and clipped	58.2b	59.9a	54.3b

[1]Means for a nutrient within a sampling date followed by the same letter are not significantly ($P > 0.05$) different according to Tukey's test.

Calcium was lower ($P < 0.05$) in regrowth than in browse from controls in October and January but not in July (Table 4). Mature growth in plants is associated with high calcium concentration (McDowell et al. 1983) because Ca is immobilized in intercellular spaces and the phloem (Fitter and Hay 1981). No significant ($P > 0.05$) difference in Ca existed between top removal only and top removal and clipped treatments. Ca requirements for white-tailed deer range from 0.1-0.2% (Verme and Ullrey 1972). Ca concentration was above these levels on all sampling dates.

Table 4. Mean percent calcium, percent potassium and percent phosphorus of spiny hackberry browse from control (i.e., no top removal or simulated browsing) plants, plants subjected to top removal only, and top-removed plants with regrowth clipped in October 1984 and January 1985.

Chemical analyses	Sampling date		
	October 1984	January 1985	July 1985
Calcium (%)			
Control	3.0a[1]	3.3a	3.2a
Top removal only	2.2b	2.9b	2.9a
Top removed and clipped	2.3b	2.3c	2.9a
Potassium (%)			
Control	1.6a	1.8a	1.8a
Top removal only	1.6a	1.7a	1.8a
Top removal and clipped	1.6a	1.7a	2.0a
Phosphorus (%)			
Control	0.09a	0.10a	0.06a
Top removal only	0.11b	0.10a	0.10b
Top removed and clipped	0.12b	0.10a	0.08b

[1]Means for a nutrient within a sampling date followed by the same letter are not significantly ($P > 0.05$) different according to Tukey's test.

Potassium concentrations did not differ significantly ($P > 0.05$) among treatments and controls on all sampling dates (Table 4). Everitt (1983) reported similar findings for growth from shredded and untreated shrubs. Potassium requirements for white-tailed deer are not established; however, Maynard et al. (1979) stated that minimum levels for ruminants are 0.2-0.3% of the dry ration. Potassium concentrations in spiny hackberry browse exceeded these levels on all sampling dates.

Phosphorus concentration was significantly ($P < 0.05$) higher in top removed than in control plants in October and July (Table 4). Browse from top removed only and top removed and clipped plants had similar ($P > 0.05$) phosphorus concentrations. Phosphorus requirements for white-tailed deer range from 0.25-0.56% of the dry ration (Magruder et al. 1957). Browse samples from controls and regrowth from treated plants contained P levels below these requirements. Other authors have reported P deficiency in range plants in south Texas (Black et al. 1943, Reynolds et al. 1953).

CONCLUSIONS

Inferences based on the results of this study are restricted to the study area because experiments were conducted at only 1 location. Fall and early winter browsing of spiny hackberry subjected to top removal in the summer may have little effect on vigor of regrowth the following growing season. Heavy simulated browsing does not affect the nutritional quality of regrowth; however, regrowth may have higher crude protein and phosphorus levels and higher digestibility than current growth from mature plants for at least 13 months after treatment.

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Latent and Saprophytic Fungal Infections of Grapefruit in South Texas

J.K. Okamura and R.M. Davis[1]

ABSTRACT

Colletotrichum sp. and *Alternaria* sp. were the most common fungi isolated and identified from apparently healthy leaves from grapefruit trees in the lower Rio Grande Valley of Texas. These fungi were also the most abundant fungi isolated from incubated detached leaves. *Colletotrichum* sp. was commonly isolated from healthy twigs while *Diplodia* sp. and *Phomopsis* sp. were the most abundant colonizers of dead twigs. Decayed leaves from the orchard floor yielded *Phyllostictina* sp., the first time this fungus has been documented from Texas citrus. Few fungi were isolated from asymptomatic fruit.

INTRODUCTION

Latent fungal infections are invasions of host tissue without the expression of symptoms by the host plant or the appearance of fungal fruiting bodies. Some latent infections are important in the commercial production of citrus since they may become pathological under environmental conditions conducive to their development. For example, latent infections by **Diplodia natalensis** P. Evans under the button of fruit often result in a post-harvest decay of the fruit. Latent infections of leaves and twigs by **Colletotrichum gloeosporioides** Penz. can result in a stem disease called withertip if the climate is conducive to fungal development (Fawcett, 1936). One study indicated that latent infections by **Guignardia citricarpa** Kiely, the cause of citrus black spot, are capable of persisting within plant tissues for years before manifesting themselves in the form of disease (Kotze, 1981). Thus, the study of latent infections can be important in the epidemiology of citrus diseases. The purpose of this study was to identify fungal infections of asymptomatic grapefruit tissue from South Texas by isolation and culture of recoverable fungi and by microscopic examination of grapefruit tissue.

MATERIALS AND METHODS

Leaf samples were collected from 5 grapefruit trees in various locations within a 4-acre 25 year-old orchard at the Citrus Center in Weslaco. In the last week of June 1986, five asymptomatic leaves from the March and June 1986 flushes of growth and from the previous fall growth flush were picked from each tree. Three sections of leaf tissue approximately ¼″ in diameter were cut at random from each leaf, surface sterilized for 5 minutes in a 10% sodium hypochlorite solution, and aseptically transferred onto potato-dextrose agar plus streptomycin. Subsequent cultures were grown on V-8 juice agar. At the same time, 5 leaves from the same flushes and trees as above were surface sterilized and placed in a cheesecloth bag in a mist chamber. After drying for 5 days, the leaves were sprayed with a fine water mist for approximately 3 minutes per day for a period of 5 weeks. One leaf disk approximately ¼″ in diameter was then cut from each leaf and plated on V-8 juice agar. Five fruit from each tree were also harvested from the test trees. Small pieces of the fruit rind were surface sterilized and plated in a manner similar to the leaves, except that the epidermis of the rind was removed.

To identify fungi from healthy or dead twigs, isolations were made from 220 chips of wood from either asymptomatic live twigs or dead twigs collected in an 8 acre block of 22 year-old grapefruit trees at the Citrus Center. The wood chips were surface sterilized, aseptically transferred to petri dishes of V-8 agar, and incubated 4 to 10 days at room temperature.

Fungal infections were also examined microscopically on fallen leaves on the orchard floor. In addition, single disks were cut from 30 fallen leaves, surface sterilized, and plated as above.

RESULTS AND DISCUSSION

The most common latent infection in healthy fresh grapefruit leaves from all flushes was caused by **Colletotrichum** sp. (Table 1). The number of **Colletotrichum** infections increased as the age of the leaves increased. Similarly, the number of infections by **Alternaria** sp. was greatest in the oldest leaves. The incidence of infection by other fungi was relatively low in all flushes. Only 16% of the leaf disks were apparently not infected by a fungus.

Table 1. Occurrence of latent fungal infections in fresh, asymptomatic grapefruit leaves.[z]

	Leaf flush		
Fungus	Fall 1985	March 1986	June 1986
Colletotrichum sp.	62	56	46[y]
Alternaria sp.	22	4	8
Helminthosporium sp.	0	1	5
Nigrospora sp.	0	7	2
Cladosporium sp.	1	0	0
Unidentified ascomycete	1	0	0
None	9	10	17

[z]Leaf samples collected June 24, 1986.

[y]Number of isolations in 75 leaf disks approximately ¼″ in diameter.

When fresh asymptomatic grapefruit leaves were collected and allowed to dry and decay in a mist chamber, **Colletotrichum** sp. and **Alternaria** sp. were the most commonly isolated fungi, although the incidence of their recovery was lower than recovery from fresh leaves (data not presented). However, these leaves did yield three fungi, **Diplodia, Phomopsis,** and **Macrophoma** sp. not isolated from fresh leaves collected and processed directly from the field. Fungal infections were found in only 2 of the 25 pieces of fruit. In healthy grapefruit twigs, **Colletotrichum** sp. was the most commonly encountered fungus (Table 2). **Diplodia** and

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Table 2. Fungi isolated from healthy and dead grapefruit twigs.

Fungus	Number of isolations in 220 pieces of wood	
	Healthy wood	Dead wood
Colletotrichum sp.	185	32
Phomopsis sp.	15	124
Diplodia sp.	12	176
Fusarium sp.	5	9
Nigrospora sp.	2	18

Phomopsis sp. were commonly isolated from dead twigs, whereas **Colletotrichum** was more commonly isolated from healthy twigs. The fungi on the fallen leaves from the orchard floor, identified either directly by microscopic examination of fruiting bodies or indirectly by examination of fungi recovered in culture from leaf disks, are listed in Table 3.

Table 3. Fungi directly and indirectly identified from fallen and decayed grapefruit leaves.

Direct microscopic examination	Indirect identification via culture of leaf disks[z]
Alternaria sp.	**Alternaria** sp.
Ascochyta sp.	**Cladosporium** sp.
Cladosporium sp.	**Colletotrichum** sp.
Colletotrichum sp.	**Diplodia** sp.
Diplodia sp.	**Fusarium** sp.
Fusarium sp.	**Helminthosporium** sp.
Helminthosporium sp.	Unidentified ascomycete
Nigrospora sp.	
Phyllostictina sp.	

[z]30 leaf disks approximately 1/4" in diameter were plated on V-8 juice agar.

Phyllostictina sp. and **Ascochyta** sp. were the only fungi identified directly on the leaves from the orchard which were not also identified in cultures of these leaves or in cultures of the leaves taken fresh off the trees. The reason for this anomaly was unknown.

The fungus **Colletotrichum** sp. was the most common organism causing latent infections in Texas grapefruit leaves. Baker (1938) found that this fungus also caused frequent latent infections in fruit from grapefruit trees. Adam **et. al.** (1949) came to a similar conclusion in their studies with oranges. In Texas citrus **Colletotrichum** sp. is commonly associated with damaged citrus tissue but in periods of prolonged rainfall accompanied by warm temperatures a wilt and decay of very young shoots can result from infection. Our results indicate that this fungus is extremely common in citrus tissue but apparently becomes pathogenic only in rare cases.

Latent infections of **Alternaria** sp. are also relatively common in Texas grapefruit. **Alternaria** sp. is often associated with necrotic spots on oranges and grapefruit leaves in Texas, but it is probably a secondary invader of weakened tissue and not a primary causal agent of the leaf spots.

Dead wood from grapefruit twigs was commonly colonized by **Diplodia** and **Phomopsis** sp., fungi present but not common in h ealthy tissue. **Diplodia** sp. has been implicated as a causal agent in Rio Grande gummosis, a disease of citrus in Texas always associated with dead wood (Davis, 1980). **Phomopsis** sp. is the cause of melanose, an important rind blemishing disease of citrus (Fawcett, 1936). Apparently, these fungi quickly colonize dead wood and have the ability, at least to a small degree, to form latent infections in live citrus twigs.

Leaves on the orchard floor were colonized by **Phyllostictina** sp., the imperfect state of **Guignardia. Guignardia citricarpa** is the cause of citrus black spot, a serious disease of citrus in South Africa and Asia. We assume that the organism found in our study is an avirulent **Phyllostictina** sp. since citrus black spot is not present in North America. McOnie (1964a) suggested that **Guignardia citricarpa (Phyllostictina citricarpa)**, the pathogenic species, is not found in localities where citrus black spot symptoms are not evident. However, **Phyllostictina** sp. is a commonly occurring avirulent organism in a wide range of plant species. McOnie clarified this issue by showing that although the pathogenic species and the nonpathogenic species are morphologically indistinguishable, they are physiologically and pathogenically different (McOnie 1964b). An avirulent **Phyllostictina** sp. is known to exist latently in citrus in Florida (J.O. Whiteside, personal communication), but this is the first time this organism has been identified in Texas.

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Dietary Factors Affecting Feed Intake In Receiving Feedlot Cattle

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ABSTRACT

Four trials and 822 cattle were used to evaluate the effects of certain dietary factors on initial feed intake in receiving cattle. Cattle offered water only the first 6 to 8 hours off the truck consumed more feed the first day (d) in the feedlot than those offered feed only (1.23 vs .78% of live weight (LWT), P<.05). Cattle offered a mixed corn silage/milo diet consumed more (P<.05) the first d and the first week in the feedlot than cattle offered chopped alfalfa hay (1.27 vs .93 and 1.61 vs 1.41% of LWT, respectively). Cattle offered diets containing 12.5% crude protein (CP) tended to consume more the first d than cattle offered diets containing 10.5% CP. Also, cattle tended to consume greater amounts of diets containing urea and cottonseed meal as supplemental protein than diets containing a corn gluten meal/blood meal mixture. In conclusion, cattle should be offered water and a ration containing a moderate nutrient density (greater than 10.5% CP) when first received at the feedlot.

INTRODUCTION

Inadequate feed consumption as a result of shipping stress, can result in increased health problems and decreased animal performance. Hutcheson (1986) reported that healthy cattle consumed 1.55 vs .9% of live weight (LWT) for morbid cattle. It is not possible for an animal consuming less that 1% of its LWT to achieve adequate nutrient intake. Two major causes of the low intake are the effects of the transportation experience and deprivation of feed and water (Cole et al. 1986). It is not uncommon to fast cattle before shipping, which increases the length of the deprivation period. Stress encountered during transport can have long-term effects. It may lengthen the time required for re-alimentation after the fasting period (Cole et al., 1986). This can lead to a delay in getting the cattle "on feed" and started up the concentrate ladder to the finishing ration. Therefore, any setback at the initiation of the feeding period will result in an extended feeding period and increased costs to the cattle feeder.

The magnitude of the shipping stress will depend in part on the length of feed and water deprivation and management of the cattle when they are received in the feedlot. Diets offered to receiving cattle vary from long grass hay to mixed rations containing 30 to 75% concentrate. Some managers also feel that allowing cattle to fill up on water after truck unloading will decrease feed intake during this critical period (Anonymous, 1985; Thomas, 1986). Barney and Dean (1985) and Hutcheson (1986) reviewed the effects of ration type, feed additives and parasite control on cattle performance the first 28 days (d) in the feedlot, however, factors affecting intake the first week (wk) were not reported. The objectives of these studies were to evaluate the effects of certain dietary factors on initial feed intake in receiving cattle.

EXPERIMENTAL PROCEDURES

Four trials were conducted to evaluate dietary factors affecting feed intake during the first d and first wk of receiving feedlot cattle. Table 1 shows the number of cattle, average weights, length of haul, average shrink and overall intakes for the four trials. Cattle in trials 1, 3, and 4 were gathered off of wheat pasture before being shipped; the feeding background of the cattle in trial 2 was not known. Experimental diets are shown in table 2. Alfalfa hay was chopped through a 2" screen using a tub grinder. All rations were mixed and weighed individually by pen. Cattle were fed once daily and Aureo-S 700 (provided 350 mg of Aureomycin and 350 mg of sulfamethazine per head per day) was top dressed. Feed remaining in the bunk was weighed back one d and one wk after the cattle were put in the pens. Average individual feed intake (DM basis) is expressed on a per head per d basis and was calculated by dividing the feed consumed per pen by the number of cattle in the pen and adjusting for diet dry matter content. The number of cattle per pen (6, 7 or 8 head) varied with trial and was balanced over treatment.

Table 1. Number of cattle, average arrival weight, length of haul, shrink and daily feed intakes (dry matter)[a]

	Trial			
Item	1	2	3	4
Number of cattle	200	200	192	230
Arrival weight, lb	477	423	648	564
Length of haul, miles	135	720	225	135
Shrink				
lb/hd	12	30	34	15
%	2.6	6.6	4.9	2.6
Average Daily intake				
One day, lb	7.5	4.6	7.4	7.4
One day, % of LWT[b]	1.5	1.0	1.1	1.2
One week, lb	9.7	9.4	10.3	11.2
One week, % of LWT	1.9	2.1	1.5	1.9

[a]Least-squares means

[b]LWT = live weight

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Table 2. Experimental Diets[a]

Ingredient	Ration 1	2	3	4	5	6	7	8	9
					%				
Alfalfa hay, chopped	95.0								
Corn silage		73.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9
Cottonseed hulls			22.1	22.1	22.1	22.1	22.1	22.1	22.1
Corn, flaked		15.6							
Milo, flaked			29.0	33.3	32.8	28.7	24.6	30.9	28.4
Cane molasses	4.0	3.0	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Cottonseed meal		5.62	4.97			5.34	9.40		
Blood meal								1.26	2.27
Corn gluten meal								1.83	3.28
Urea		.40	.27	.62	1.11				
Calcium carbonate		.73	.60	.56	.56	.66	.74	.56	.56
Dicalcium phosphate				.40	.40	.17		.38	.36
Salt	.5	.25	.17	.17	.17	.17	.17	.17	.17
Trace mineral premix[b]	.25	.25	.18	.18	.18	.18	.18	.18	.18
Vitamin A premix[c]	.25	.25	.18	.18	.18	.18	.18	.18	.18
Trials	1,2,3	1,2	3	4	4	4	4	4	4

[a]As fed basis.
[b]Adds the following mineral levels to the final ration: Mn 12, Zn 20, Fe 10, Cu 1.5, I .24, Co .15 and Mg 5 ppm.
[c]Adds 1002 IU vitamin A per lb DM.

Receiving procedures. Cattle were unloaded into holding pens with no feed or water available and processing started immediately. Each animal was individually weighed, ear-tagged, the switch cut and horns tipped if necessary. They received the following injections: combined IBR, BVD and PI_3, seven-way clostridium and dewormer (Tramisol or Ivomec, balanced over dietary treatment). Cattle were then gate cut into holding pens containing the appropriate number for that study. Immediately after the completion of processing, cattle were taken to their respective pens. Treatments were randomly assigned to pens.

Trials 1 & 2. Two trials and a total of 400 crossbred cattle (100 heifers and 100 steers in trial 1; 200 heifers in trial 2) were used to evaluate the effect of water only, feed only or free access to both water and feed the first 6 to 8 hours off the truck, on initial feed intake. Cattle were unloaded, processed and assigned to pen and treatment (24 and 31 pens for trials 1 and 2, respectively). The first day's diet was primarily chopped alfalfa hay (ration 1, table 2). The second d a 50:50 mixture of ration 1 and a corn silage ration (ration 2, table 2) was fed. Ration 2 was fed ad lib for the rest of the study (7 d).

Trial 3. One hundred and ninety two crossbred steers were used to evaluate the effects of chopped alfalfa hay (ration 1, table 2) vs a corn silage/milo ration (ration 3, table 2) on feed intake. Cattle were unloaded, processed and randomly assigned to pen and treatment (12 pens per treatment). The first d in the feedlot cattle were offered either ration 1 or 3 (table 2). All cattle were fed ration 3 for the remainder of the trial (7 d).

Trial 4. Two hundred and thirty crossbred heifers were used to evaluate the effects of protein source and level on feed intake. Heifers were unloaded, processed, and randomly allotted to pens and one of six treatments. Supplemental protein sources were urea, cottonseed meal (CSM) and a 50:50 mixture of blood meal:corn gluten meal (BM-CGM; N basis). These sources were added to the diet in appropriate amounts to achieve diet crude protein contents of 10.5 and 12.5% (3 × 2 factorial). Diet composition for the protein treatments is shown in table 2 (rations 4, 5, 6, 7, 8 and 9).

Statistical analysis was done using the General Linear Models procedure of SAS (SAS, 1985). The model contained treatment effects as the independent variables.

RESULTS

Cattle used in the studies were shipped from approximately 135 to 720 miles to reach the Burnett Center for Beef Cattle Research, Texas Tech University (table 1). Percentage shrink was related to length of haul (2.25 + .63/100 miles, r = .90, $P<.05$). Increasing length of haul decreased one d intake as a percentage of LWT (1.36 - .053/100 miles, r = -.70, P = .09) but tended to increase one wk intake (1.70 + .049/100 miles, r = .54, P = .15).

Trials 1 and 2. Table 1 shows the 1 d and 1 wk average daily feed intakes in lb/head and as a percentage of LWT for each trial. In trial 1 (2.6% shrink), there was no effect of treatment on feed intake. Water only, feed only, and the combination resulted in cattle consuming about 1.5% of LWT the first d and about 1.9% of LWT the first wk. The same treatments in trial 2 (6.6% shrink) resulted in significance differences among treatments. Water only resulted in greater 1 d intake than did feed only (1.23 vs .78% of LWT, respectively). Access to both water and feed resulted in an intermediate intake (1.01% of LWT). One wk intakes were not different.

Table 3. Daily feed intake (dry matter) for trials 1,2,3, and 4[a]

Item	Dry matter intake[b]			
	One day		One week	
	lb	% of LWT	lb	% of LWT
Trial 1				
Water only	7.3	1.44	9.6	1.86
Feed only	7.6	1.52	9.7	1.92
Water and feed	7.6	1.51	9.8	1.94
Standard error		.14		.06
Trial 2				
Water only	5.5	1.23[b]	9.2	2.06
Feed only	3.7	.78[c]	9.4	2.04
Water and feed	4.6	1.01[b]	9.4	2.08
Standard error		.13		.06
Trial 3				
Alfalfa hay, chopped	6.1	.93[b]	9.6	1.45[b]
Corn silage/milo	8.6	1.27[c]	11.0	1.61[c]
Standard error		.08		.03
Trial 4				
Source:				
Urea	7.9	1.34	11.3	1.92
CSM[e]	7.7	1.29	11.4	1.92
BM[f]/CGM[g]	6.6	1.10	10.8	1.80
Standard error		.09		.07
Percent (%):				
Protein 10.5	7.0	1.19	11.0	1.87
Protein 12.5	7.8	1.30	11.4	1.90
Standard error		.07		.06
Source by percent:				
Urea 10.5	8.0	1.36	11.0	1.88
Urea 12.5	7.8	1.32	11.6	1.96
CSM 10.5	6.8	1.15	10.9	1.85
CSM 12.5	8.6	1.43	11.9	2.00
BM/CGM 10.5	6.2	1.05	11.1	1.87
BM/CGM 12.5	7.1	1.16	10.6	1.73
Standard error		.12		.10

[a]Least-squares means.

[b,c,d]Means in the same trial and column with different superscripts are different (P<.05).

[e]CSM = cottonseed meal.

[f]BM = blood meal.

[g]CGM = corn gluten meal.

Trial 3. Steers consumed more of the corn silage/milo ration than the chopped hay ration (1.27 vs .93% of LWT, respectively; P<.001) the first d in the feedlot. Negative effects of the chopped hay appeared to carry over, since steers given ration 1 the first d consumed less during the first wk than steers given ration 2 (1.46 vs 1.61% of LWT, respectively; P<.05) even though both groups were given the same diet for six of the seven days.

Trial 4. There was no significant interaction of protein source and level. Heifers tended to consume more of the 12.5% rations than the 10.5% CP rations (1.30 vs 1.19% of LWT, respectively, P=.25) the first d in the feedlot. However, 1 wk intakes were not different due to protein level. The first d feed intake for urea and CSM tended to be higher than BM-CGM (1.34 and 1.29 vs 1.10% of LWT, P=.07 and .13 respectively). One wk intakes for urea and CSM also tended to be higher than BM-CGM (1.92 and 1.92 vs 1.80% of LWT, respectively, P=.24).

DISCUSSION

Trials 1 & 2. The contrasting results of trial 1 and 2 suggest that length of haul or percentage shrink may have affected the response of cattle to treatment. The "long haul" cattle (trial 2) consumed less when offered feed first than when offered water first. There was, however, no effect of treatment in the "short haul" cattle (trial 1). It should be noted that the 2.6% shrink in the trial 1 cattle was a relatively small weight loss. Lofgreen et al. (1983) termed cattle with 6.1% shrink "low stress" and cattle with 10.8% shrink "high stress". Although water intake was not determined, trial 2 cattle were obviously thirsty and drank before feeding when given the choice. These results indicate that there was no negative effects of allowing the cattle to fill up on water before feed was available.

Trial 3. Steers consumed more of the corn silage/milo diet (approximately 50% concentrate equivalent) than chopped alfalfa the first d in the lot (table 3). Chopped hay was apparently less palatable than the mixed ration. The cattle appeared to be mostly long yearlings and may have received rations containing corn silage and concentrates previously. There were no digestive problems noted with the mixed ration indicating receiving cattle (consuming 1.0 to 1.5% of LWT) can initially be fed a ration containing 50% concentrate with no negative effects. In fact, the increased nutrient intake due to greater nutrient density may be beneficial as indicated by the greater 1 wk intakes observed in the cattle fed the mixed diet in this study.

Trial 4. It is possible that the greater first d intake of the 12.5% vs the 10.5% CP rations was due to a more rapid recovery of rumen fermentation activity. First wk intakes were not different between protein levels. There was no difference in intake on the first d or first wk when comparing urea and CSM. However, both tended to be superior to the BM-CGM combination. This is most likely attributable to a palatability problem of the blood meal and/or the corn gluten meal.

In conclusion, these results indicate that along with proper processing and health management, cattle should have access to at least water and probably water and feed when first received at the feedlot. Feed should contain a greater nutrient density than hay alone and should contain more than 10.5% crude protein.

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Integrating Microcomputer Instruction In Vocational Agriculture Through Programmatic Research and Development

Marvin J. Cepica[1]

ABSTRACT

The purpose of this study was to assist in the successful integration of computer related instruction into regular vocational agriculture programs in Texas by determining the types of computer hardware and software which were available for use by vocational agriculture students and teachers, to ascertain additional software needs, and to develop software packages to meet high priority needs of vocational agriculture teachers and students. In addition, the inservice needs of vocational agriculture teachers regarding computer instruction were determined.

Radio Shack TRS-80 and Apple computer brands were most prevalent in public schools of Texas. Software packages were developed based on the utilization of high priority needs as identified by vocational agriculture teachers. Radio Shack and Apple versions of a supervised occupational experience record book program and Radio Shack programs for vocational agriculture equipment/supply inventories and carpentry were developed.

Microcomputers are beginning to be accepted and utilized in vocational agriculture programs in Texas. Increased usage will parallel the acquisition of hardware and appropriate software by vocational agriculture teachers who do not currently have access to computers, the additional development and availability of appropriate instructional software packages, and the upgrading of vocational agriculture teacher skills as provided by inservice workshops at universities, by private industry and individual study.

INTRODUCTION

Technology is changing the world daily. Educators, especially vocational educators, must stay abreast of the technological changes to be effective in teaching students a marketable skill. One area vocational educators should be particularly attuned to is computer education.

The need for computer related instruction and the impact of high technology on our society has been expressed through numerous sources and by various leaders in industry and education. The Texas Advisory Council for Technical-Vocational Education and the Texas Education Agency explored this impact through a **State-wide Conference on High Technology** (1982). Conference presentations addressed the need for educators to provide students the opportunity to develop skills which can be utilized in future employment. It was pointed out that curriculum models should be developed to teach certain skills in connection with an occupational objective rather than in abstract form.

A report by the Texas Advisory Council for Technical-Vocational Education (1982) supports the need for vocational programs to expand the curriculum to include computer instruction. The report indicated that computers are frequently used in many school districts for instructional purposes, but the extent of these resources and how effectively they are being used is not currently known. The report made the following two recommendations for the State Board for Vocational Education:

1. Conduct a statewide computer resource, utilization and needs survey of secondary and post-secondary institutions as it relates to instruction; and
2. Develop a plan of action for developing computer literacy among vocational personnel and students, and expand current microcomputer technology in the vocational education curricula.

NEED FOR THE STUDY

Computer literacy is especially important for students in vocational agriculture programs since computers are used throughout the agricultural sector, from small family farms to international agricultural corporations. Computer literacy is important not only for those students seeking vocational careers, but also for those students planning a college education. Most agricultural college curriculums, regardless of major, include at least one computer course. The student who learned the basics of computer operation in high school will have the advantage of approaching college classes with introductory level computer skills.

A recent legislative mandate in Texas requires the inclusion of computer related instruction in regular vocational programs to provide a well balanced curriculum. The need is further addressed in the proceedings of the USDA Joint Council which states, "Everything possible must be done to ensure that students in agriculture-related curriculums have computer skills" (Kramer, 1982).

Several limiting factors exist which hinder the use of microcomputers in vocational agriculture classrooms (Rodenstein, 1983). One major drawback has been the limited availability of microcomputers to vocational agriculture programs. Another problem has been the lack of applicable, high quality software packages which have been available for use in vocational agriculture courses. A third factor has been the vocational agriculture teachers' lack of knowledge concerning the use of microcomputers in their classrooms.

As vocational agriculture teachers begin to accept computers as a beneficial instructional aid and begin to request microcomputers for use in their programs, the problem of computer availability should be reduced. However, only when teachers become computer literate and begin to assist others in the development of software especially designed for use in vocational agriculture will the problem of limited software availability be overcome.

OBJECTIVES OF THE STUDY

1. Identify existing types of computer software which are adaptable for use by vocational agriculture students and teachers.
2. Ascertain additional software needs for use by vocational agriculture students and teachers.
3. Develop software packages to meet high priority needs of vocational agriculture teachers and students.
4. Determine inservice needs of vocational agriculture teachers regarding computer instruction.
5. Determine what computer hardware and software is accessible to vocational agriculture teachers.

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6. Project future computer equipment needs in Texas public schools.

7. Recommend procedures needed to incorporate computer instruction in the regular vocational agriculture programs in Texas.

METHODS AND PROCEDURES

This project was conducted simultaneously in two phases. Phase I included an extensive review of literature, a descriptive survey of vocational agriculture programs, and a survey of teacher education programs in Texas. Phase II consisted of feasibility studies of existing software and the development of additional software packages as determined by the vocational agriculture program survey.

All Texas vocational agriculture departments (922) were included in the program survey and one follow-up mailing was made. Of the 465 returned questionnaires (50.4 percent), 446 usable questionnaires were included in data tabulation. All nine agricultural education departments were included in the study. A telephone call preceded a single mailing which yielded a 100 percent return.

Results of the vocational agriculture departmental survey were tabulated by geographical area, size of school, and number of students enrolled in vocational agriculture programs. Number counts, percentages, medians, and weighted means were used in tabulation. Factors such as microcomputer uses in the school, as well as in vocational agriculture classes were analyzed. The location, number, and makes of microcomputers used for student instruction were also tabulated. Chi-square and ANOVA were computed to determine differences by geographical area and school size; however, no statistical differences were found at the .05 level of significance. Analyses of the data provided by the Agricultural Education Department survey were grouped by frequencies regarding past and projected microcomputer inservice training provided (or to be provided) vocational agriculture teachers.

From the vocational agriculture department survey, priority areas for software development within the curriculum areas listed in the **Texas Basic Curriculum Guide for Vocational Agriculture** was determined. Existing software packages available within determined priority areas were ordered for review. Software was reviewed in relation to cost, adaptability to Texas vocational agriculture programs, suitability of instruction for intended students, and the quality of the program in regard to interaction and graphics.

RESULTS

Through a review of existing literature and feasibility studies, it was determined that numerous sources were available for agriculturally-oriented software packages for use in secondary vocational agriculture programs. There was, however, a critical shortage of practical and economical computer programs.

To ascertain additional software needs for use by vocational agriculture students and teachers, open-ended responses were tabulated by curriculum areas as listed in the **Texas Basic Curriculum Guide for Vocational Agriculture**. In the area of Animal Science, "feed rations and conversion analyses" was requested by 128 respondents. Software packages involving "production records" were requested by 41 respondents. In the area of Soil Science, software packages for "soil analysis" (44 respondents) and "land evaluation" (38 respondents) were most requested (50 and 28 requests respectively) in the area of Plant Science. In the area of Agricultural Mechanics, a software package involving figuring a "bill of materials" was requested by 46 respondents followed by 32 respondents requesting software for "small gasoline engine" instruction. Teachers needing software for Agricultural Management most requested the area of "farm records" (39 respondents) followed by "depreciation" and "income tax" requested by 30 respondents each. The most requested software program in the survey was in the area of Supervised Occupational Experience, were 201 respondents requested a software package enabling students to keep "record books" on the microcomputer. "Parliamentary procedure problems" was the most requested area in Leadership Instruction (118 respondents) and "careers in agriculture" was the most requested software (60 respondents) in the curriculum area entitled Opportunities in Agriculture. Requests for software packages other than specific curriculum areas (but relating to the vocational agriculture program) were software packages for a vocational agriculture equipment/supplies inventory, for which 158 requests were received.

Teachers from 241 schools (54 percent) reported that microcomputers were used for administrative purposes in their school system. Three hundred forty-six schools (78 percent) reported that microcomputers were currently being used for teaching purposes in their school system. Computers were available for student and teacher use in 189 (42 percent) of the vocational agriculture departments surveyed. Only eight percent (34 schools) had computers located in the vocational agriculture department.

The brands of microcomputers available in secondary schools were determined through the teachers' survey. The following information was revealed.

	TRS-80	Apple	Commodore	TI	IBM	Others
Total Number of Schools	146	137	62	24	20	16

Less than one-half (45 percent) of the schools having computers available utilized commercially produced software and only 25 percent utilized school system or personally developed software. There were no statistical differences concerning hardware and software availability and use between size of school, number of students enrolled in vocational agriculture and geographical areas of the state.

Only 18 percent of the schools surveyed indicated they had no plan to integrate computer related instruction in their vocational agriculture programs within the next five years.

Through tabulation of the open-ended question in the vo-ag department survey, "What instruction do you need to help integrate computer instruction in your vo-ag program?", 88 percent of the respondents indicated that inservice workshops were needed to develop basic computer skills. Several indicated that two or three-day workshops would not give enough time to remove deficiencies in this area. Only 10 percent of the teachers who had access to computers available for instruction in vocational agriculture were presently capable of writing programs for their own use.

The survey of Agricultural Education Departments revealed that universities currently providing or planning to provide computer inservice workshops utilized or will utilize instructors primarily from within their own university system. Over 50 percent of the computers used in university inservice workshops were Radio Shack models. There was general agreement that beginning, intermediate, and advanced levels of instruction would be used in future inservice educational workshops for vocational agriculture teachers.

To assist in the successful integration of computer related instruction in vocational agriculture in Texas vocational agriculture programs, four software programs were developed for use by vocational agriculture teachers and students. Radio Shack and Apple versions of a program enabling students to keep records of their supervised occupational experience programs were completed. As noted by the vocational agriculture program survey, this was the highest priority area identified, coupled with the predominant access to available hardware. Two additional software packages (based on priority and availability) were developed for use on Radio Shack hardware. These were in vocational agriculture equipment/supplies inventories and carpentry program to determine a bill of material.

CONCLUSIONS AND RECOMMENDATIONS

1. Some vocational agriculture teachers need to work with their administrators in obtaining access to computers located in the school or make plans for purchase of computers for use in their departments.

2. The compatability of hardware and the availability of appropriate software should be a careful consideration in future equipment purchases by school districts. Future trends should be considered.

3. Additional specialized software will be in demand for further development of computer related instruction in vocational agriculture.

4. Priorities have been determined for needed software; however, the priority needs should be reevaluated as teachers and students become more proficient in the use of microcomputers.

5. Vocational agriculture teachers are generally interested in integrating computer related instruction in their vocational agriculture program but need additional training in the use of computers. Universities should provide inservice workshops at beginning, intermediate and advanced levels. Additional workshops should be made available at district, area and state levels. Teacher education programs should incorporate pre-service education concerning microcomputers if they are currently not required for graduation.

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Effects of Postemergence Herbicides on Seedling Development of Selected Legumes[1]

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ABSTRACT

Three herbicides were evaluated in a series of growth chamber experiments for possible phytotoxic or growth retarding effects on alfalfa (*Medicago sativa* L.), crimson clover (*Trifolium incarnatum* L.), and subterranean clover (*Trifolium subterraneum* L.) seedlings emerging through a straw mulch treated with the herbicides. After legumes were planted in a coarse, sterile sand and covered with a .25 in. layer of chopped bermudagrass, treatments of Fusilade (0, .125, .25, and .50 lb. a.i./acre), Roundup (0, .45, .90, and 1.8 lb. a.i./acre), and Paraquat (0, .25, .50, and 1.0 lb. a.i./acre) were applied. One-half of each herbicide treatment received a daily misting while the other received water only as needed to maintain plant health.

A daily misting apparently gave significantly higher emergence percentages compared to the 4-day interval when Paraquat was applied to either crimson or subterranean clover plantings. Herbicide treatment apparently had little or no effect on hypocotyl or radicle elongation of subterranean clover. However, a significant reduction in a radicle length was seen with the Roundup treatment on crimson clover while a similar trend was observed with subterranean clover.

INTRODUCTION

It is the objective of many forage growers to produce high quality vegetation throughout the year. This is often accomplished by overseeding perennial pastures with annual crops which grow most actively during periods in which the perennial crop is dormant. Previous studies have shown that certain postemergence herbicides provide effective seedbed preparation for establishment of grass and legume crops being interseeded into a perennial pasture (Appleby and Benchley, 1968; Lee, 1964; Salazar and Appleby, 1982). Two herbicides that are commonly used for chemical seedbed preparation are Paraquat (1, 1'dimethy 1-4, 4'bipyridinium ion) and Roundup [N-(phosphonomethyl)glycine]. Another chemical that may be of some value in this type of program is Fusilade (butyl 2[4'(6-trifluoromethyl-2pyridyloxy)phenoxy]-propionate).

Several researchers have indicated that a possible disadvantage of chemical desiccation might be that of damage caused to young seedlings emerging through plant residues that have been sprayed with herbicides (Hurto and Turgeon, 1979; Moshier et al., 1978; Moshier and Penner, 1978). The purpose of this study was to evaluate the effects of the previously mentioned herbicides on alfalfa (**Medicago sativa** L.), crimson clover (**Trifolium incarnatum** L.), and subterranean clover (**Trifolium subterraneum** L.) when emerging through residues treated with the herbicides.

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MATERIALS AND METHODS

A bioassay study was conducted in three separate growth chamber experiments at Sam Houston State University Agronomy Lab. In each experiment, 72 aluminum loaf pans, approximately 4 in. × 8 in. × 3.5 in. deep were filled with washed, coarse sand. The 72 pans were divided into three groups of 24, each planted to either subterranean clover, crimson clover, or alfalfa. Twenty-five legume seeds were placed in each pan and covered with an additional 1/8 in. layer of sand. A layer of dried bermudagrass, chopped into 1½ in. lengths and approximately ¼ in. in depth was then placed in each pan. The 24 pans planted to each legume were further divided into four groups of six each. These four groups received the following rates of herbicide application:

Fusilade	Glyphosate	Paraquat
1. Control - no chemical	control	control
2. .125 lb. a.i./acre*	.45 lb. a.i./acre	.25 lb. a.i./acre
3. .25 lb. a.i./acre	.90 lb. a.i./acre	.50 lb. a.i./acre
4. .50 lb. a.i./acre	1.8 lb. a.i./acre	1.0 lb. a.i./acre

*a.i./acre - active ingredient per acre

Only one herbicide treatment was in the growth chamber at one time. Three replicates of each herbicide treatment on each legume were randomly arranged in the lower portion of the growth chamber and received a light daily misting with a hand sprayer upon emergence of the first seedlings. The purpose of the misting was to simulate the effect of morning dew each day during seedling emergence through the straw or grass covering under field conditions.

The other three pans of each group were randomly arranged in the upper portion of the growth chamber and the straw covering was misted only when providing necessary water to the seedlings at four day intervals.

The seedlings were allowed to grow for 21 days at temperatures of 60° F during the day and 54° F at night. Day length was set at 12 hours. After 21 days, 10 seedlings were randomly selected from each pan and carefully removed intact and measured for hypocotyl elongation, root length, and dry matter. Additionally, germination percentage was calculated for each pan. Data on subterranean clover and crimson clover were statistically analyzed by the analysis of variance (AOV) and Duncan's multiple range test. Data collected from alfalfa treatments could not be analyzed statistically due to numerous missing values caused by a low germination rate. The poor germination rate of the alfalfa was assumed to be due to poor seed quality based upon subsequent germination tests.

RESULTS AND DISCUSSION

The data presented in tables 1 and 2, comparing the two mist treatments, show insignificant effects of mist treatment on most parameters measured. Exceptions were noted in radicle length of crimson clover treated with paraquat in which daily misting produced a reduction, and percent emergence was improved by daily misting of both clovers treated with paraquat. A possible explanation for the reduced emergence with the 4-day misting treatment is that plants did not receive adequate moisture during this critical stage with the problem being corrected in the subsequent experiments with Roundup and Fusilade. These observations warrant further investigation using alternate means of supplying soil moisture and additional soil types, with and without the mulch covering.

Table 1. The effect of daily misting vs. misting at 4-day intervals on crimson clover following herbicide application to a straw mulch covering, Huntsville, 1984.

Herbicide	Parameter	Mist Treatment Daily	4-Day
Paraquat	Emergence (%)	70.7 a*	60.7 b
	Hypocotyl Length (in.)	.63a	.52a
	Radicle Length (in.)	.33a	.47a
	Dry Matter (mg/10 plants)	143a	136a
Roundup	Emergence (%)	55.0 a	57.7 a
	Hypocotyl Length (in.)	.32a	.45a
	Radicle Length (in.)	.25a	.28a
	Dry Matter (mg/10 plants)	108a	122a
Fusilade	Emergency (%)	90.3 a	90.0 a
	Hypocotyl Length (in.)	.58a	.47a
	Radicle Length (in.)	.33a	.29a
	Dry Matter (mg/10 plants)	105a	61a

* Mist treatment means followed by the same subscript within each row are not significantly different at the 5% level as determined by ANOVA and Duncan's multiple range test.

Table 2. The effect of daily misting vs. misting at 4-day intervals on subterranean clover following herbicide application to a straw mulch covering, Huntsville, 1984.

Herbicide	Parameter	Mist Treatment Daily	4-Day
Paraquat	Emergence (%)	88.3 a*	68.0 b
	Hypocotyl Length (in.)	.52a	.48a
	Radicle Length (in.)	.34a	.38a
	Dry Matter (mg/10 plants)	111a	98a
Roundup	Emergence (%)	70.0 a	73.7 a
	Hypocotyl Length (in.)	.48a	.49a
	Radicle Length (in.)	.29a	.25a
	Dry Matter (mg/10 plants)	98a	111a
Fusilade	Emergence (%)	90.5 a	90.0 a
	Hypocotyl Length (in.)	.48a	.49a
	Radicle Length (in.)	.29a	.26a
	Dry Matter (mg/10 plants)	89a	89a

*Mist treatment means followed by the same subscript within each row are not significantly different at the 5% level as determined by ANOVA and Duncan's multiple range test.

As a consequence of the inconclusive or insignificant effects observed due to mist treatment, tables 3 and 4 display means averaged across the mist treatments. For the most part, herbicide treatment had little or no significant effect on seedling development of either clover. However, radicle length in crimson clover was significantly reduced with the Roundup treatment. The same general trend was observed with subterranean clover, but the differences were not statistically significant. No other definite trends were noticed with either clover regardless of treatment. Glyphosate (active ingredient in Roundup) treatment with a high concentration solution (10^{-4} M) was reported to reduce shoot growth but not root growth on red fescue (**Festuca rubra** L.) and Kentucky bluegrass (**Poa pratensis** L.) (Moshier et al., 1976). Moshier and Penner (1978) also found that glyphosate applied at higher rates (10^{-6} M solution) could cause a reduction in the shoot length of vernal alfalfa. It is interesting to note that we did not observe a significant reduction in shoot length with either clover. It is unlikely that Roundup rates any higher than those used in this study could be used in a sod desiccation program without causing significant damage or death of the sod crop.

Table 3. The effect of various herbicide treatments on crimson clover, averaged across mist treatments, Huntsville, 1984.

Herbicide Treatment (1b.a.i./acre)	Emergence (%)	Hypocotyl Length (in.)	Radicle Length (in.)	Dry Matter (mg/10 plants)
Fusilade				
Control	85.3a*	.54a	.30a	109a
.125	76.0a	.56a	.28a	89a
.25	79.3a	.52a	.35a	69a
.50	71.3a	.50a	.32a	97a
Roundup				
Control	59.3a	.50a	.46a	146a
.45	54.0a	.45a	.24b	123a
.90	58.0a	.35a	.17b	88a
1.80	54.0a	.42a	.18b	132a
Paraquat				
Control	55.3b	.57a	.44a	159a
.25	65.3a	.60a	.38a	124a
.50	68.7a	.56a	.38a	132a
1.0	73.3a	.58a	.40a	144a

*Means with the same subscript within a column and within a herbicide are not significantly different at the 5% level according to ANOVA and Duncan's multiple range test.

Table 4. The effect of various herbicide treatment on subterranean clover, averaged over mist treatments, Huntsville, 1984.

Herbicide Treatment (1b.a.i./acre)	Emergence (%)	Hypocotyl Length (in.)	Radicle Length (in.)	Dry Matter (mg/10 plants)
Fusilade				
Control	85.3a*	.43a	.30a	87a
.125	90.0a	.46a	.28a	72a
.25	90.7a	.40a	.29a	97a
.50	94.7a	.44a	.30a	67a
Roundup				
Control	76.0a	.51a	.32a	120a
.45	67.3a	.53a	.31a	105a
.90	77.3a	.44a	.25a	100a
1.8	66.7a	.46a	.21a	93a
Paraquat				
Control	74.0a	.49a	.35a	112a
.25	80.0a	.51a	.33a	108a
.50	83.3a	.49a	.36a	80a
1.0	75.3a	.51a	.39a	118a

*Means with the same subscript within a column and within a herbicide are not significantly different at the 5% level according to ANOVA and Duncan's multiple range test.

SUMMARY AND CONCLUSIONS

The data from this study indicate that fusilade and paraquat could be used in a sod desiccation program for the establishment of crimson or subterranean clover without any danger of reducing germination or seedling development. A field study is currently being conducted to evaluate the effects of these compounds on a bermudagrass sod when Fall applied. Although glyphyosate had no apparent effect on subterranean clover in regards to seedling development, the trend noted on seedling emergence and its significant effect on crimson clover warrant further investigation.

From these data, it appears that dew formation following herbicidal application (simulated by mist treatments) would have little or no effect on legume seedlings emerging through plant residues that had been treated with the herbicides. Evidently, the activity of the herbicides is much reduced by the time actual seedling emergence takes place. This is possibly due to inactivation by environmental elements. Possibly, the misting treatment was sufficiently heavy to wash herbicides from the straw mulch into the soil, thereby causing reduced radicle elongation due to herbicide activity in the soil solution with Roundup. This is assumed to be possible only because the sand used in this study was sterile and possessed no chemical activity that might have otherwise rendered the Roundup inactive.

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Earth Sheltered Structures: Soil Temperature Variation and Site Aesthetics[1]

R.E Zartman and K.S. Hutmacher[2]

ABSTRACT

Soil temperature variations were evaluated at an earth-sheltered church and several ancillary sites in Lubbock, Texas. The objectives were to compare the fluctuations in soil temperature over an existing earth sheltered structure versus those in a native soil, and to evaluate the influence of vegetation and water management on soil temperature fluctuations. In experiment I, thermocouples were installed at various depths under a bermudagrass (Cynodon dactylon) turf above the roof of an earth sheltered church and in a similarly vegetated area adjacent to the church. Temperatures were measured daily in both sites at four depths from July, 1983 through March, 1986. Mean soil temperatures above the roof were approximately 5° F warmer from March to September and 5° F cooler from October to February than the adjoining soil area. In a second experiment, the vegetative cover was evaluated using (1) bermudagrass, (2) buffalograss (Buchloe dactyloides), (3) and bare soil. Results indicated grass covers did not significantly (< 2° F) influence temperatures below 18 in. Separate water management studies indicated less temperature fluctuation in moist soils than in dry soils (11 vs. 14° F) and temperature fluctuation was greater (14 vs. 9° F) in summer than winter. Soil cover no deeper than 18 in. and plants able to thrive without irrigation should be advocated for this area's earth sheltered structures.

INTRODUCTION

Earth-sheltered structures are as old as humankind and as new as tomorrow. Golanz (1986) reported on below-ground dwellings in use for 4000 years in Turkey and on those currently inhabited by 40,000,000 Chinese in the loessial soils the controlling factor in the determination of architectural design. Today, earth-sheltered architecture has grown in popularity faster than technology can define its optimal design. In the interim, architects, builders, and engineers have progressed in the construction of earth-sheltered buildings guided by a blend of climatic knowledge and "conventional wisdom" (Geiger, 1965; Underground Space Center, 1982).

Supplementing the insulative quality of soil with plant materials in earth-sheltered structures is one example of conventional wisdom used to respond to contemporary situations. Depending on characteristics such as those of the site, (Robinette, 1976a), soil (Wright, 1986), plant materials (Taylor and Terrell, 1982; Robinette, 1972), and geography (Labs, 1982) designers modify the basic earth-sheltered shell to attempt to provide superior energy efficiency and aesthetics. Experience indicates that though deciduous woody ornamentals provide shade during the summer and light transmission in the winter, they are too deep rooted to be used above earth sheltered structures (Robinette, 1976b). However, deciduous woody ornamentals may be planted outside the soil envelope surrounding the earth sheltered structure to provide shading for entrances and wells. Herbaceous plant materials are more suited for "above structure" planting due to shallower rooting depths (Taylor and Terrell, 1982). Plant materials also have an important aesthetic role in the development and acceptance of earth-sheltered housing. The need exists to document vegetation and water management influences on temperature variation over earth-sheltered structures. Our objectives were to evaluate the fluctuation in soil temperature over an existing earth-sheltered structure and to investigate the influence of several vegetation and water management schemes on soil temperature variation.

MATERIALS AND METHODS

This study consisted of three independent experiments conducted in Lubbock, Texas. Data were analyzed using a completely randomized design with split plots (locations).

Experiment I: The primary site for this experiment was St. John Neumann Catholic Church, which is virtually earth

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covered to a depth of 2 ft. and vegetated with bermudagrass (**Cynodon dactylon**). Duplicate copper-constantan thermocouples were installed within the soil envelope at depths of 2, 6, 12, and 24 in. immediately above and adjacent to the styrofoam insulated roof. Duplicate thermocouples were buried in another bermudagrass location 12 ft. away from the building. Soil temperature, ambient air temperature, and interior building temperature (from return air ducts) were automatically recorded every six hours from July, 1983 through March, 1986. Mean monthly temperatures were determined by averaging daily data across all the depths.

Experiment II. To study the effects of vegetative cover on soil temperature fluctuation, three additional Lubbock sites were selected with similar soil characteristics. Sites were chosen with the following cover conditions — (1) mature stand of buffalograss (**Buchloe dactyloides**), (2) mature, well-managed bermudagrass lawn, and (3) bare soil. Each site was instrumented with thermocouple pairs at 0.5, 2, 6, 12, 18, and 24 in. depth and replicated three times. Soil and air temperatures were manually determined biweekly for 17 months. The bermudagrass was mowed twice weekly during the summer and received 12 in. of irrigation and 6 lbs. N per 1000 ft.^{2}. The dryland buffalo grass was shreaded annually. The bare soil treatment was periodically sprayed with herbicide (Roundup, 2% solution) to eliminate seasonal weed growth over the instrumented profile.

Experiment III. Additional bare plots on campus were used to determine irrigation water temperature effects on soil temperature. Sites were instrumented similarly to the plots in experiment II except for the omission of the 0.5 and 24 in. depth thermocouples. Two inches of hot, tepid, or cold water (treatments) were added once in the summer and once in the winter. The summer conditions were as follows: 77° F initial (dawn) soil temperature; 73° F initial air temperature; hot water, 176° F; tepid water 68° F; cold water, 40° F. The winter conditions were as follows: 32° F initial (dawn) soil temperature; 33° F initial air temperature; hot water, 140° F; tepid water, 57° F, and cold water, 37° F.

RESULTS

I. Earth Sheltered Structure Study

Soil temperatures above the church roof were cooler in the winter and warmer in the summer than temperatures in the adjacent soil (Fig. 1). The exceptions were December 1984

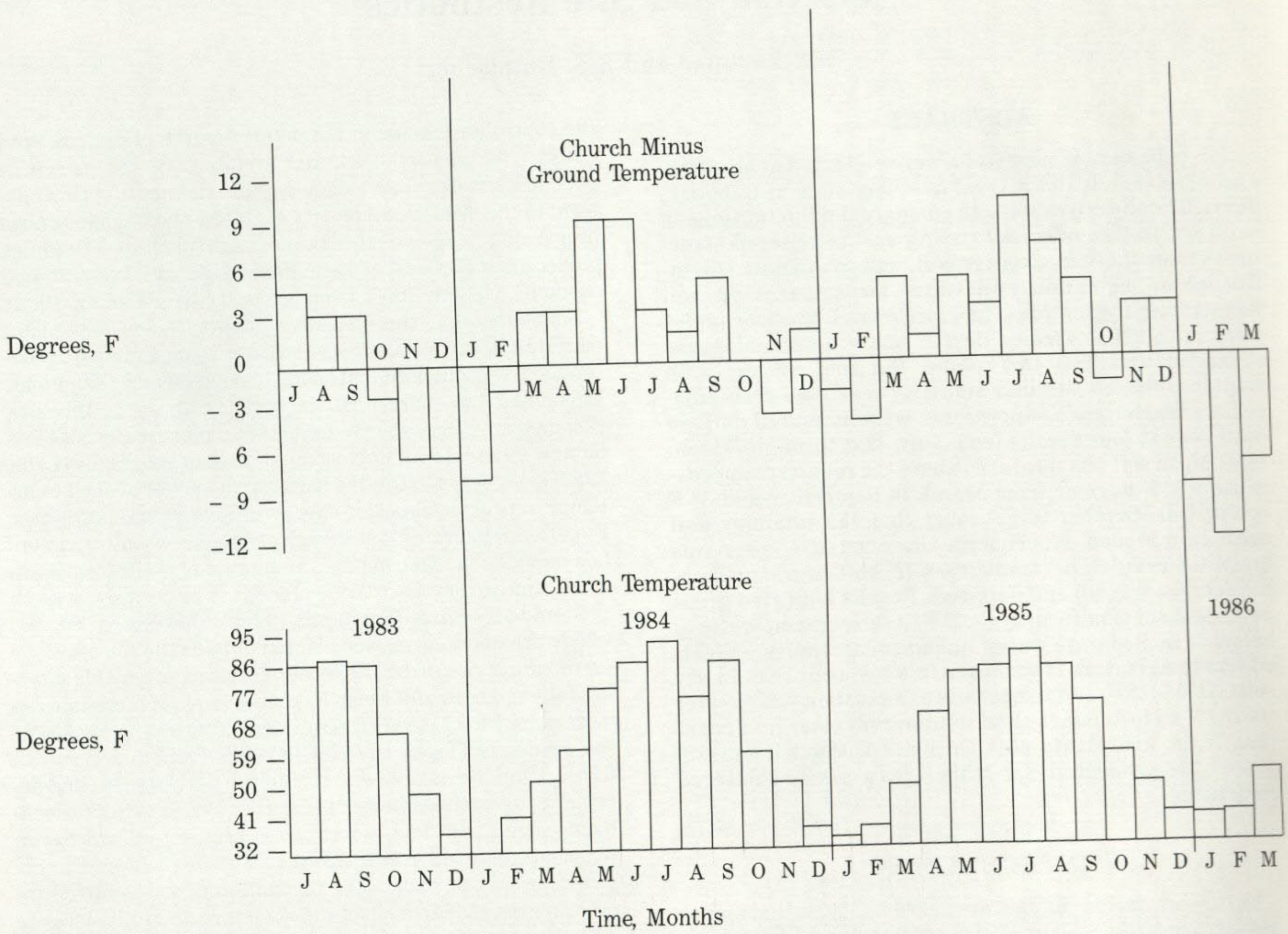

Fig. 1. Monthly Soil Temperature above St. John Neumann Church in Lubbock, Texas and Temperature Difference between Church and Ground. (Experiment 1)

and November and December 1985. Above roof soil temperatures fluctuated from a warm monthly (July) average of 95° F to a cold monthly average of 32° F (January, 1984). Temperature for the soil plots adjacent to the church were cooler in summer (July, 85° F maximum) and warmer in the winter (January, 38° F minimum). Soil temperature amplitude for the test period was less (63 vs 47° F) due to the soil mass acting as heat sink/source to the soil. From October to February, the soil below the zones of measurement served as heat source for the soil above. The insulated church roof did not supply comparable heat during this period of time. From March through September, the soil above roof was approximately 5° F warmer than the adjacent soil. Temperature differences again were due to the insulated roof. As the solar radiation and heat load increased, the insulated church did not act as a heat sink to the same extent as the soil mass in the adjacent site. The soil temperature increased above the roof more than in the adjacent area; however, had a lower peak temperature than the ambient outside air temperature.

II. **Vegetation and Temperature Fluctuation Study**

Soil temperature varied with depth, cover treatment, and air temperature. The fluctuations in soil temperature were greatest at the shallow depths under all cover treatments. The annual fluctuation at the 2 in. depth was 72° F while it was only 36° F at 24 in. Deeper depths had less fluctuation, thus demonstrating the buffering effect of the soil. Differences due to mulching effects between the three sites were evident in magnitude of temperature variation as a function of depth (Table 1). Temperature fluctuation was also noticeably dampened by a cover crop at the shallow depth of 2 in. Depth, however, was more efficient in dampening temperature variation than was cover crop. Specifically, from March through July, the bare soil was significantly warmer (5 to 9° F) at the 0.5 and 2 in. depth than either grass. At the 6 and 12 in. depth the bare soil was approximately 2° F warmer than the grasses from April through July. The bare soil was approximately 2° F warmer than the grasses from mid-April to June and May for the 18 and 24 in. depths, respectively. The buffalograss and bermudagrass did not exhibit significantly different temperatures despite supplemental irrigation of the bermudagrass.

Table 1. Mean soil temperature variation with time as a function of vegetative cover, 1982. (Experiment II)

	Bufallo-grass	Bare Soil	Bermuda-grass
		° F	
Jan	40	41	42
Feb	46	48	45
Mar	53	56	54
Apr	64	66	63
May	69	72	69
June	73	76	76
July	79	86	81
Aug	84	87	92
Sept	86	91	80
Oct	75	79	73
Nov	57	59	56
Dec	44	46	45

III. **Water Management Study**

The water management was evaluated to determine the efficiency of water in cooling and heating a soil. Results (Table 2) indicated that moist soils had less diurnal temperature fluctuation than dry soils in the summer. The very presence of water in the soil acts as a temperature buffer due to the differences in specific heat capacity of water and soil. Although the hot water treatment summer soil temperature initially increased from 77 to 86 and 82° F at the 2 and 6 in. depth, respectively; after 8 hours there were no significant differences in temperatures. In the summer, the wet soil treatments remained 3 to 7° F cooler after 8 hours than the dry one demonstrating that the presence of water was more important than its application temperature. The hot water treatment soil temperature increased at the 2 and 6 in. depth for 45 min. before it stabilized and began to cool. The heating of the day caused increased temperature at 300 min. The soil temperature of the dry and tepid water treatments remained relatively constant ($<2°$ F) at the 2 in. and 6 in. depth, until the afternoon warming. The cold water treatment decreased for 45 and 120 min. at the 2 in. and 6 in. depth, respectively, before warming. In the winter, due to initial cold soil temperature (32 and 36° F for the 2 and 6 in. depth respectively) and the cold air temperature, little response to irrigation water temperature were evidenced. These results indicated that in the environment of Lubbock, Texas, application of irrigation water had no significant long term effect on the structure.

Table 2. Two and 6 inch depth soil temperatures as a function of time and temperature of water applied. (Experiment III)

Time	Season															
	Summer								Winter							
	Hot		Dry		Tepid		Cold		Hot		Dry		Tepid		Cold	
Min	2″	6″	2″	6″	2″	6″	2″	6″	2″	6″	2″	6″	2″	6″	2″	6″
0	77	77	77	77	77	77	77	77	32	36	32	36	32	36	32	36
15	79	77	79	77	75	77	66	77	48	41	32	36	32	36	32	36
30	88	81	79	79	77	77	61	72	53	43	32	34	32	36	32	34
45	88	82	79	79	75	77	59	70	57	45	34	34	34	37	32	34
60	86	82	79	79	75	77	61	68	59	45	34	34	37	37	32	34
90	84	82	79	79	77	77	63	68	63	45	32	34	41	41	34	36
120	84	82	81	79	77	77	66	68	63	45	34	34	41	41	34	36
180	84	82	82	81	82	77	77	72	63	45	34	34	43	41	36	37
240	80	82	86	82	88	82	77	73	61	45	36	36	43	43	37	37
300	86	84	86	82	86	82	79	77	61	45	39	37	45	43	39	37
360	86	84	90	86	86	82	82	77	59	45	43	39	45	43	41	37
420	88	84	91	88	88	82	82	79	46	45	43	39	45	45	41	37
480	88	86	91	90	88	86	84	81	45	45	43	41	45	45	41	39

CONCLUSIONS

The major influence on the soil as a contributor to the energy balance of an earth-sheltered structure was its mass. Data indicated that increasing soil depth decreased temperature fluctuation. However, the influence of each additional inch of soil must be weighed against its impact on the structural components of the building. No reason to advocate soil depths greater than 18 in. could be substantiated by this research.

Secondly, the use of plant materials on earth covered roofs and walls should be promoted primarily for aesthetic reasons, as their effect at an 18 in. depth was not significant. Similarly, the use of water to irrigate plants, especially water that has been heated or cooled, did not significantly benefit the structure's energy balance. Since elimination of irrigation lessens the challenges to the building's waterproofing barriers, planting should be designed to minimize irrigation demands while maintaining aesthetic quality. We believe that native and naturalized plants which are able to thrive without supplementary irrigation would be the best choice for vegetative cover on earth structures.

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Effects of Repeated Shredding on a Guajillo (*Acacia belandieri*) Community

Timothy E. Fulbright[1]

ABSTRACT

Shredding is often used to manage brush in South Texas. The objective of this study was to determine the effects of repeated shredding on density and canopy cover of browse plants used by white-tailed deer (*Odocoileus virginianus*) and on brush species diversity in a guajillo (*Acacia berlandieri*) community. About 2000 acres in Zavala County were shredded at 3-year intervals from 1969-1978 with a drag-type shredder. In 1985, brush density and canopy cover were determined in 5 unshredded and adjacent shredded areas. Shredding had little effect on density and canopy cover of high, medium, and low value browse plants. Density of exceptionally palatable plants was lower on shredded than on unshredded areas. Brush species diversity was also lower on shredded range.

INTRODUCTION

Shredding is widely used for brush management on the South Texas Plains (Hamilton et al., 1981). The treatment removes top growth but rarely kills brush (Welch et al., 1985). Although top growth is replaced within 2-3 years (Welch et al., 1985), a short-term increase in forage production often occurs following shredding (Scifres, 1980). Other advantages of shredding include improved management efficiency by increasing visibility of livestock and improved grazing distribution (Scifres, 1980). Hamilton et al. (1981) suggested shredding at 3-5 year intervals to suppress stands of mixed brush in South Texas.

Top removal increases palatibility of brush for cattle and white-tailed deer (**Odocoileus virginianus**) (Box and Powell, 1965; Powell and Box, 1966). Powell and Box (1966) attributed increased palatibility to greater browse availability and nutritional quality. Everitt (1983) found that regrowth of shredded brush had higher crude protein and phosphorus levels than current growth from nonshredded plants.

Guajillo (**Acacia berlandieri**) is a desirable livestock and wildlife browse species that dominates shallow ridges in the Rio Grande Plain of Texas (Davis and Spicer, 1965). The USDA Soil Conservation Service recommends shredding for management of guajillo because of its value for browse (Scifres, 1980). The objective of this study was to determine the effects of shredding at 3-year intervals for 9 years on white-tailed deer browse and brush species diversity of a Guajillo community.

MATERIALS AND METHODS

The study was conducted on the A.L. Cardwell Ranch in Zavala County in the South Texas Plains. The study area is a Gravelly Ridge range site with gravelly loam over caliche

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or gravelly clay soils (USDA-SCS, unpublished information). The ranch is grazed by cattle at 18-20 acres/animal unit yearlong (A.L. Cardwell, pers. commun.).

About 2000 acres of brush were shredded at 3-year intervals from 1969-1978 with a drag-type shredder (A.L. Cardwell, pers. commun.). Initially, a machine with a heavy 9-foot single blade was used. Later, a "Terrain King" with a 15-foot "bat-wing" blade was used. To provide regrowth for deer, the shredder was adjusted to a cutting height of 10-12 inches. Shredding was done primarily in the spring. Small tracts of untreated brush were left to provide cover for wildlife.

Five untreated sites ranging from about 1-8 acres in size were used for study. Maximum distance between sites was about 2 miles. At each site, 2 164-foot transects were randomly placed in the untreated area and in an equal-sized portion of the adjacent shredded area. Three 5 × 16-foot plots were placed at 49-foot intervals along each transect. Woody plants and cacti rooted in each plot were recorded by species. Canopy cover of brush was determined by the line intercept method (Canfield, 1941) using 4 66-foot transects in each treatment at each site. Data were collected in the summer of 1985.

Shannon's index was used to determine brush diversity (Pielou, 1977). Absolute brush density was used in the calculation of Shannon's index and evenness. Values for evenness should accompany values for diversity because diversity depends on both the abundance of each species and species richness.

Brush species were categorized into exceptional, high, medium, and low value browse for white-tailed deer (Nelle, 1984). Paired t-tests (n=5 sites) (Snedecor and Cochran, 1967) were used at the 0.05 level to determine if differences in canopy cover and density between treatments were significant for each category. Diversity and evenness were also compared between treatments using paired t-tests.

RESULTS AND DISCUSSION

Canopy cover of exceptional, high, and low value browse was similar on shredded and unshredded areas (Table 1).

Table 1. Mean canopy cover (%) and density (plants/acre) of 4 categories of white-tailed deer browse plants on rangeland shredded at 3-year intervals from 1969-1978 and on unshredded range, Zavala County, Texas 1985.

Brush parameter	Value for white-tailed deer[1]			
and treatment	Exceptional	High	Medium	Low
Canopy Cover (%)				
Unshredded	3	29	36	5
Shredded	$<1^{ns}$	33^{ns}	31*	$<1^{ns}$
Density (plants/acre)				
Unshredded	647	1,205	5,360	647
Shredded	126**	$1{,}817^{ns}$	$5{,}552^{ns}$	162^{ns}

[1]Exceptional plants were Texas kidneywood (**Eysenhardtia texana**) and elbowbush (**Forestiera angustifolia**); high value plants were guajillo (**Acacia berlandieri**), spiny hackberry (**Celtis pallida**), pricklypear (**Opuntia lindheimeri**), and guayacan (**Porlieria angustifolia**); medium value plants were blackbrush (**Acacia rigidula**), Mexican persimmon (**Diospyros texana**), purple sage (**Leucophyllum frutescens**), honey mesquite (**Prosopis glandulosa**), shrubby blue sage (**Salvia ballotaeflora**), and desert yaupon (**Schaefferia cuneifolia**). The only low value plant was whitebrush (**Aloysia lyciodes**). Classification of species based on Nelle (1984).

*,** Values significantly different between treatments at the 0.05 or 0.01 levels, respectively.

Shredded areas supported 14% lower canopy cover of medium value browse than unshredded range. Density of exceptional plants was lower on shredded than on unshredded areas. For other browse categories, density weas similar between treatments.

Fulbright and Beasom (1985) found that medium value browse species such as honey mesquite (**Prosopis glandulosa**) were more abundant on sites that had been root plowed 30 years earlier than on unplowed sites. High value browse plants were present in lower abundance on root-plowed than on unplowed sites. Although shredding may reduce the density of exceptional browse plants, it may be a more desirable brush management treatment than root plowing for landowners who want to maintain high value deer browse. Exceptional browse plants are highly palatable but usually compose a smaller portion of deer diets than high value plants because they do not make up a significant part of the brush community, even on range that has not been subjected to brush management (Nelle, 1984).

Brush species diversity was significantly ($P<0.01$) higher for unshredded (0.66) than for shredded areas (0.49). Values for evenness were also significantly ($P<0.01$) higher on unshredded range (0.76) than on shredded range (0.64). Species richness was also lower on shredded areas. Thirteen brush species were encountered on untreated areas compared to 11 on shredded range.

Results of this study were consistent with previous studies on the effects of mechanical brush management on brush diversity. Fulbright and Beasom (1985) found that at 30 years post-treatment, fewer brush species were present on root plowed than on untreated range.

Plant species diversity is important for quality white-tailed deer habitat (Varner et al., 1977; Scifres, 1980). However, no clear relationships between level of diversity and quality of deer habitat have been established. Thus, further studies are needed to determine if the reduction in brush diversity resulting from repeated shredding would be detrimental to white-tailed deer.

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Was It Grassland? A Look at Vegetation in Brewster County, Texas through the Eyes of a Photographer in 1899

James T. Nelson and Patrick L. Beres[1]

ABSTRACT

In 1984 research was initiated to determine the field locations of several photographs taken in the Trans-Pecos in 1899 by R.T. Hill of the U.S. Geological Survey. The objective was to re-photograph the scene and document, through repeat photography, apparent changes in vegetation since 1899.

At each site photos were taken with a 35 mm SLR camera using a 50 mm and a 28 mm lens with black and white print film. A visual survey of vegetation was made and dominant species identified.

Comparative analysis of historic and modern photos indicate a wide variety of trends — from a large degree of shrub increase to no perceptible change, as well as situations in which the overall aspect of vegetation is the same as in 1899 but shrub height has increased.

INTRODUCTION

In the spring of 1984 research was initiated to determine the field locations in the Trans-Pecos at which various historic photographs had been taken. The objective was to re-photograph the scene and document, through this repeat photography process, apparent changes in vegetation since the period in which the original photograph was taken.

Documentation of original vegetation before extensive disturbance by civilized man's activities is of interest to range scientists in that the original vegetation may be indicative of potential natural vegetation, or climax vegetation, for the area. Ecological range condition is based on present species composition compared to perceived climax composition (Dyksterhuis, 1949). Several sources of information can be used to gather evidence concerning the nature of pre-settlement vegetation patterns. One is through historical literature, another by examining undisturbed natural landscapes (relict areas) and another through the use of historic photographs.

Quantitative description of vegetation in the Trans-Pecos seems to be non-existent in historic literature. Historic descriptions of vegetation can be very general or may provide a documentation of species (Parry, 1859), but the concept of relative amounts of different species (species composition) was apparently not considered important by early day travelers. It is precisely that type of information that modern scientists would like to have.

Early photographs can be useful in providing clues to the nature of historic vegetation in the absence of representative relict areas (Ames, 1976; Hastings and Turner, 1965; and Nelson, 1981). Ninteenth century photographers generally did not choose landscapes and vegetation as their primary subject matter. Exceptions to this are the photos taken on geologic surveys such as the Haydon expedition of 1876 and the expedition of R.T. Hill through the Big Bend region of Texas in 1899. Hill was primarily interested in recording the Trans-Pecos landscape and his photos provide a view of vegetation as it existed at a particular moment, 87 years ago.

METHODS

A series of photographs taken in 1899 by R.T. Hill of the U.S. Geological Survey were used as a basis for then-and-now photographic comparison. The Hill photos were provided by the U.S.G.S. in Denver, Colorado where the original glass plate negatives are on file along with a brief description of photo locations. The field location of each photograph was determined by extensive travel throughout the suspected area by car and on foot. Exact locations were determined by matching topographical features visible in the background or foreground or both if possible. Hill traveled by wagon and used a bulky tripod mounted camera. Most of his photos were taken close to existing roads. Old maps (1895-1915) were useful in locating possible or probable photo points once the general area was determined. Exact dates of the historic photos are not available, but every attempt was made to match lighting as evidenced by direction and length of shadows. Modern photos were taken with a 35 mm SLR camera using a 50 mm or 28 mm lens and black and white print film. The 50 mm lens came closest to approximating the view in the historic photographs. At each site a visual survey of vegetation was made and dominant species identified. The distribution of dominant vegetation was compared between current conditions and the 1899 photos. The following presentation is based on an analysis of four representative photo matches out of 17 taken in 1984. Current research is continuing in the analysis of 20 or more of Hill's photos. Negatives, photographs and other archival material will be housed in the Archives of the Sul Ross State University library.

RESULTS

Figure 1-A (Hill, 1899) shows an open grassland on the 02 flats 37 miles south of Alpine (possibly tobosagrass — **Hilaria mutica**) with scattered shrubby plants (possibly mesquite — **Prosopis glandulosa**) to the left. A band of dense shrub growth extends northward from the center of the photo and appears to be encroaching onto the grassy flat. Large numbers of livestock were introduced into the area in the 1880's, and this grassland appears to be grazed closely. A fence is visible behind the horse indicating some degree of livestock management at the time (pieces of this fence were found by the authors). The modern photo taken in 1984 (Fig. 1-B) shows a well established community of creosotebush (**Larrea tridentata**) along with some whitethorn (**Acacia constricta**) and mesquite. The principle grass present is burrograss (**Scleropogon brevifolius**) with a few scattered remnants of tobosagrass. The actual grass cover appears to be as good as in 1899, but creosotebush has taken over as an overstory dominant.

[1]Authors are Assistant Professor and Graduate Student in Range Management Respectively, Sul Ross State University. This project was Funded by a Grant From the State of Texas.

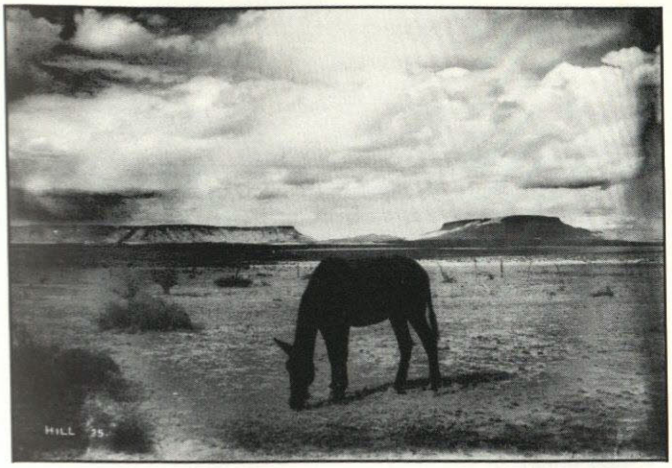

Figure 1-A. R.T. Hill #35, 1899. "Elephant mesa and whirlwind plateau, looking north; Brewster County, Texas" (U.S.G.S.).

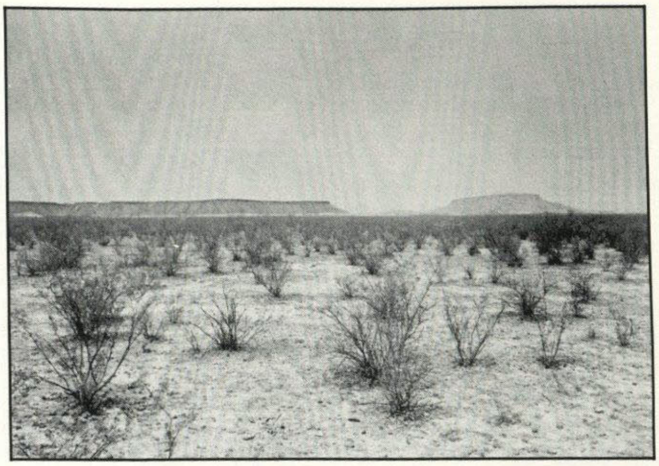

Figure 1-B. April, 1984. Elephant mountain and Mitchell mesa from the 02 flats, 37 miles south of Alpine, Texas, and 4 miles west of HyWy 118. U.S.G.S. grid coordinants FD3102 Emory Peak sheet.

Figure 2-A (Hill, 1899) shows a fully developed desert shrub community 54 miles south of Alpine probably consisting of creosotebush, mesquite and tarbush (**Flourensia cernua**). Interspaces between the shrubs consists of a low grass cover. Today (Figure 2-B) the brush density appears very similar to what existed in 1899 and is composed of creosotebush, tarbush, whitethorn acacia and scattered cacti. The grass cover appears as good or better than in 1899 and consists of three-awns (**Aristida spp.**), slim tridens (**Tridens mutica**), burrograss and ear muhly (**Muhlenbergia arenacea**). This photo pair documents a desert shrub community present in 1899 persisting relatively unchanged to the present time.

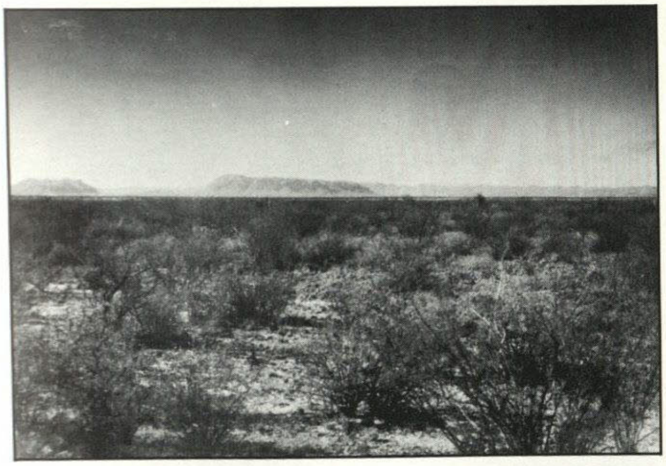

Figure 2-A. R.T. Hill #40, 1899. "Agua Fria mountain ten miles west; Brewster County, Texas" (U.S.G.S.).

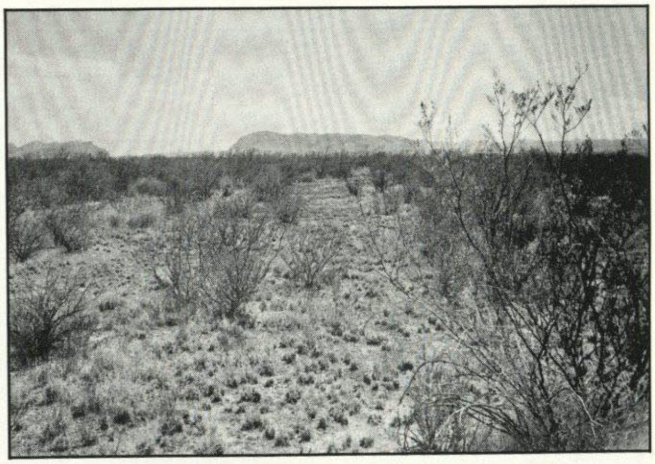

Figure 2-B. April, 1984. Aqua Fria Mountain with Packsaddle mountain to the left and the Solitario mountains in the background, 54 miles south of Alpine, Texas and .75 miles west of HyWy 118. U.S.G.S. grid coordinants FC3974, Emory Peak sheet.

Figure 3-A (Hill, 1899) was taken approximately 56.5 miles south of Alpine of the Camel's hump and Corazones mountains. The scene in 1899 is of a well established shrub community with an understory of short and sparse grass. There appears to be several species of shrubs present — possibly acacias, four-wing saltbush (**Atriplex canescens**) and creosotebush. The scene in 1984 (Figure 3-B) shows a scene dominated by shrubs much as it was in 1899. The creosotebush, mesquite and tarbush present today are taller than the shurbs present in 1899, and grass cover is almost non-existent. Mariola (**Parthenium incanum**) and whitethorn acacia are also present.

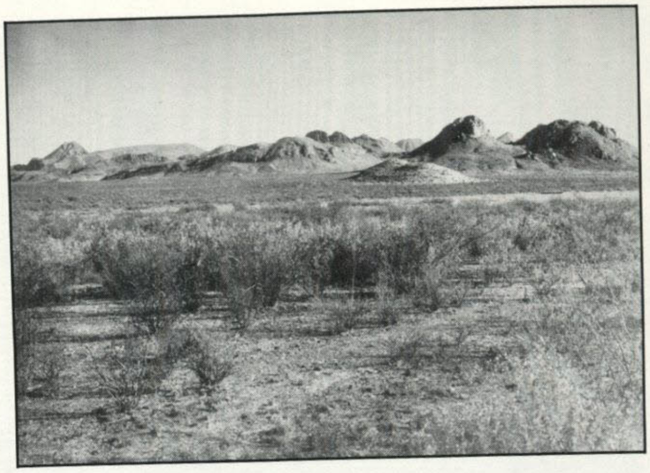

Figure 3-A. R.T. Hill #41, 1899. "Northwest mountains of the Corazones group; Brewster County, Texas"

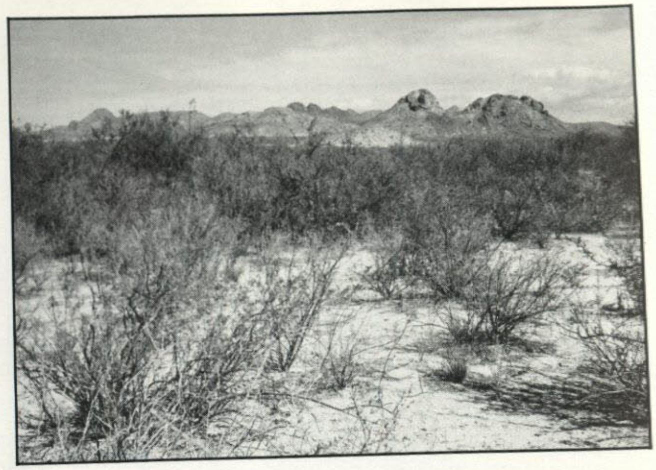

Figure 3-B. April, 1984. The Camel's Hump (right) and Corazones (left), 56.5 miles south of Alpine, Texas, and 1.5 miles east of HyWy 118. U.S.G.S. grid coordinants FC4270, Emory Peak sheet.

Figure 4-A (Hill, 1899) was taken of Mitre peak ten miles north of Alpine, Texas. Comparison with figure 4-B (1984) shows a stable grass cover since 1899 but a large increase in density and cover of catclaw mimosa (**Mimosa biuncifera**). Juniper trees (**Juniperus erythrocarpa**) are also evident today but absent in 1899. Scattered shrubs in the distance of the 1899 photo may be mesquite. Mesquite is present today in that area of the photo. The distant slopes of Mitre peak seem to be clear of shrubs in 1899. Today the slopes are quite closed with catclaw.

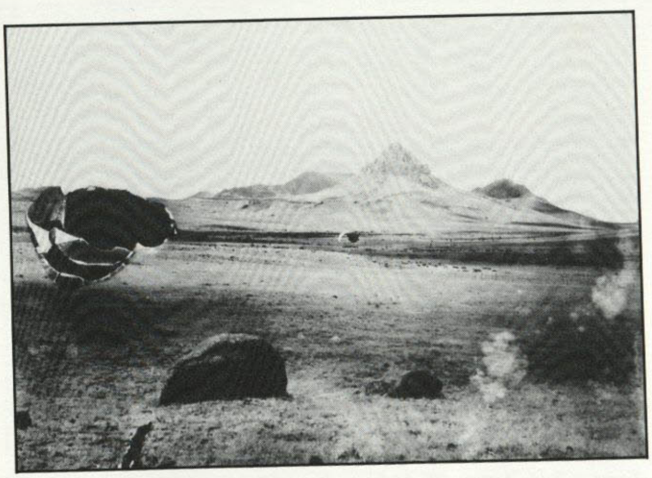

Figure 4-A. R.T. Hill #98, 1899. "Mitre peak, north edge of Alpine sheet, Texas. Jeff Davis County, Texas". (U.S.G.S.).

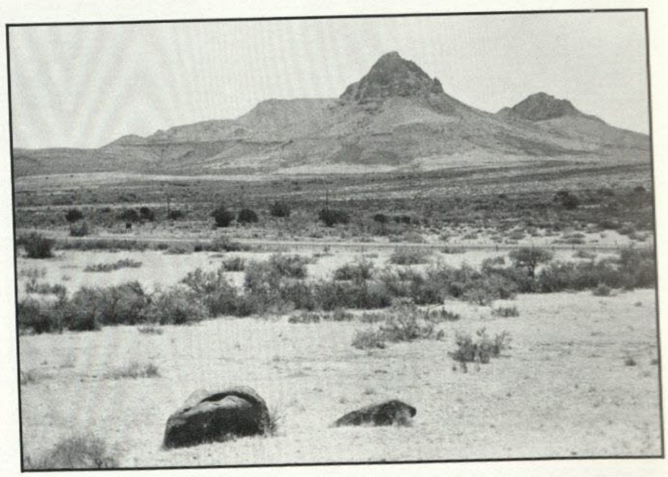

Figure 4-B. April, 1984. Mitre peak from a point .5 miles east of HyWy 118 at entrance to Musquiz Canyon, 10.5 miles north of Alpine, Texas. U.S.G.S. grid coordinants FD2174, Fort Stockton sheet.

DISCUSSION

Comparative analysis of the historic and modern photos indicate a wide variety of trends from a large degree of shrub increase (Figure 1 and 4) to no perceptible change (Figure 2) and a situation in which the overall aspect is similar today but shrub height is greater (Figure 3). Creosotebush and mesquite have been reported to have increased on, or invaded former desert grasslands. Reasons postulated have included overgrazing by livestock, suppression of wildfire and climate changes (Branson, 1985). Locations depicted in figures 1-3 are all within a zone designated as formerly or potentially desert grassland by the Soil Conservation Service. Figure 1 clearly supports the hypothesis of a grassland to shrub pattern since settlement. Figures 2 and 3 indicate the presence of shrub dominated communities only 17 years after the first intensive settlement and introduction of large numbers of livestock. On the basis of figures 2 and 3 we might conclude that: 1) the area was not a grassland but a desert shrub community prior to settlement, or 2) that conversion from grass to brush took place very rapidly and has remained relatively stable ever since.

The increase or invasion of catclaw in the Davis mountains since the 19th century is clearly indicated in figure 4. Similar trends were evident at Fort Davis where dramatic increases in catclaw were documented on the basis of 19 photos of the 1870-90 period (Nelson, 1981).

Grass cover appeared to be as good in the spring of 1984 as in 1899. The 1984 photos were taken prior to the normal precipitation season and depict the grass in its most deteriorated annual condition. Available records do not indicate a notable or widespread drought in the late 1890's in Texas (U.S.D.A., 1941). The aspect of grass cover in the historic photos is probably normal for the period under the influence of contemporary grazing, and may also represent year-old forage prior to seasonal rains.

Vegetation as recorded in Hill's photos of the Big Bend might not be considered pristine or climax (contemporary authorities such as Bently in 1904 and Bray in 1901 noted deteriorating rangeland in West Texas at the turn of the century), but the photos document vegetation types existent only 17 years after intensive ranching was begun in the region (Casey, 1972). Southern Brewster county apparently supported a vegetation type closer to a shrub or shrub savana than an open grassland at that time. Shrub density or height increased on most sites since 1899. Creosotebush has encroached into some low lying tobosa flats and catclaw has encroached heavily on mountain footslopes.

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Yield and Quality Components of Six Grass Species

James D. Arnold and Philibert X. Kapinga[1]

ABSTRACT

Management of warm season perennial grasses in south Texas can be improved if seasonal fluctuations in nutritional quality and productivity are documented. The objectives of this study were to determine the phenological changes in nutritional quality and productivity of Bell rhodesgrass (*Chloris gayana* (Kunth)), buffelgrass (*Cenchrus cilaris* L.), Kleberg bluestem (*Dichanthium annulatum* (Stapf)), kleingrass (*Panicum coloratum* L.CV. 75), and Callie and common bermudagrass (*Cynodon dactylon* L.). Samples were analyzed for crude protein (CP), *in vitro* dry matter digestibility (IVDMD), neutral detergenet fiber (NDF), acid detergent fiber (ADF), permanganate lignin (PL) and dry matter yield (DM). Average DM ranged from 1.03 (common bermudagrass) to 3.62 (buffelgrass) tons per acre. All of the grass species tested were below 7% CP during February and August. The IVDMD and CP% of all species were higher while ADF, NDF and PL were lower in the spring. Results of this study indicate that buffelgrass is a desirable grass for this region.

INTRODUCTION

Soil fertility and management practices affect the quantity and quality of warm-season grasses. In general, the nitrogen (N) levels, dry matter (DM), crude protein (CP), and **in vitro** dry matter digestibility (IVDMD) increase with nitrogen fertilizer applications; and nitrogen levels, CP, and IVDMD decrease and DM content increased with the maturation of the forage (Taliaferro **et al.**, 1980; Jolliff **et al.**, 1979; Varner and Blankenship; 1980).

McCawley and Dahl (1980) compared livestock gains of heifers grazing Bell rhodesgrass (**Chloris gayana**), Coastcross -1 bermudagrass (**Cynodon dactylon**), and kleingrass - 75 (**Panicum coloratum**). The heifers consumed an average of 26.5 lbs/head/day regardless of plant species. There were no differences in seasonal gain of yearlings grazing Coastcross -1 bermudagrass or kleingrass - 75. Heifers grazing Bell rhodesgrass had the lowest digestibility, crude protein, phosphorous and digestible energy. Duble **et al.**, (1971) also found that animal performance declined as available forage and dry matter digestibility decreased. The cell wall content (r = -0.80) and IVDMD (r = -0.78) are both reliable criterion for evaluating animal performance on forage (Duble **et al.**, 1971).

The objective of this study was to assess monthly variations in yield and quality of six perennial warm-season grass species.

MATERIALS AND METHODS

This study was conducted on the Texas A & I University farm, located 1 mile north of Kingsville, Texas. The soil in the test area was sandy clay loam. Commercial soil tests indicated a low amount of N; medium to high P; very high K, Ca, and Mg; and pH of 7.5 to 8.1

The six grass varieties included in the study were Bell rhodesgrass, buffelgrass (**Cenchrus ciliaris**), Callie and common bermudagrass, kleingrass - 75, and Kleberg bluestem (**Dichanthium annulatum**).

Five year old stands of the six grasses in six 40 acre pastures were used as the study sites. In each pasture, a 40 ft × 40 ft enclosure was divided into 2 equal blocks, and on half of each block 16-10-5 fertilizer was broadcast at the rate of 100 lbs/A. The enclosures were uniformly mowed to a height of 2 inches in February.

The forages were clipped by hand, using a 1.6 × 1.6 ft quadrat, randomly placed within each block. The harvested samples were dried at 158° F, ground in a Wiley mill to pass through a 40-mesh screen, and stored in airtight polyethylene sample bags. The samples were analyzed for dry matter (DM), crude protein (CP) (Harris, 1970), **in vitro** dry matter digestibility (IVDMD) (Tilley and Terry 1963 from Harris, 1970); neutral detergent fiber (NDF), acid detergent fiber (ADF), and permanganate lignin (PL) (Goering and Van Soest, 1970). All assays were run in duplicate. Data was analyzed by analysis of variance using a factorial experimental design and differences among grass species means were identified using Tukey's w-procedure (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Monthly yields ranged from a low of 0.09 T/A of kleingrass - 75 (March) to a high of 5.67 T/A of buffelgrass (October). Buffelgrass produced the highest average monthly yield of dry matter (3.65 T/A) while common bermudagrass produced the lowest average monthly yield (1.25 T/A) (Table 1). Bell rhodesgrass and kleingrass - 75 produced approximately the same ($P<.05$) average monthly yields 2.46 and 2.41 T/A, respectively; while Kleberg bluestem produced 3.17 T/A. Callie bermudagrass produced an average monthly yield of 1.25 T/A.

By July, Bell rhodesgrass and common bermudagrass reached peak production. The other four species reached peak production in October. There was no decline in production of buffelgrass during the summer months (Table 1).

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Table 1. Dry matter yield (T/A) crude protein (% DM) and in vitro dry matter digestibility (% DM) of six grasses grown near Kingsville, Texas.

Month	Component	Kleberg bluestem	Bell rhodesgrass	Callie bermuda	Common bermuda	Buffel grass	Kleingrass 75
Mar	DM (T/A)	0.49	0.49	0.26	0.40	0.26	0.09
	CP (%)	16.5	12.2	25.6	19.2	21.0	17.0
	IVDMD (%)	62	56	75	71	72	73
Apr	DM (T/A)	0.94	1.25	1.07	1.07	1.29	1.03
	CP (%)	10.4	9.7	15.3	12.4	17.7	13.4
	IVDMD (%)	58	65	73	67	74	68
May	DM (T/A)	2.23	2.14	0.85	1.03	2.28	1.61
	CP (%)	7.2	8.3	12.6	13.4	11.5	11.7
	IVDMD (%)	56	57	66	63	66	66
Jun	DM (T/A)	2.72	2.59	1.38	1.52	3.62	2.19
	CP (%)	7.2	8.3	12.6	13.4	11.5	11.7
	IVDMD (%)	56	57	66	63	66	66
Jul	DM (T/A)	3.80	3.57	1.70	2.19	4.60	3.17
	CP (%)	3.3	3.6	7.2	6.9	6.7	6.4
	IVDMD (%)	40	43	53	52	53	53
Aug	DM (T/A)	3.13	2.72	1.47	1.11	4.83	3.26
	CP (%)	3.8	3.6	6.0	5.6	4.2	8.2
	IVDMD (%)	58	45	49	44	55	46
Sep	DM (T/A)	3.44	2.46	1.88	1.12	4.73	2.46
	CP (%)	4.5	3.9	7.4	8.9	6.0	3.8
	IVDMD (%)	43	40	47	41	50	44
Oct	DM (T/A)	5.28	3.04	1.43	0.76	5.68	3.62
	CP (%)	4.7	5.7	9.9	9.4	6.7	8.2
	IVDMD (%)	41	39	54	41	49	43
Nov	DM (T/A)	5.14	3.13	1.43	0.90	5.14	3.57
	CP (%)	4.7	5.7	9.9	9.4	6.7	8.2
	IVDMD (%)	33	35	50	42	43	42
Dec	DM (T/A)	4.69	3.35	1.38	1.07	4.51	3.08
	CP (%)	4.7	5.1	8.4	8.3	8.0	7.7
	IVDMD (%)	32	32	51	39	43	39
Jan	DM (T/A)	3.17	2.41	1.29	0.67	3.57	2.32
	CP (%)	3.5	4.0	7.8	6.8	7.6	7.0
	IVDMD (%)	30	30	43	35	36	35
Feb	DM (T/A)	3.08	2.28	1.16	0.62	3.21	2.14
	CP (%)	3.2	3.1	6.3	6.3	6.5	6.2
	IVDMD (%)	26	27	41	32	31	30
Means	DM(T/A)	3.17b	2.46c	1.25d	1.03e	3.62a	2.41c
	CP (%)	6.0d	5.8d	10.6a	9.7b	9.2c	8.9c
	IVDMD (%)	42d	43d	55a	49c	53b	50c

Means followed by the same letter are not significantly different (P = 0.05).

Monthly levels of CP ranged from a low of 3.10% in Bell rhodesgrass in February to a high of 25.6% in Callie bermuda in March. The average CP contents of the grasses ranged from 10.6% for Callie bermudagrass to 5.8% for Bell rhodesgrass (Table 1). Forages at levels less than 7% are considered deficient in CP because animal intake and rumen microorganism activity is reduced. Callie and common bermudagrass were sufficient in CP throughout the year, except for August and February. Kleingrass was low in July (6.4), September (3.8) and February (6.2) and bufflegrass was low in CP in August (4.2), September (6.0) and February (6.5). Kleingrass was the only grass that had a CP% above the critical level of 7% in the month of August (8.2). Bell rhodesgrass and Kleberg bluestem were sufficient in CP only during the spring.

Callie bermudagrass and common bermudagrass had average CP contents of 10.6 and 9.7% respectively (Table 1); Callie bermudagrass was below 7% CP in August as was common bermudagrass in July, January and February (Table 1). Buffelgrass and kleingrass - 75 averaged 9.2% and 8.9% CP, respectively (Table 1); however, buffelgrass was low in CP in July (6.7), August (4.2), September (6.0), October (6.7), November (6.7) and February (6.5) while common bermudagrass was low in CP in July (6.9), August (5.6), January (6.8) and February (6.3) (Table 1). Bell rhodesgrass and Kleberg bluestem were adequate in CP only during March, April, May and June; both species averaging 5.8% and 6.0% CP respectively for the year (Table 1).

Variation in IVDMD was significantly different among species (Table 1). Callie bermudagrass had the highest average

(P <.05) IVDMD (55%) with a range of 75% in March to 41% in February. Buffelgrass IVDMD was significantly (P <.05) different from all other grasses. Buffelgrass IVDMD ranged from 74% to 31% with an average of 53%. There was no difference (P >.05) in IVDMD of common bermudagrass (49%) and kleingrass - 75 (50%). Kleberg bluestem (42%) and Bell rhodesgrass (43%) had similar (P >.05) IVDMD for the year. Kleberg bluestem and Bell rhodesgrass had the two lowest (26% and 27% respectively) IVDMD of the test in February (Table 1). We found that Callie bermudagrass and kleingrass - 75 were the two more digestible grasses in the test.

Grasses increased in ADF and NDF with advanced maturity (Table 2), Kleberg bluestem had the highest ADF (45.1%) followed by Bell rhodesgrass (40.9%), buffelgrass (38.8%), Callie bermudagrass (38.1%), kleingrass - 75 (37.8%), and common bermudagrass (37.6%). All species were significantly different (P <.05) from each other in ADF except kleingrass - 75 and common bermudagrass. In general, grasses that are low in ADF are more digestible and subsequently higher in quality.

Permangenate lignin increased in all species with maturity. By June, Kleberg bluestem reached 7.1% PL (Table 2). This is because it matures very early in comparison with the other grass species. Of the six species used in this study, buffelgrass (5.3%), callie bermudagrass (5.2%) and kleingrass - 75 (5.5%) were the lowest in PL (Table 2). Increasing lignin content in grasses is associated with decreased IVDMD (Blaser, 1964; Duble **et al.** 1971; Cogswell and Kamstra, 1976; Ellis and Lippke, 1976).

Table 2. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and permangenate lignin (PL) of six grasses grown at Texas A & I University near Kingsville, Texas.

Month	Component	Kleberg bluestem	Bell rhodesgrass	Callie bermuda	Common bermuda	Buffel grass	Kleingrass 75
				%			
Mar	NDF	61.1	60.7	53.9	61.0	55.6	54.1
	ADF	33.6	30.9	24.7	27.9	27.3	28.5
	PL	4.1	4.2	3.4	3.4	3.7	3.3
Apr	NDF	66.7	61.0	64.9	65.8	55.0	62.8
	ADF	39.0	36.1	29.7	32.1	30.7	32.4
	PL	5.4	4.0	3.6	4.2	4.2	3.9
May	NDF	66.8	68.0	66.6	65.7	61.5	66.0
	ADF	42.7	36.6	33.1	34.8	32.0	35.5
	PL	4.0	5.5	5.2	5.0	5.1	4.5
Jun	NDF	71.2	70.7	68.9	70.2	66.6	70.3
	ADF	45.4	34.5	38.2	35.2	35.0	37.6
	PL	7.1	4.7	4.7	5.0	4.6	5.6
Jul	NDF	68.6	70.7	76.7	73.5	73.8	68.6
	ADF	46.2	39.8	40.4	40.5	39.8	36.2
	PL	6.7	5.9	6.0	6.4	6.1	6.6
Aug	NDF	69.6	74.0	71.9	70.2	71.1	72.7
	ADF	47.0	41.4	41.0	39.7	39.1	38.1
	PL	6.1	6.1	5.3	7.5	6.7	6.1
Sep	NDF	69.7	74.2	73.1	71.1	72.2	77.0
	ADF	47.8	43.4	42.4	41.1	42.2	40.6
	PL	6.3	5.6	5.4	6.6	6.2	5.9
Oct	NDF	71.7	74.2	72.4	72.9	73.3	75.2
	ADF	48.5	45.6	41.2	40.8	43.1	40.6
	PL	6.3	6.0	5.8	6.5	5.5	6.2
Nov	NDF	72.2	75.7	75.1	74.2	74.6	74.9
	ADF	47.5	44.9	41.0	40.8	43.6	40.4
	PL	7.2	6.4	5.3	7.0	5.3	6.2
Dec	NDF	72.2	74.8	72.6	73.8	70.6	72.0
	ADF	47.3	45.5	42.1	40.5	43.5	41.3
	PL	7.6	6.5	5.6	7.2	5.6	6.3
Jan	NDF	72.2	71.7	71.8	71.5	73.7	73.1
	ADF	47.3	45.6	42.3	41.1	44.2	41.5
	PL	7.0	7.1	5.9	6.4	6.3	6.1
Feb	NDF	71.9	74.1	72.7	72.6	73.0	72.6
	ADF	46.8	45.8	42.2	40.9	44.2	41.8
	PL	7.6	7.5	6.0	7.0	6.1	6.1
Means	NDF	69.5b	70.8a	70.0b	70.1b	68.4c	70.0b
	ADF	45.1a	40.9b	38.1d	37.6e	38.8c	37.8e
	PL	6.3a	5.8b	5.2d	6.0b	5.3cd	5.5c

Means followed by the same letter are not significantly different (P = 0.05).

CONCLUSION

These results indicated that the intensity of management anticipated for a seeded site should be considered in selecting a grass species. The selection of a grass species for seeding sites for livestock production is an important decision. The data discussed in this paper indicates that buffelgrass is the most desirable species tested, followed by kleingrass - 75. Both species should be grazed in the spring when protein levels are adequate (above 7%). Both species produce well during the summer months and did not begin to decline in production until December. The low quality of the late winter forage samples indicates a nutritionally critical period if levels of livestock production are to be maintained, especially if early spring calving is planned.

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An Economic And Nutritional Evaluation of Pricklypear As An Emergency Forage Supplement

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ABSTRACT

This investigative research centered on the comparison of supplemental feeding of pricklypear as opposed to conventional hay feeding during drought conditions. Nutritive values of four commonly used supplemental hays were compared to those of pricklypear. Costs of supplementing pricklypear in relation to fuel consumption, protein supplementation, and maintenance of machinery were obtained from ranchers throughout South Texas who have fed pear to their range cattle in the past. Pricklypear supplementation was found to be a rather inexpensive means of feeding and maintaining range cattle during drought conditions - up to 60% less than typical hay feeding programs. This was regardless of weather conditions and month of the year. Pricklypear was found to have extremely low nutritive values as compared to the hay varieties studied.

INTRODUCTION

Pricklypear has been used as livestock feed for more than a century. It usually is considered an undesirable plant on Texas rangelands, but does have some economic value as supplemental forage for cattle during winter and drought periods. Pricklypear has the unique ability of storing water in its flattened fleshy stems. This water reserve enables the plant to withstand long drought periods (Hoffman, 1914). During droughts and range overuse, pricklypear density increases as grass cover lessens. The most common and widespread pricklypears known to Texas ranchers are Engelmann (**Opuntia engelmanni**), Nopal (**Opuntia Lindheimeri**), and Plains (**Opuntia polyacantha**).

Extensive areas of rangeland in South Texas are occupied by dense stands of pricklypear and its net value is controversial (Vallentine, 1971). The pricklypear region par excellence is in Texas, from the Edwards Plateau southward (Griffiths, 1920).

Even relatively inflexible systems of range deferment have resulted in better grass production and higher animal carrying capacity in Texas. In South Texas, orderly programs of range deferment break down during droughts when most pastures should not be grazed at all (Lehmann, 1969). The best native grasses seldom hold more than 2.5 tons of forage per acre at the onset of drought. Purposefully planted and cultivated pricklypear commonly provides 37.50 tons of emergency forage per acre. Cows consume approximately 65.0 lbs. of pricklypear daily (Lehman, 1969). With this known, 93.0 tons of pricklypear on 2.50 acres of land is sufficient for one cow for more than three years. A range stocked with one cow per 15.0 acres should have a year's supply of emergency forage; also, there would be enough pear for quick regrowth if only two percent of the total acreage is in pricklypear (Lehmann 1969). As a forage reserve, pricklypear is more drought resistant than grass and more dependable. Furthermore, pricklypear now is relatively economical to feed. A few South Texas cattle ranchers have been growing substantial numbers of acres (500-625) of pear and harvesting the crop. Af-

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ter burning off the spines, they then process the cactus by chopping (or shredding) it; afterwards, cottonseed, cottonseed meal, or cottonseed cake is added as a protein supplement.

Lehmann (1969) found that one person properly equipped can burn enough pricklypear to satisfy the daily needs of 5,000 yearling steers. The basic pricklypear diet was supplemented with 1.0 lb. of cotton seed meal per animal per day (offered free choice in combination with minerals). Test groups totaling 10,000 steers gained slightly over one pound per day for periods ranging up to 120 days. The total cost of gain was approximately 16 cents per lb. Breeding cattle usually do not add weight on a ration consisting mostly of pricklypear. The vegetative part of cactus can be spiny or spineless and has been widely used for livestock forage in semiarid regions.

Cactus has been described as an unbalanced ration that is low in protein and lipids, but rich in digestible carbohydrates (40% more than alfalfa hay), water, and vitamins (Monjauze and LeHoueron, 1965; and Shoop **et al.** 1977); its digestible energy production per unit of water is high. Chemical analysis and microdigestion trials by Shop **et al.** (1977) indicated that digestibility of pricklypear was equal or superior to that of high quality alfalfa hay. Thus, cactus should provide a good complement to semiarid-adapted nitrogen fixing, high protein trees, like **Leucaena** (Brewbaker and Hutton, 1979), **Prosopis** (Felker and Clark, 1982), and the grasses preferred by cattlemen for livestock forage.

The objective of this study was to: 1) evaluate the nutritional aspects of pricklypear in respect to the needs of pregnant dry cows, 2) determine the economic feasibility of feeding pricklypear as a forage supplement during drought, 3) evaluate the nutritional and economic differences in feeding pricklypear as compared to four different hay varieties.

MATERIALS AND METHODS

A nutritional evaluation of the pricklypear was obtained through analysis from the Texas A & I University Forage Lab. Information was obtained for % dry matter, TDN (total digestible nutrients), crude protein, and digestible energy. These data were then compared to the same type of analysis from four different types of hay: coastal bermudagrass, alfalfa, Kleberg bluestemgrass, and sudangrass hays. These specific hays were chosen because of their popularity or abundant usage among South Texas cattlemen.

An economic evaluation on the supplementation of pricklypear was performed. Costs were determined for the overall supplement program. Expenses were calculated for protein supplementation, fuel (butane), maintenance and depreciation of machinery. A questionnaire was utilized to determine how South Texas ranchers use pricklypear during drought and to procure cost information. From these data, an overall figure for the cost was compared to the costs of supplementing the four previously mentioned hays on a per head, per day basis. Prices for the hays were obtained through published information sources (Anonymous 1980-85).

A students T-test with unknown variences o_1^2 and o_2^2 assumed to be equal was performed to determine any differences between costs of feeding hay vs. pricklypear during drought conditions. The following formula (Bailey, 1959) was used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$\bar{x}$ = mean

S = estimated standard deviation

RESULTS AND DISCUSSION

The mean values of the dry matter percentages for the different forage supplements were as follows: Kleberg bluestemgrass hay 91.3%; coastal bermudagrass hay 91.0%; alfalfa hay 90.1%; sundangrass hay 88.1%; and pricklypear 17.4% (Table 1).

Table 1. Nutritive values of forage supplements (mean figures)

Supplement	DM	TDN	CP	DE (mcal/kg)
Alfalfa hay	90.1%	58.5%	19.7%	2.62
Coastal bermuda-grass hay	91.0%	53.5%	12.0%	2.36
Kleberg bluestem-grass hay	91.3%	48.4%	6.3%	2.14
Sudangrass hay	88.0%	51.0%	13.7%	2.24
PRICKLYPEAR (Natural)	17.4%	11.0%	1.40%	0.47
PRICKLYPEAR (with protein supplement)	21.0%	13.9%	2.92%	0.56%

Total Digestible Nutrients

Mean values of TDN for the feed supplements were as follows: alfalfa hay 58.5%; coastal bermudagrass hay 53.9%; sudangrass hay 51.0%; Kleberg bluestemgrass hay 48.4%; pricklypear 11.0% (Table 1).

Crude Protein

The crude protein mean values were as follows: alfalfa hay 19.7%; sundangrass hay 13.7%; coastal bermudagrass hay 12.0%; Kleberg bluestemgrass 6.3%; and pricklypear 1.4% (Table 1).

Digestible Energy

Digestible energy mean values of the five forage supplements were: alfalfa 2.62 mcal/kg; coastal bermudagrass hay 2.36 mcal/kg; sudangrass hay 2.24 mcal/kg; Kleberg bluestemrass hay 2.14 mcal/kg; and pricklypear 0.47 DE mcal/kg (Table 1).

Nutritive Evaluation After Protein Supplementation

After the pricklypear (100 lbs.) was supplemented with 4.5 lbs of 41% crude protein cottonseed, the nutritive values changed very little. The following values resulted: the dry matter value of the pricklypear-cottonseed mixture increased from 17.4% to 21.0%. Total digestible nutrients (TDN) had a slight increase from 11.0% to 13.9%. The crude protein rose from the 1.40% level to a value of 2.92%. The added cottonseed also contributed to a slight increase in digestible energy from 0.47 mcal/kg to 0.56 mcal/kg (Table 1).

Table 2. Selected costs associated with feeding pricklypear as a forage (feedlot situation) to beef range cattle.

Expenses	dollars/head/day
cottonseed (any form)	.24
fuel (butane)	.32-.35
maintenance of machinery	
1983	.05
1984	.03-.04
Total costs 1983	.61-.64
Total costs 1984	.59-.63

The protein was supplemented in three basic forms: cottonseed, cottonseed meal, and cottonseed cake. The average costs per metric ton of these three forms differed. When supplementation was necessary and cottonseed was used, the cost per ton was $160.00. The advantage of supplementing with cottonseed was the fat which is derived from the oil of the seed. Cottonseed meal supplement cost $152.00 per ton. The advantage of cottonseed cake supplement was to feed the pricklypear-cottonseed cake mixture to cattle on the ground without having much wasted. The cost per ton of the cottonseed cake was $161.00. Altogether, the average costs per day per cow of cottonseed (in any form) was 24 cents (Table 2).

The fuel source used in the pricklypear feeding operations was butane. The costs of the butane were charged directly to the cattle by the ranchers (for all purposes). Butane cost varied from 64-70 cents per gallon. An average of 1 gallon of butane was sufficient amount of fuel to prepare enough pear to feed two animal units (32¢ -35¢/animal unit). The cactus was burned in windrows to get rid of the spines. The cost of burning ten windrows of cactus was 65-70 cents (1 gallon of butane). Actual costs on a per head per day basis of butane varied from, 32 to 35 cents (Table 2). It generally took one person to haul enough cactus to feed 100 cows each day. In such an operation, there were chopping crews consisting of three people. Each crew was capable of chopping enough pear to feed 650-700 cows daily.

During the first feeding year, maintenance of farm machinery and equipment costs per head, per day were five cents. This included repairs such as welding and truck, tractor, chopper, and burner breakdowns. The following year, costs decreased to 3.0-4.0 cents per head per day (Table 2).

The sum of expenses for pricklypear during 1983 showed that an overall cost of 61-64 cents/head/day was achieved with a slight decrease in 1984 to 59-63 cents/head/day (Table 2). Table 3 shows comparisons of overall costs for feeding pricklypear as a forage as compared to typical hay supplementing on a per head, per day basis. In 1983 the average cost was $1.58/head/day to feed common hays found in the region; supplementing with pricklypear cost was .63/head/day or 60% less. In 1984, cost was $1.84/head/day while feeding hay versus .62/head/day associated with feeding pricklypear (66% less).

Table 3. Overall costs of feeding pricklypear as a forage to beef cattle vs. average costs of feeding common hays.

Year	Dollars/Head/Day
1983	
Hays	1.58
PRICKLYPEAR	.63
1984	
Hays	1.84
PRICKLYPEAR	.62

Table 4. Recommended daily requirements for pregnant dry cows (1000 lbs.) as compared to nutritive values of pricklypear supplemented with 41% crude protein cottonseed.

	DM	TDN	CP	DE (mcal/kg)
Recommended values	20%	9%	.45kg	1.27
PRICKLYPEAR	21%	13%	.77kg	.56

Table 4 shows how the recomended daily nutritive requirements (minimum) compared to the values of pricklypear. With the exception of DE values, it is evident the pricklypear is quite capable of satisfying the daily nutritional needs for pregnant dry cows. In 1983 and 1984 the T-test indicates a high degree of significance (at .05 level), that pricklypear is indeed economically more beneficial on a cost basis as opposed to hay when feeding cattle during drought (Tables 5-6).

Table 5. Results from T-test indicating significance in feeding costs for pricklypear vs. hay during drought conditions.

1983

Source Variation	SS	°Freedom	Mean sq	T val
Hay	.012	2	.006	
PRICKLYPEAR	.0005	2	.0003	4.75*

*Significant at .05

Table 6. Results from T-test indicating significance in feeding costs for pricklypear vs. hay during drought conditions.

1984

Source Variation	SS	°Freedom	Mean sq	T val
Hay	.0042	2	.002	
PRICKLYPEAR	.0014	2	.0007	13.6*

*Significant at .05

SUMMARY

Pricklypear was found to be a feed which possesses quite low nutritive values. When compared to the four hays in the study, it was quite easily outmatched. Because of its extremely high water content, pricklypear's closest competitor in percentage dry matter was 71.0% higher. In crude protein, DE (mcal/kg), and TDN values, pricklypear was also outclassed by its nearest competitor by almost 4 to 1 (Table 1).

Ranchers used 4.5 pounds of 41% crude protein cottonseed per 100 pounds of pricklypear to improve the forage's nutrient quality. Dry matter percentage increased to a point where the range from its closest competitor narrowed from 71% to 67%. Crude protein, DE (mcal/kg), and TDN values of pricklypear were below their nearest competitor by almost 3 to 1 (Table 1).

Protein supplementation with the cottonseed as used by South Texas Ranchers raised nutritive values to a point that the pricklypear provided a forage which quite effectively maintained herds but did not provide a balanced ration (Table 4).

Costs associated with the pricklypear feeding programs proved to be feasible. After harvesting, burning, and processing the pear for the cattle, associated costs were added. The 1983 drought season had an overall cost per head per day of 61-64 cents. This proved to be quite economical compared to the $1.58/head/day figure for feeding hay in 1983. Pricklypear costs during 1984 ran between 59 and 63 cents/head/day. Compared to hay costs of $1.84/head/day, pricklypear fed as a forage again proved to have an economic advantage in 1984. Both seasons provided pricklypear costs ranging from 60 to 66 percent less than conventional hay feeding.

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Effect of Phenology on Total Available Cabohydrates and Crude Protein in Tobosagrass

James T. Nelson and Michael L. Johnson[1]

ABSTRACT

Total available carbohydrate and crude protein content of tobosagrass (*Hilaria mutica*) was monitored in relation to phenology in the Trans-Pecos region of Texas. The immature leaf, mature leaf, culm elongation, boot, anthesis, seed, and winter dormancy stages were evaluated. Total available carbohydrates only were measured in roots and crowns.

Stems and leaves showed an initial crude protein level of 6.88% which dropped throughout the plant's development to 4.75%. Root and crown carbohydrates showed an initial level of 19%. Shifts in carbohydrates between stems and leaves, roots, and crowns occured throughout the growing season. Root and crown carbohydrates dropped significantly (to 11% and 9% respectively) before and during seed production, but regained early season levels before dormancy.

INTRODUCTION

Non-structural carbohydrates in plants, also known as total available carbohydrates or TAC (Weinman, 1961), are either used as a source of energy, converted to structural form or are stored in the root system for future energy needs. Stored or reserve carbohydrates are essential for the perennial plant to break winter dormancy and initiate the new year's growth. Excessive or repeated removal of new green photosynthetic tissue reduces the plant's ability to produce carbohydrates and forces it to draw on its root reserves. If this continues over a number of years the plant's ability to overwinter and break dormancy is reduced. Eventually the plant may be unable to compete for nutrients and may die (Stoddart, Smith, & Box 1975; Trilica, 1977; White, 1973). Proper grazing management relies on an understanding of the dynamics of carbohydrate storage and protein production in key grazing species. In general protein peaks early and declines as the plant matures. Carbohydrate reserves are usually depleted early and are gradually replenished as the plant matures. Although the general nature of these cycles is recognized the exact nature of this process is unique for each species and is not well documented, especially in the Trans-Pecos.

Tobosagrass is a major component of the vegetation on heavy soils and draw sites in the Trans-Pecos and is an important forage species, especially during its early stages of growth. This study was undertaken in 1985 to monitor total available carbohydrates and protein content in tobosagrass in relation to phenological growth stages. Protein and TAC's were monitored in relation to phenology because we felt that it is important to estimate protein and TAC reserve levels in relation to easily recognizable physical plant characteristics.

Materials and Methods

The study area was located in a draw site on the Del Norte Ranch 12 miles south of Marathon, Texas in a desert grassland association. Average annual rainfall is reported to be 11 inches most of which occurs in the form of summer thunderstorms (SCS, 1972). Precipitation was measured from April to December, 1985.

Tobosagrass collections were made in an ungrazed area from April through December, 1985 during each of 7 identifiable growth stages: immature leaf (less than 3 leaves), mature leaf (3 or more leaves), culm elongation, boot, anthesis, seed, and winter dormancy. Each collection consisted of 5 subsamples of 1 or more entire plants (roots, crowns, stems and leaves).

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Plant material was collected at or as close to 1800 hrs. as possible since TAC's are reported to be at their highest daily levels at that time (Weinman, 1947). Samples were placed in an insulated container with dry ice and transported to the laboratory where they were dried at 120 degrees F for 72 hours. After drying, plant material was separated into three categories: current year's stems and leaves, crowns, and roots. Each of this material was then separately ground in a wiley mill using a 1 mm screen and stored in glass jars. Before chemical analyses all ground samples were oven dried again at 120 degrees F for 16 hours to remove all moisture. Nitrogen determinations were made by the kjeldahl method and multiplied by 6.25 to obtain crude protein content (A.O.A.C., 1970). Non-structural carbohydrate content was determined using the anthrone method of Viles and Silverman (1949) with modifications described by personnel of Texas Tech University (G. Scott, personal communication, January, 1986). Following analysis of variance, Duncan's multiple range test was used to determine if differences between carbohydrate levels at each growth stage and between protein levels at each growth stage were significant ($P<.01$), (Little and Hills, 1978).

RESULTS

Root and crown carbohydrates followed a parallel pattern throughout the growing season, although the magnitude of change between growth stages was different between these 2 plant components (Fig. 1). Total available carbohydrates in both roots and crowns decreased from the immature leaf stage through mature leaf to culm elongation. TAC's then increased significantly ($P<0.01$) between culm elongation and boot. This was followed by a sharp and significant ($P<0.01$) decrease through anthesis and seed production. TAC's in roots and crowns regained early season high levels by winter dormancy.

Stem and leaf TAC's increased slightly (from 16% to 18%) between the immature and mature leaf stage. This was followed by a significant ($P<0.01$) decrease to 13% at culm elongation. Minor fluctuations occured until after seed production, when at dormancy stem and leaf TAC's regained early season levels.

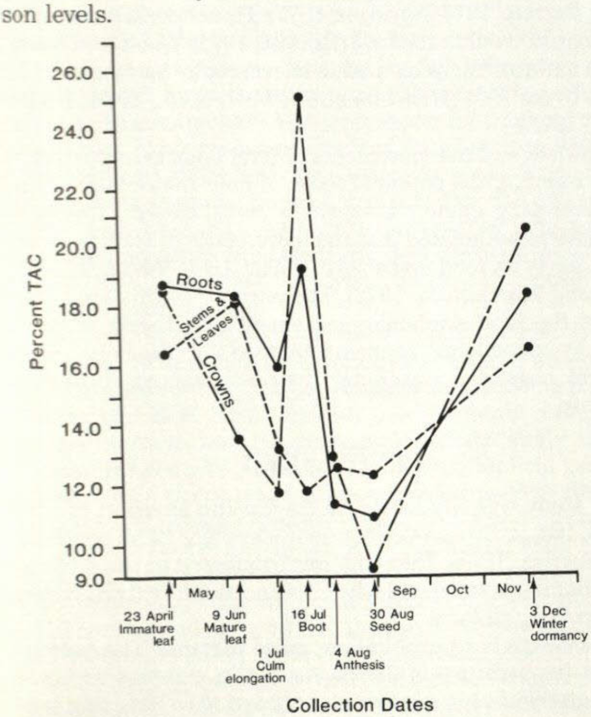

Figure 1. Total available carbohydrate content of roots, crowns, and stems and leaves of tobosagrass at 7 stages of growth from 23 April to 3 December 1985.

Above ground crude protein was highest (7%) early in the growing season at the immature leaf stage. Crude protein content decreased significantly ($P<0.01$) to 5% by culm elongation, made a noticeable but statistically insignificant ($P>0.01$) increase at seed development and then decreased to below 5% at dormancy (Fig. 2).

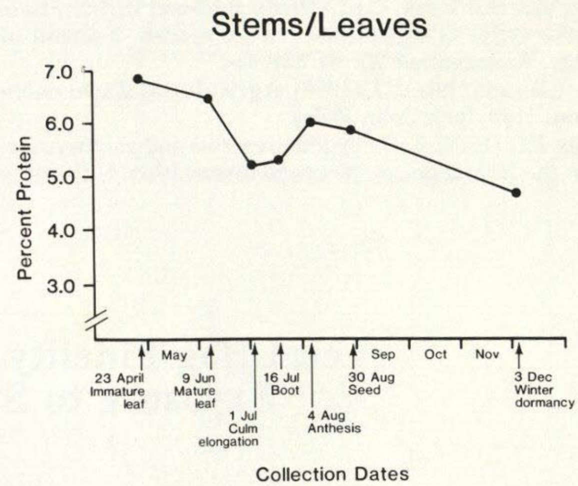

Figure 2. Crude protein content in tobosagrass stems and leaves at 7 stages of growth from 23 April to 3 December 1985.

DISCUSSION

Total available carbohydrates in tobosagrass exhibited fluctuations throughout the growing season that indicated translocation between roots and crowns, and stems and leaves; and periods of net TAC depletion alternating with net TAC production. The 16 day period between culm elongation and boot appeared to be extremely important for TAC accumulation in roots and crowns. At the same time stem and leaf TAC decreased indicating TAC translocation from the photosynthesising areas of the plant to storage zones. Anthesis and seed formation appeared to place high energy demands on the plant once again, as shown by the rapid decrease in root and crown TAC's to their lowest levels. All plant components regained their original TAC levels by the onset of winter dormancy. These data confirm the results of other reseachers such as Trilica (1977) who found low TAC root reserves in desert grasses after spring regrowth and maximum levels at winter dormancy, and Coyne and Cook (1970) who found higher concentrations and greater fluctuations of TAC in the crowns than in the roots of indianricegrass **(Oryzopsis hymenoides)** and needleandthreadgrass **(Stipa comata).** Our data suggest that the TACA fluctuation in tobosagrass follows a pattern more similar to that found in curly mesquite **(Hilaria belangeri)** than to that found in galletagrass **(H. jamesii)** by Pinkney (1972). Apparently tobosagrass, like curly mesquite is able to build up TAC reserves during high July temperatures and again during the cool fall period. Galletagrass made its major TAC gains in the fall (Pinkney, 1972).

Two general patterns of grazing are recognized to allow replenishment of TAC reserves in range grasses. One is to graze early and remove livestock early enough to allow TAC reserves to build back up prior to dormancy. The other is to defer grazing until after reserve TAC has been replenished (usually at seed stage). The carbohydrate and protein cycles in tobosagrass on this study area appear to support the first pattern rather than the latter.

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Feral Hog Fidelity to Home Range After Exposure to Supplemental Feed

Ahmed Mansouri and Charles A. DeYoung[1]

ABSTRACT

Thirteen feral hogs were captured on the King Ranch in South Texas and fitted with radio transmitters in order to test if their movements were based on food availability. Supplemental feed was introduced into the range of some animals after they were tracked for a period of time with no feed. Six sows and a boar yielded enough radio locations to calculate home range size. The average home range size calculated by the minimum convex polygon method for unsupplemented sows was 143% of that for supplemented sows. Two sows exhibited a decrease of 67% in their average core areas after exposure to feed. Supplemented animals spent a great deal of time in the vicinity of feeding sites but did not totally abandon their previous home range.

INTRODUCTION

Feral hogs (**Sus scrofa**) are descendents of domestic swine gone wild and in some cases are crossed with the taxonomically identical European wild boar. European wild hogs were introduced in Texas as a game animal in the 1930's and since then many landowners have released them in new areas as well as areas which already had feral hog populations (Ramsey, 1968). Jackson (1964) estimated the Texas population of feral hogs at between 0.5 and 1 million animals.

In some areas, feral hogs are important game animals. In other locals, they are economically significant pests because of their depredation on agricultural crops (Pine and Gerdes, 1973; Barrett, 1977; Springer, 1977). Feral hogs also compete with native wildlife for food (Barrett, 1971; Wood and Roark, 1980) and can serve as a disease reservoir, particularly for swine brucellosis (**Brucella suis**) (Wood et al., 1976; Becker et al., 1978).

Knowledge of the movements of feral hogs is important to understanding the potential scope of their depredations, and for developing game management plans. Several investigators have hypothesized that the movements of feral hogs are based solely on food availability (Pullar, 1950; Wodzicki, 1950; Kurz and Marchinton, 1972). The purpose of this study was to test the food availability-movement hypothesis in South Texas by introducing supplemental feed into the home range of feral hogs and observing their subsequent movement response.

STUDY AREA

The study was conducted on the Encino Division of King Ranch, Inc., in Brooks County, approximately 12 mi southeast of Falfurrias, Texas. Research was conducted in the 6,000 ac Mota Bonita pasture and 640 ac of the southwestern corner of Hormigas pasture.

The climate is subtropical but quite variable. The average annual temperature is 22° C. As a rule, winters are mild although cold fronts may cause short periods of freezing temperatures. Rainfall for Falfurrias has averaged 23.8 in. annually since 1907. However, there are great fluctuations from year to year.

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Soils are of the Falfurrias-Sarita-Nueces association, and are described as moderately well, well, and somewhat excessively drained fine sands that have moderately slowly, moderately rapidly, and rapidly permeable lower layers (Soil Conservation Service, General Soil Map, Brooks County, Texas).

Vegetation varies from solid stands of live oak (**Quercus virginiana**) and mesquite (**Prosopis glandulosa**) to open grassland with intermittent live oak and mesquite mottes. The most common grasses are threeawn (**Aristida** spp.), seacoast bluestem (**Schizachyrium scoparius**), and thin paspalum (**Paspalum setaceum**). The dominant forbs are croton (**Croton capitalus**) and sunflower (**Helianthus debilis**).

METHODS

Hogs were trapped beginning in July 1985 in order to instrument them with radio transmitters which allowed remote location of animals. Trap sites with abundant hog sign were selected and prebaited with corn. A square trap made of metal pipes and heavy mesh welded-wire fencing was used. The trap was prebaited with the door fixed open so that hogs could move in and out. When it appeared that animals were regularly visiting the bait, the door was positioned to allow hogs to get in, but not out of the trap. Captured hogs were handled without drugs.

An 150-151 MHz radio transmitter inserted in a leather collar was placed on each hog selected for study. Signal range was approximately 1 mi and battery life was about 2.5 yrs. A receiver connected to a pair of directional yagi antennas attached on a boom that was disposed transversely across the top of a 10 ft. mast was used to take bearings on collared animals. The antenna apparatus was mounted on a truck. Both antennas and the receiver were connected to a triple connector, which increased signal strength, gave greater accuracy, and subtracted the signals from the antennas (giving a null) when they were directly in line with a transmitter. A pointer attached to the mast indicated the null pattern on a compass through which the mast rotated. The precise bearing to the transmitter was the center (in degrees) of the null pattern.

We generally attempted to locate hogs 2 or 3 times per week. Some locations were obtained in the late summer of 1985 but little or no tracking was done during fall 1985 so as not to interfere with hunters on the area. Radio tracking effort increased in January 1986 and continued until tracking ceased in late May. Most radio-tracking was done between 0700 and 2100. However, 24-hr tracking sessions were also undertaken. During these sessions the position of each hog was determined every 2 to 3 hrs. Locations were determined by triangulation from bearings taken from the truck. Bearings were taken from 1 point, then the vehicle was driven quickly to another point for the second bearing.

Bearings were plotted on aerial photographs with an 1:15,840 scale, and their intersection (the location) was marked on an acetate overlay. Autocad-Engineering drafting package (Racker and Rice, 1985) was then used to obtain coordinates for the locations and for the boundry of the study area.

Home ranges were calculated using the McPaal program (Stuwe, 1985). Home range sizes were determined by the minimum convex polygon method (Mohr, 1947) and by the harmonic mean technique (Dixon and Chapman, 1980). For the latter, an overall home range corresponding to 95% of the radio locations and a core area (Kaufman, 1962; Springer, 1982) corresponding to 60% of the locations, were calculated.

To assess the effect of supplemental feeding on movement of feral hogs, approximately half of the collared animals were supplemented with a pelleted hog ration and corn. Hogs were fed from February to May 1986. Three wooden troughs with lift-lids were used as self-feeders.

RESULTS

Twelve sows and 1 boar were collared during the study. Several hogs lost collars resulting in few locations on these animals. Problems were also encountered when hogs chewed off the transmitting antenna on the collar. Home ranges were only calculated on those animals on which 15 or more locations were available. Six sows and the boar had sufficient locations (range 15-51) under this criterion. The period of monitoring of these hogs ranged from 42-298 days.

Five of the sows had overlapping ranges as determined by the minimum convex polygon method (Fig. 1).

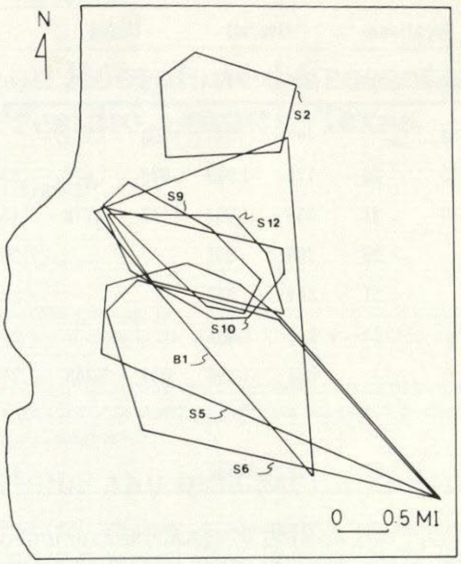

Figure 1. Home range polygons for 6 sows and 1 boar tracked on Encino Division, King Ranch, South Texas, July 1985-May 1986.

Although belonging to different family groups, S5 and S6 had similar home ranges. Animals S9, S10, and S11 also overlapped for a considerable extent although we did not determine if they ranged in the same group. The boar overlapped with all sows. The home ranges tended to be elongated and appeared to be bounded by open areas.

Overall home range size as determined by the minimum convex polygon method varied from 378-1,339 acres (Table 1).

Table 1. Home range size determined by the minimum convex polygon method for 6 sows and 1 boar monitored on the Encino Division, King Ranch, South Texas, July 1985 - May 1986.

	No. locations		Home range (acres)		
Sows	Unfed	Fed	Overall	Unfed	Fed
S2	15		452	452	
S5	20	23	1,173	795	847
S6	30	21	1,309	931	482
S9		28	415		415
S10		21	378		378
S11		23	420		420
Avg.			692	726	509
Boar					
B1		51	1,339		1,339

The overall home range size of the boar was 194% of the mean overall home range size for the 6 sows. Mean home range size for unsupplemented females (726 acres, SD = 247) was 143% of that obtained for supplemented sows (509 acres, SD = 200). Home range sizes using the harmonic mean method at 95% contour varied from 603-2,984 acres (Table 2).

Table 2. Home range and core area sizes calculated by the harmonic mean method for 6 sows and 1 boar monitored on the Encino Division, King Ranch, South Texas, July 1985 - May 1986.

	No. locations		Home range (Acres)					
			Overall		Unfed		Fed	
Sows	Unfed	Fed	60%	95%	60%	95%	60%	95%
S2	15		163	711	163	711		
S5	20	23	771	1,909	879	1,677	304	1,729
S6	30	21	358	1,764	442	1,778	138	1,055
S9		28	269	951			269	951
S10		21	262	553			262	553
S11		23	240	1,035			240	1,035
Avg.			343	1,154	494	1,388	242	1,065
Boar								
B1		51	427	2,984			427	2,984

The average core area (60% contour) size for unfed females (494 acres, SD = 361) was 204% of that obtained for supplemented sows (242 acres, SD = 62). Comparison of core areas before and after exposure to supplemental feed for S5 and S6 revealed a decrease of 67% in their average core area size. Figure 2 illustrates the shrinkage in core area after feed became available for S5.

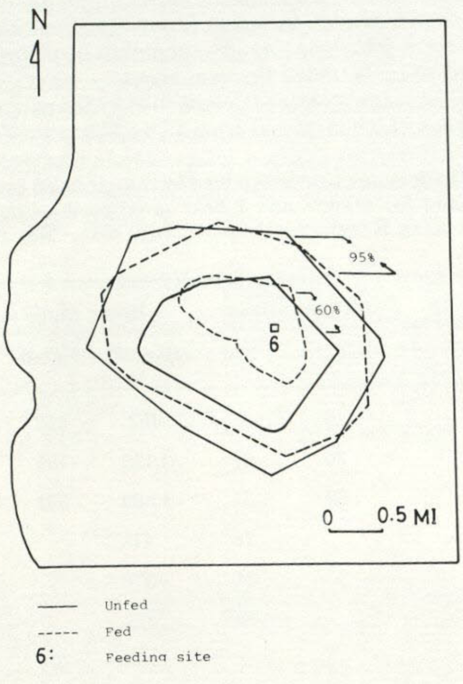

Figure 2. Ranging areas before and after supplemental feeding for sow S5 calculated by the harmonic mean method using 60 and 95% of location.

DISCUSSION

The overall mean home range size for sows was smaller than those reported elsewhere. This could have been related to habitat, sample size, length of study, and different time intervals over which individual animals were tracked. Hogs seemed to prefer dense stands of oak which were scarce on the study area. This may have contributed to hog concentration in relatively small areas. Where the vegetation was more open and oaks occurred only in scattered clumps, hogs (S5 and S6) exhibited larger home ranges and day-to-day movements.

In general, the mean home range size for unsupplemental sows was larger than that of supplemented females. However, the home range of S5 was slightly larger while she was being fed compared to when no feed was available. The feed may have caused her to enlarge her range to encompass the feeding site if it was outside her regular area of concentration. Although this hog was frequently located in wooded areas adjacent to the feeding site, she kept making occasional travels back to her previous area of concentration.

It was difficult to keep out enough feed to meet the energy demands of the study animals because of the large concentration of hogs at feeding sites. However, the response to feed observed (generally smaller home ranges and core areas) is an indication of how supplemental feeding can be used to manipulate movement patterns and concentrations of hogs.

CONCLUSIONS

Feral hogs spend a great deal of time in the vicinity of supplemental feeding sites. However, it appeared, at least in the short term, that hogs did not totally abandon previous areas of concentration. Thus, hog movements were heavily, but not totally, based on food availability.

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Initial Establishment of 14 Forage Species on Rootplowed Creosotebush (Larrea tridentata) Rangeland in Presidio County, Texas

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ABSTRACT

In June and July of 1985, 14 species were broadcast seeded on a sandy and gravelly range site in Presidio County, Texas. Both sites supported heavy creosotebush (Larrea tridentata) communities and were rootplowed and disced to remove the shrubs and prepare a seedbed. Overall average seedling density in the fall of 1985 was 84.68 per 50 square feet on the sandy site and 76.38 on the gravelly site. Five species (and a mixture) showed better than average establishment on both sites. These were: A-68 Lehmans lovegrass (Eragrostis lehmanniana), Cochise lovegrass (E. lehmanniana × tricophora), Niner sideoats grama (Bouteloua curtipendula), green sprangletop (Leptochloa dubia) and Llano buffelgrass (Cenchrus ciliaris).

INTRODUCTION

The Trans-Pecos region of Texas consists of approximately 18,000,000 acres, most of which is rangeland important for livestock production. Grazing capacity of the Trans-Pecos has been compromized by an abundance of brush species such as mesquite (**Prosopis glandulosa**), creosotebush (**Larrea tridentata**), tarbush (**Flourensia cernua**), and catclaw (**Acacia greggii** and **Mimosa biuncifera**). Traditional means of controlling unwanted brush include mechanical methods (such as plowing, shredding and rollerchopping), prescribed burning and the application of chemicals. Mechanical methods of control followed by reseeding have been widely practiced on many types of rangeland. Reseeding on arid rangelands however is risky from the standpoint of seedling establishment and cost effectiveness. Many ranchers, who own their own crawler tractors and have either a rootplow or heavy disc, prefer mechanical control of brush over chemical methods, since they feel they spend less cash out of pocket. A common practice is to broadcast seed immediately behind the rootplow or disc.

Species used for reseeding should be well adapted to the climate and soils of the area, be nutritious and palatable enough to be of value to a producer but yet be able to withstand moderate grazing pressure. Another consideration, from a rancher's point of view, is the availability of seed at low or moderate cost.

The objective of this study was to evaluate several potentially adapted forage species in a seeding trial on rootplowed and/or disced creosotebush rangeland.

METHODS AND DESCRIPTION OF AREA

Two creosotebush-dominated study sites, located on the Johnny Surratt ranch near Plata, Presidio County, Texas, were initiated in the spring of 1985. The region lies within the desert grassland vegetation zone as defined by the Soil Conservation Service, but is currently dominated by desert shrubs such as creosotebush and tarbush. Average annual rainfall is 11 inches, usually concentrated in late summer. The average frost-free period is generally from March 21 to November 10. High winds in spring, temperatures of over 100° F. in summer, and potential summer evapotranspiration rates of approximately 100 inches are common in this desert ecosystem.

One of the sites was located on a gravelly soil of an upland topographic position; the other was located on a sandy soil in a basin or low topographic position. The basin soil was classified as a sandy loam, mixed, thermic ustollic camborthid. The upland soil was classified as a loamy skeletal, mixed, thermic, ustollic calciorthid. Two 150 foot by 150 foot macroplots were established on each site — one plot in each location had been rootplowed in 1984 and disced in 1985; the other plot in each location was rootplowed and disced in 1985 prior to seeding.

Each macroplot was divided into three blocks, each of which was further subdivided into 15 subplots 10 feet wide and 50 feet long. A different species was assigned to each of 14 subplots in each block in a randomized complete block design. One subplot received a mixture of all species. The northeast corner of each subplot was marked with a stake and an identifying number.

Seed of the 14 forage species was hand broadcast at approximately 20 pure live seed per square foot with a cyclone seeder on June 20 (basin site) and on July 3, 1985 (upland site). All seed except that of Eragrostis spp. was covered by dragging with a section of chain link fence. Eragrostis seed was not covered because of its very small size (Cox and Martin, 1984). The species used (table 1) were selected on the basis of known or expected adaptability to arid regions and their value as forage for livestock and wildlife.

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Table 1. Forage Species seeded in Mechanically treated Creosotebush communities in Presidio County, Texas, June and July. 1985.

Species	Accession or Variety	Source
Atriplex canescens (Pursh) (4-wing saltbush)	T 4474	SCS-Los Lunas, N.M.
Atriplex semibaccata (R.Br.) (Australian saltbush)	Corto	Pecoff Bros. Escondido, Calif.
Bouteloua curtipendula (Torrey) (sideoats grama)	Niner	SCS-Los Lunas, N.M.
Bouteloua gracilis (Griffiths) (blue grama)		SCS-Los Lunas, N.M.
Buchloe dactyloides (Nuttall) (buffalograss)		Curtis & Curtis Clovis, N.M.
Cenchrus ciliaris (Linnaeus) (buffelgrass)	Llano - ANA-3866	Foster-Rambie Uvalde, Tx.
Ceratoides lanata (Pursh) (winterfat)		Curtis & Curtis Clovis, N.M.
Eragrostis curvula (Nees) (weeping lovegrass)		SCS-Tucson, Az.
Eragrostis lehmanniana (Nees) x **tricophora** (Coss & Dur.)	Cochise	SCS-Tuscon, Az.
Eragrostis lehmanniana (Nees) (Lehman's lovegrass)	A-68	SCS-Tuscon, Az.
Eragrostis superba (Peyr.) (Wilman's lovegrass)	Palar 5037	SCS-Tuscon, Az.
Leptochloa dubia (Nees) (green sprangletop)	441186	SCS-Knox City, Tx.
Mendora longifolia (Gray) (showy menodora)		SCS-Knox City, Tx
Setaria leucopila (Scr. & Merr.) (plains bristlegrass)	ANA-3865	Sharps Bros. Amarillo, Tx.

All macroplots were fenced to exclude livestock after seeding was completed. A precipitation gauge was set up at each site and a temperature-humidity recording device was set up in an instrument shelter at the upland site.

On October 18, 1985, just prior to expected cold-induced dormancy, the plots were surveyed to determine density of each seeded species. Density was determined by counting the number of seedlings in a transect belt one foot wide and 50 feet long placed diagonally from the southwest to northeast corners of each 10 × 50 foot subplot.

Data were subjected to analysis of variance and treatment means were separated based on least significant differences and Duncan's multiple range tests at $P < .05$ (Little and Hills, 1978).

RESULTS AND DISCUSSION

Nine inches of rainfall was recorded on the upland (gravelly) site and 10.33 inches fell on the basin (sandy) site from June 27 through October 18. Two-thirds (6.33 inches and 6.37 inches) of this occured after August 29. Average daily high temperature during July and August was 96° F. Temperatures of 100° F. were reached during the periods of August 23-29 and August 2-8 respectively.

The only species that failed to germinate or become established between June 27 and October 18 was winterfat (Figs. 1 and 2). Australian saltbush, showy menodora and four wing saltbush (which was seeded only on the upland site) all germinated in September with cooler temperatures and fall rains.

The average establishment rate for all species on the basin site was 84.68 plants/50 square feet (Figs. 1 & 2). The same five species and the mixture — A-68 Lehman's lovegrass, Cochise lovegrass, Niner sideoats grama, green sprangletop and Llano buffelgrass — all ranked above the mean on both sites (Fig. 3). On the basin site A-68 Lehman's did significantly better ($P < 0.05$) than the mixture or any other species. On the upland site the mixture did significantly better than all other species (Figs. 1 and 2). It should be noted that Lehman's lovegrass was predominant in the mixed stand on both sites.

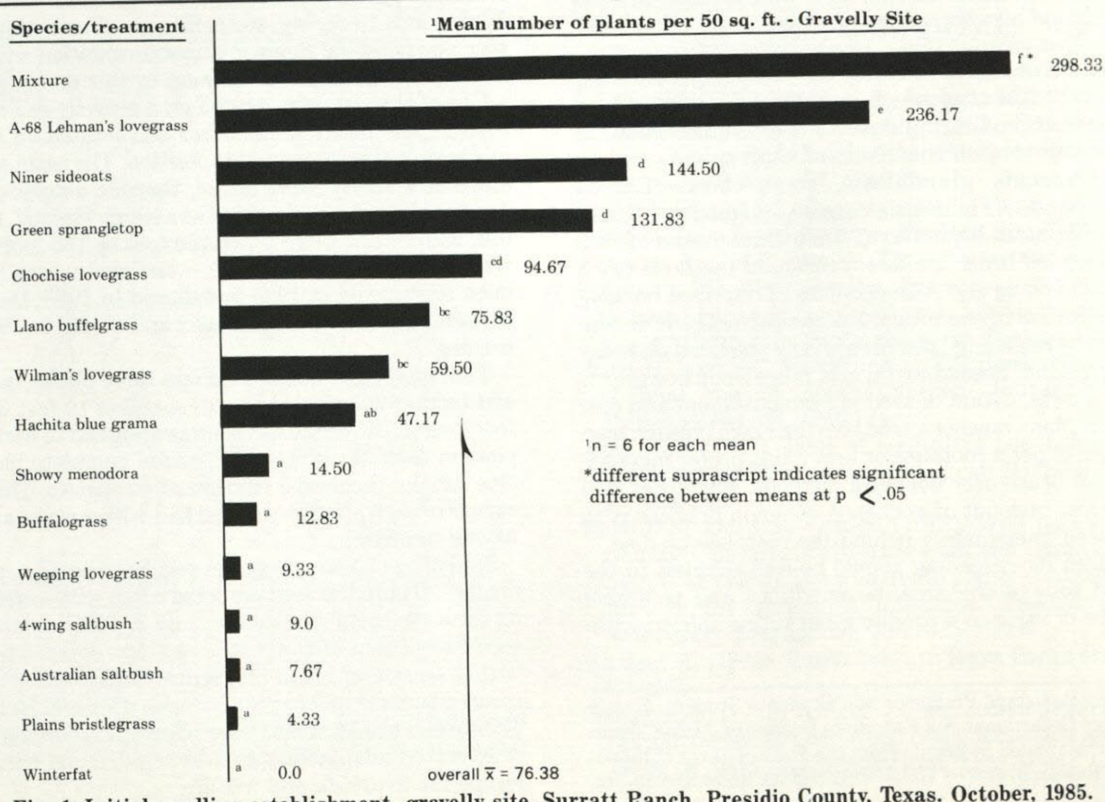

Fig. 1. Initial seedling establishment, gravelly site, Surratt Ranch, Presidio County, Texas. October, 1985.

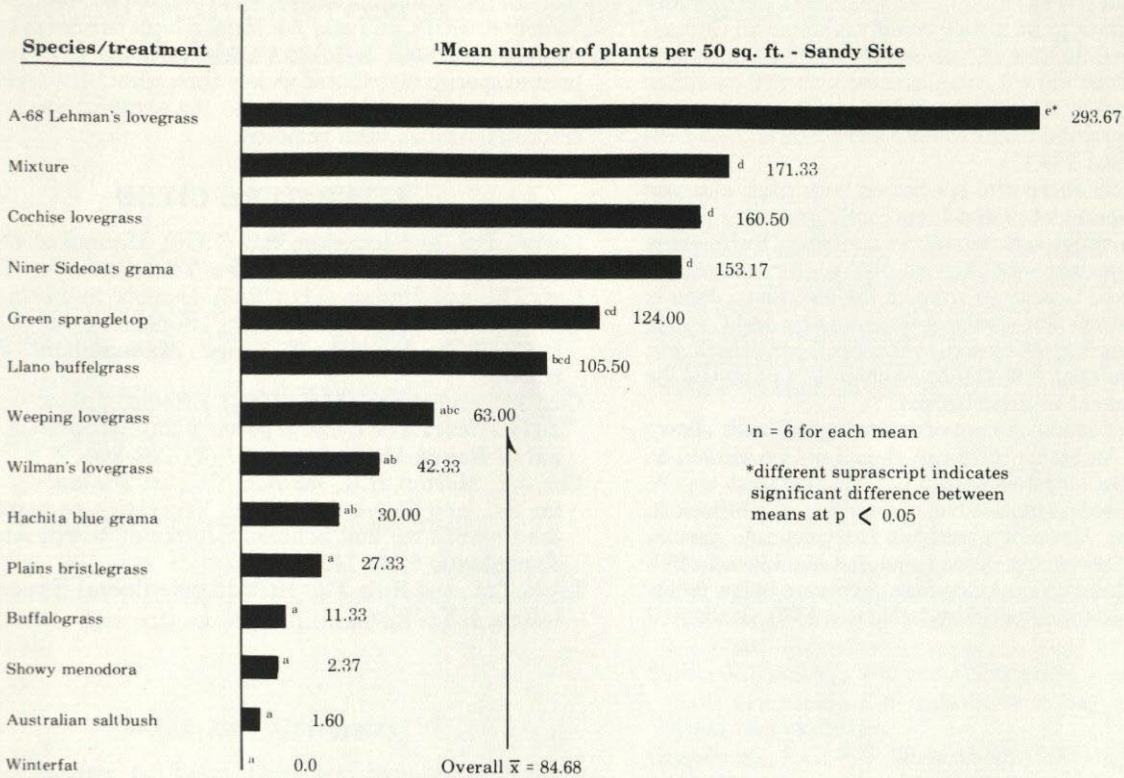

Fig. 2. Initial seedling establishment, sandy site, Surratt Ranch, Presidio County, Texas. October, 1985.

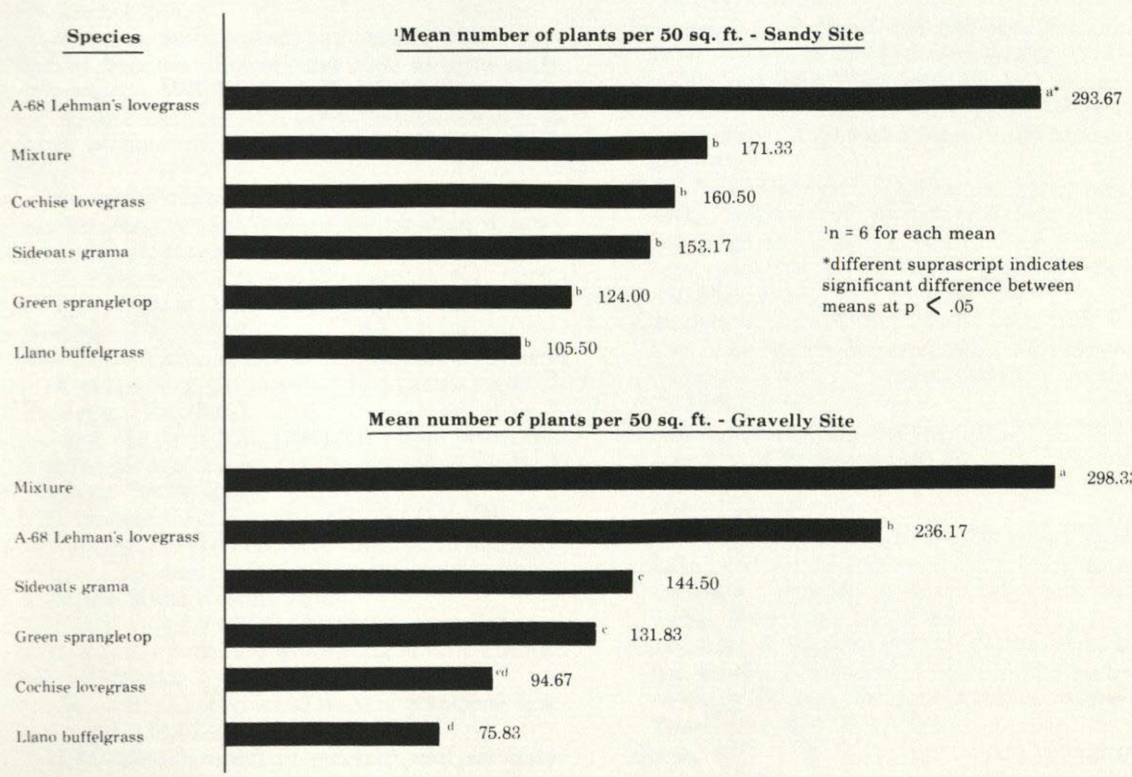

Fig. 3. Initial seedling establishment, top six species, sandy and gravelly sites, Surratt Ranch, Presidio County, Texas. October, 1985.

Cox and Jordan (1983) found A-68 Lehman's, Cochise and Wilman's lovegrass to be nearly equally adapted to Chihuahuan desert conditions at San Simon, Arizona. In our study Wilman's lovegrass did not establish nearly as well on either the sandy or gravelly site (42.83 and 59.5 plants per 50 square feet respectively) as did Cochise (160.5 and 94.62) or A-68 Lehman's (293.67 and 236.17).

Of the six most successful species on both sites, sideoats grama, green sprangletop and Llano buffelgrass are probably the most palatable and valuable to a rancher. Buffelgrass however may or may not survive the winter climate in southern Presidio County in spite of the fact that Llano is a relatively cold tolerant strain. A-68 Lehman's and Cochise lovegrass are not favored by some ranchers for livestock, but according to Cox et al. (1984) they do show high potential for cover establishment in desert areas.

The low rate of establishment of four-wing saltbush, showy menodora and Australian saltbush should not be viewed as poor success. The objective should not be to estabish a pure stand of these browse species but to provide some browse in a grass mixture. Australian saltbush is a palatable species adapted to very low precipitation zones, but like Llano buffelgrass, may not tolerate prolonged temperatures below freezing. Showy menodora, a species valuable to wildlife, is adapted more to rocky soil and ledges in the Trans-Pecos (Correll and Johnston, 1970), and may not show a high degree of success on finer textured soils. Four-wing saltbush is a desirable browse species distributed widely throughout the Chihuahuan desert and is a logical choice for establishment where creosotebush has been removed.

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