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S. Hamma

B. Kirch

B. Downey

*See next page for additional authors*



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# Effect of maturity at harvest on yield, composition, and feeding value of forage and grain sorghum silages

Authors
S. Hamma, B. Kirch, B. Downey, J. White, and K. Bolsen

# Effect of Maturity at Harvest on Yield, Composition, and Feeding Value of Forage and Grain Sorghum Silages

Susan Hamma, Brett Kirch, Barbara Downey,
Jim White, and Keith Bolsen

## Summary

In the last 2 years, three trials were conducted to determine the influence of hybrid and stage of maturity at harvest on silage yield, composition, and nutritive value for 15 forage and nine grain sorghum hybrids. Agronomic data, such as days to half bloom, plant height, and whole-plant dry matter (DM) and grain yields, were also obtained. In Trial 1, Pioneer 947, Acco Paymaster 351, and DeKalb 25E forage sorghum hybrids had different whole-plant DM and crude protein (CP) contents. Whole-plant DM increased, whereas CP generally decreased with advancing maturity. Hybrid affected both DM intake and CP digestibility. Results indicated that the late-dough stage of maturity optimized both yield and nutritive value.

In Trials 2 and 3, grain sorghums reached the late-dough stage in fewer days than forage sorghums. The whole-plant DM and CP contents and grain yields differed considerably among the forage sorghums, and all were lower than values for the grain sorghum hybrids. However, whole-plant DM yields were generally higher, but much more variable for the forage than for the grain sorghums. These results substantiate that large variations exist among forage sorghums and between grain and forage sorghum hybrids. Sorghums with higher DM and grain content should be favored and harvested at the late-dough stage for silage.

## Introduction

In 1984, Kansas produced almost 2 million tons of forage sorghum silage. It is essential that cattlemen have information on the relative yields and feeding values of the many hybrids and varieties that are currently available for this important feed resource. Our objective was to supplement previous research results documenting how hybrid and stage of maturity at harvest influence yield, composition, and nutritive value of silage made from different forage sorghums. Grain sorghum hybrids were included in two trials for comparison.

## Experimental Procedures

Trial 1. Three forage sorghums (Pioneer 947, Acco Paymaster 351, and DeKalb 25E) were grown as described in Report of Progress 494 (Cattlemen's Day, 1986). Agronomic data from that report are reproduced in Table 38.1. Hybrids were harvested at four stages: late-milk to early-dough (stage 1), late-dough (stage 2), post-frost, hard-grain (stage 3), and 2 to 4 weeks post-frost, hard-grain (stage 4).

Each of the 12 forages was ensiled in 55 gallon metal drums lined with plastic and fed to mature wethers in a three-period voluntary intake and digestion

trial. All rations were 90% silage and 10% supplement on a dry matter (DM) basis and formulated to contain 11.5% crude protein. Each 20-day feeding period consisted of a 6-day ration acclimation phase followed by a 5-day voluntary intake measurement, a 2-day ration intake adjustment to 90% of voluntary intake, and a 7-day fecal collection phase. Wethers were randomly assigned to the rations for each period.

Trial 2. Dryland forage and grain sorghum field plots were established in the summer of 1985. Four forage sorghum hybrids (Warner's Sweet Bee, Warner's Sweet Bee Sterile, Golden Harvest T-E Silomaker, and Conlee's Cow Vittles) and four grain sorghum hybrids (WAC 652G, DeKalb DK 42Y, NC+ 174, and Asgrow Colt) were used. They were chosen to represent a range of sorghum pedigrees, which included variation in maturity (season length), plant height, and forage and grain yields. Each hybrid was harvested at three stages of kernel development: late-milk to early dough, late-dough, and hard-grain. Warner's Sweet Bee Sterile, which produces no grain, was harvested shortly after each harvest of the grain-producing Sweet Bee. Treatments were arranged in a split-plot design with stages of harvest as main plots and hybrids as subplots, with four replications.

About 100 lb per acre of anhydrous ammonia and a broadcast pre-emergence herbicide (Ramrod®-Atrazine®) were applied before planting. All plots were planted on June 13. Two to 3 weeks after emergence, the plots were thinned to 34,850 plants per acre (6 inches between plants). On July 24, Lorsban® insecticide spray was applied for greenbug control. Each plot had six rows, 30 inches apart and 30 ft long.

Agronomic data collected for each plot included days to half bloom, plant height, whole-plant DM, and grain yields. Days to half bloom were used to measure season length. This is defined as the number of days between planting and the date when half the main heads exhibited some florets. Plant height was measured to the tallest point of the head immediately prior to the first harvest. Whole-plant DM yields were determined by harvesting 20 ft from each of the two center rows. All rows were harvested using a modified, one-row forage harvester. Chopped forage from each plot was weighed, sampled, and collected for making silage. Grain yields were determined by hand-cutting the heads from 20 ft of one of the remaining rows. The heads were dried and threshed in a stationary thresher.

Trial 3. Seven forage sorghum hybrids and five grain sorghum hybrids were grown in 1986. The forage sorghums included two early maturing (Buffalo Canex and Pioneer 956), two intermediate (DeKalb FS-5 and Pioneer 947), and three late maturing (Truimph Supersile, Golden Harvest T-E Silomaker, and DeKalb 25E) hybrids. Grain sorghums were represented by two early maturing (Funk's G 522 and Pioneer 8493), two intermediate (Asgrow Topaz and NC+ 174), and one late maturing hybrid (DeKalb 41Y). Within maturity groupings, hybrids were selected to represent a range of plant heights and forage and grain yields. Atlas, an intermediate maturing forage sorghum variety, was included for comparison.

Field plots were seeded on May 31, 1986 under dryland conditions near Manhattan. Approximately 100 lbs per acre of anhydrous ammonia was applied one month prior to planting. Furadan 15G® insecticide was placed in the furrows at

planting and the following day pre-emergence herbicide (Ramrod®) was broadcast. In July, the plots were sprayed with Cygon 400® for greenbug control.

The hybrids were assigned in a randomized complete block design to three replicate plots each. Single plots had 6 rows, 30 inches apart and 200 ft long. Whole-plant yield for each plot was determined at the late-dough maturity stage by harvesting three center rows with a Field Queen forage harvester. Late-dough was selected so results could be compared to those of previous years' studies (Reports of Progress 470 and 494). Seven 55-gallon, metal drum pilot silos lined with 4 ml plastic were filled, sealed, and stored at ambient temperature to be used in a future digestion trial. The two outside rows were left as borders and heads were clipped from the remaining row from a random 60 ft to determine grain yield. The heads were dried and threshed with a stationary thresher.

## Results and Discussion

Trial 1. Harvest dates, maturities, plant heights, compositions, and yields for the three hybrids are shown in Table 38.1. Pioneer 947 required only 28 days to advance from stage 1 to stage 3; Acco 351 required 35 days, and DeKalb 25E required 44 days.

Whole-plant DM content increased ($P<.05$) at each successive harvest stage for Pioneer 947, ranging from 29.6% at stage 1 to 44.0% at stage four. For Acco 351, DM content increased with advancing maturity after stage 2 and reached 40.4% at stage four. Consistent with previous trials, the DM content of DeKalb 25E did not change after stage one. Crude protein generally decreased with advancing maturity, but only in Pioneer 947 and DeKalb 25E were the changes statistically significant.

Whole-plant DM yield of Acco 351 was influenced less by stage of maturity than that of the other two hybrids (Table 38.1). The highest yields ($P<.05$) were at harvest stages 1 or 2 for Pioneer 947 and DeKalb 25E, and their lowest yields ($P<.05$) were at stage four. Grain yield for Pioneer 947 was not affected by harvest stage, but the lowest yield ($P<.05$) for Acco 351 occurred at the first stage and the lowest yield ($P<.05$) for DeKalb 25E was at the first two stages.

Chemical composition of the 12 forage sorghum silages is presented in Table 38.2. All silages were well preserved, with low terminal pH values and adequate lactic acid contents. The wetter DeKalb 25E silages had the lowest pH and highest lactic acid values at all four harvest stages. Harvest stage affected acid detergent fiber (ADF) only for Pioneer 947, with ADF content increasing as maturity advanced. The lower grain-yielding DeKalb 25E had higher ADF values at harvest stages 1 and 2 than the other two hybrids.

Main effects of hybrid and maturity on voluntary intakes and digestibilities are given in Table 38.3. Hybrid greatly affected intake ($P<.05$), with Acco 351 having the highest intake both in grams per day and in grams per metabolic body weight. Harvest effect on intake was exhibited by the lower intakes for the wetter stage 1 silages and more mature stage 4 silages. The DM, ADF, and neutral detergent fiber digestibilities were similar for all hybrids and harvest stages. Crude protein digestibilities were affected by hybrid and harvest date.

Trial 2. The results for harvest dates, maturities, plant heights, compositions, and yields are presented in Table 38.4. An average of 29 days elapsed between first and third harvest dates for the grain sorghum hybrids and 33 days elapsed between the first and third harvests for the forage sorghums. Whole-plant DM content was significantly higher at each successive harvest stage for all grain sorghum hybrids, but significantly higher only at the third harvest for the forage sorghum hybrids. The DM content was also higher at all stages of harvest for the grain sorghums when compared to the forage sorghums.

Crude protein content was highest in the grain sorghum hybrids and decreased as maturity increased. The forage sorghum hybrids showed little reduction in CP with advancing maturity, but the lowest CP value for grain sorghums was still greater than the highest value for any of the forage sorghum hybrids. Whole-plant DM yields were generally larger for the forage sorghum hybrids and yields were not affected by stage of maturity with the exception of WAC 652G, for which the late-milk to early-dough stage had a lower yield than the hard-grain stage. After stage 1, grain yields were higher for the grain sorghum hybrids, as would be expected. In general, grain yields increased with maturity except for three hybrids (Sweet Bee, Conlee's Cow Vittles, Asgrow Colt), which decreased in yield at the third harvest because of weathering effects and bird damage in some plots.

Trial 3. Harvest dates, days to half bloom, plant heights, compositions, and yields for the forage and grain sorghums are shown in Table 38.5. Harvest dates for the forage sorghums occurred over a range of 47 days, with Canex and Pioneer 956 reaching the late-dough stage earliest and Silomaker and DeKalb 25E, the latest. In comparison, harvest dates for the grain sorghums ranged over only 8 days, with the earliest being Funk's G 522 and Pioneer 8493 and the latest, DeKalb 41Y.

It is useful to note the considerable differences in DM and CP contents, and whole-plant DM and grain yields, especially among the forage sorghums. The DM content of the forage sorghums ranged from a low of 25.3% (Canex) to a high of 34.4% (Pioneer 947) at the late-dough stage, which was a difference of 9.1 percentage units. In contrast, the grain sorghums ranged from 33.6 to 35.1% DM, which was only a 1.5 percentage unit difference. The CP content of the forage sorghums ranged from a low of 6.3% (Atlas) to a high of 7.5% (Pioneer 956). All of the grain sorghum hybrids had higher CP values than the forage sorghums.

Whole-plant DM yields were generally higher but much more variable for the forage sorghums than the grain sorghums. Among the forage sorghums, Canex had the lowest yield (5.5 tons per acre) and Silomaker, the highest (8.2 tons). Grain sorghum yields ranged from 5.2 tons per acre (Pioneer 8493) to 5.7 tons (DeKalb 41Y). The grain yields for the forage sorghums had a wide range, from 51 bushels per acre (Canex) to 105 bushels (Pioneer 947). Grain yields for the grain sorghums ranged from 99 bushels per acre (Pioneer 8493) to 113 bushels (Asgrow Topaz).

Table 38.1. Harvest Dates, Maturities, Plant Heights, Dry Matters (DM), Crude Proteins (CP), and Whole-plant Forage and Grain Yields for the Three Forage Sorghum Hybrids in Trial 1 (June 8 planting date)

| Hybrid and Harvest Stage | Harvest Date | Whole-plant DM | Whole-plant CP[2] | Whole-plant DM Yield | Grain Yield[3] | Grain: Forage |
|---|---|---|---|---|---|---|
| | 1985 | % | % | Tons/Acre | Bu/Acre | |
| Pioneer 947[1] | | | | | | |
| 1 (116) | Sept. 16 | 29.6$^{d}$ | 9.1$^{a}$ | 6.3$^{b}$ | 64 | .33 |
| 2 | Sept. 25 | 32.3$^{c}$ | 9.2$^{a}$ | 7.0$^{a}$ | 77 | .37 |
| 3 | Oct. 14 | 37.6$^{b}$ | 8.6$^{ab}$ | 5.0$^{c}$ | 62 | .44 |
| 4 | Nov. 18 | 44.0$^{a}$ | 7.8$^{b}$ | 4.0$^{d}$ | 70 | .75 |
| Acco 351 | | | | | | |
| 1 (74) | Sept. 19 | 24.4$^{c}$ | 9.6 | 6.3$^{ab}$ | 38$^{b}$ | .18 |
| 2 | Oct. 1 | 26.4$^{c}$ | 9.2 | 6.8$^{a}$ | 71$^{a}$ | .34 |
| 3 | Oct. 24 | 36.3$^{b}$ | 9.1 | 6.6$^{ab}$ | 64$^{a}$ | .31 |
| 4 | Nov. 19 | 40.4$^{a}$ | 9.0 | 6.1$^{b}$ | 74$^{a}$ | .42 |
| DeKalb 25E | | | | | | |
| 1 (128) | Sept. 24 | 22.8$^{b}$ | 8.8$^{a}$ | 7.1$^{a}$ | 32$^{b}$ | .12 |
| 2 | Oct. 7 | 25.7$^{a}$ | 8.2$^{ab}$ | 6.4$^{ab}$ | 33$^{b}$ | .14 |
| 3 | Nov. 7 | 27.8$^{a}$ | 8.3$^{ab}$ | 6.3$^{b}$ | 40$^{ab}$ | .18 |
| 4 | Nov. 19 | 27.2$^{a}$ | 7.5$^{b}$ | 4.7$^{c}$ | 50$^{a}$ | .35 |

[1]Plant height at harvest stage 1, inches.
[2]100% dry matter basis.
[3]Adusted to 12.5% moisture.
[abcd]Means within a hybrid with different superscripts differ ($P<.05$).

Table 38.2. Chemical Composition of the 12 Forage Sorghum Silages in Trial 1

| Hybrid and Harvest Stage | DM | pH | Lactic Acid | ADF | NDF | Hemi-cellulose |
|---|---|---|---|---|---|---|
| | | | Chemical Component[1] | | | |
| | % | | % of the Silage DM | | | |
| Pioneer 947 | | | | | | |
| 1 | 29.5 | 3.96 | 5.5 | 32.8 | 57.4 | 24.6 |
| 2 | 32.1 | 4.27 | 4.3 | 33.1 | 57.2 | 24.1 |
| 3 | 37.4 | 4.18 | 3.3 | 36.8 | 60.1 | 23.3 |
| 4 | 42.8 | 4.14 | 4.7 | 39.3 | 61.2 | 21.9 |
| Acco 351 | | | | | | |
| 1 | 26.2 | 3.93 | 5.5 | 35.8 | 62.8 | 27.3 |
| 2 | 28.0 | 4.23 | 3.7 | 33.3 | 60.1 | 26.8 |
| 3 | 35.1 | 4.13 | 4.8 | 36.3 | 60.0 | 23.7 |
| 4 | 41.1 | 4.39 | 3.2 | 34.9 | 57.4 | 22.5 |
| DeKalb 25E | | | | | | |
| 1 | 23.5 | 3.78 | 6.5 | 37.1 | 61.2 | 24.1 |
| 2 | 26.2 | 3.83 | 6.3 | 37.0 | 57.4 | 20.4 |
| 3 | 26.7 | 3.84 | 5.3 | 38.0 | 60.3 | 22.3 |
| 4 | 29.6 | 4.02 | 4.5 | 38.6 | 58.8 | 20.2 |

[1]ADF = acid detergent fiber; NDF = neutral detergent fiber.

Table 38.3. Effects of Forage Sorghum Hybrid and Stage of Maturity on Ration Voluntary Intakes and Apparent Digestibilities in Trial 1[1]

| Hybrid and Harvest Stage | VI | | Digestibility, % | | | |
|---|---|---|---|---|---|---|
| | g DM/Day | g DM/kg MBW[2] | DM | CP | ADF | NDF |
| Hybrid | | | | | | |
| Pioneer 947 | 509[b] | 29.9[b] | 55.2 | 42.7[b] | 42.5 | 49.8 |
| Acco 351 | 585[a] | 34.7[a] | 54.8 | 48.2[a] | 42.0 | 48.6 |
| DeKalb 25E | 456[c] | 26.7[c] | 54.1 | 44.7[ab] | 40.8 | 45.3 |
| Harvest Stage | | | | | | |
| 1 | 480[e] | 28.2[e] | 55.0 | 46.3[d] | 39.9 | 47.5 |
| 2 | 553[d] | 32.1[d] | 54.8 | 42.0[e] | 40.2 | 47.3 |
| 3 | 533[d] | 31.2[d] | 54.7 | 47.1[d] | 44.1 | 48.9 |
| 4 | 511[de] | 30.1[de] | 54.2 | 45.5[de] | 42.8 | 47.8 |

[1]VI = voluntary intake, DM = dry matter, CP = crude protein, ADF = acid detergent fiber, NDF = neutral detergent fiber.

[2]Metabolic body weight = $kg^{.75}$

[abc]Means in the same hybrid column with different superscripts differ ($P<.05$).

[de]Means in the same harvest stage column with different superscripts differ ($P<.05$).

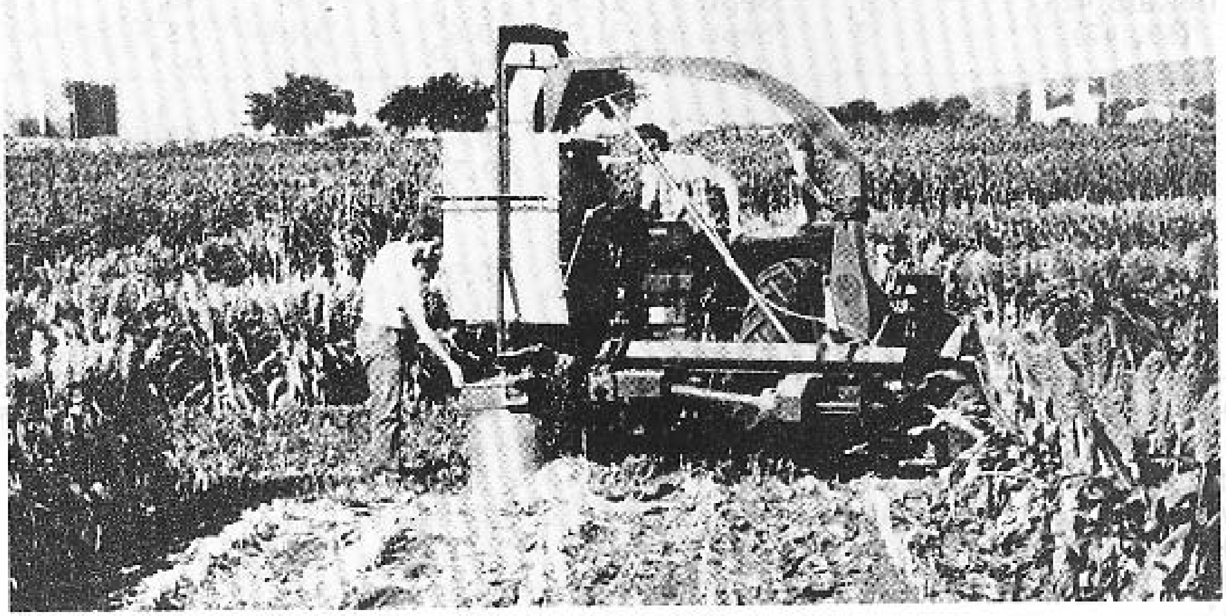


Table 38.4. Harvest Dates, Maturities, Days to Half Bloom, Plant Heights, Compositions, and Whole-plant Forage and Grain Yields for the Four Forage Sorghum and Four Grain Sorghum Hybrids in Trial 2 (June 13 planting date)

| Hybrid | Harvest Stage[1] | Harvest Date | Whole-plant DM | Whole-plant CP[2] | Whole-plant DM Yield | Grain Yield[3] | Grain: Forage |
|---|---|---|---|---|---|---|---|
| | | 1985 | % | % | Tons/A. | Bu/A. | |
| **Forage Sorghum** | | | | | | | |
| Warner's Sweet | 1 | Sept. 16 | 24.8$^{a}$ | 7.5 | 6.3 | 51$^{ab}$ | .25$^{b}$ |
| Bee | 2 | Sept. 27 | 28.0$^{b}$ | 7.9 | 6.2 | 61$^{a}$ | .33$^{a}$ |
| (74[4], 118[5]) | 3 | Oct. 14 | 29.8$^{b}$ | 7.1 | 5.4 | 50$^{b}$ | .31$^{ab}$ |
| Warner's Sweet | 1 | Sept. 20 | 24.0$^{a}$ | 8.1$^{a}$ | 7.0 | -- | -- |
| Bee Sterile | 2 | Oct. 1 | 25.3$^{a}$ | 8.0$^{a}$ | 7.1 | -- | -- |
| (--, 107) | 3 | Oct. 15 | 28.2$^{b}$ | 6.8$^{b}$ | 7.1 | -- | -- |
| Golden Harvest | 1 | Sept. 24 | 23.1$^{a}$ | 8.4 | 6.8 | 54$^{b}$ | .25$^{b}$ |
| T-E Silomaker | 2 | Oct. 4 | 25.6$^{a}$ | 8.0 | 7.0 | 59$^{ab}$ | .27$^{ab}$ |
| (84, 111) | 3 | Nov. 5 | 36.5$^{b}$ | 8.0 | 6.6 | 70$^{a}$ | .36$^{a}$ |
| Conlee's Cow | 1 | Oct. 2 | 24.5$^{a}$ | 7.5$^{a}$ | 7.4 | 36 | .14 |
| Vittles | 2 | Oct. 14 | 24.4$^{a}$ | 6.3$^{b}$ | 6.6 | 34 | .15 |
| (87, 141) | 3 | Nov. 7 | 31.4$^{b}$ | 7.1$^{ab}$ | 6.7 | 31 | .13 |
| **Grain Sorghum** | | | | | | | |
| WAC 652G | 1 | Sept. 7 | 29.0$^{a}$ | 11.6$^{a}$ | 4.4$^{b}$ | 65$^{c}$ | .59$^{b}$ |
| (63, 51) | 2 | Sept. 17 | 32.9$^{b}$ | 10.7$^{b}$ | 4.9$^{ab}$ | 88$^{b}$ | .82$^{a}$ |
| | 3 | Oct. 4 | 40.2$^{c}$ | 10.2$^{b}$ | 5.3$^{a}$ | 101$^{a}$ | .91$^{a}$ |
| DeKalb 42Y | 1 | Sept. 9 | 27.9$^{a}$ | 11.7$^{a}$ | 4.8 | 46$^{c}$ | .32$^{b}$ |
| (69, 47) | 2 | Sept. 19 | 31.0$^{b}$ | 10.6$^{b}$ | 5.1 | 78$^{b}$ | .63$^{a}$ |
| | 3 | Oct. 14 | 41.3$^{c}$ | 10.1$^{b}$ | 5.1 | 95$^{a}$ | .83$^{a}$ |
| NC+ 174 | 1 | Sept. 16 | 28.2$^{a}$ | 10.4$^{a}$ | 5.1 | 84$^{b}$ | .70$^{b}$ |
| (71, 53) | 2 | Sept. 24 | 30.8$^{b}$ | 9.7$^{b}$ | 5.8 | 103$^{a}$ | .81$^{b}$ |
| | 3 | Oct. 15 | 41.2$^{c}$ | 9.2$^{b}$ | 5.2 | 112$^{a}$ | 1.20$^{a}$ |
| Asgrow Colt | 1 | Sept. 24 | 26.9$^{a}$ | 10.0 | 5.4 | 85$^{b}$ | .66 |
| (78, 52) | 2 | Oct. 2 | 30.9$^{b}$ | 10.0 | 5.7 | 97$^{a}$ | .75 |
| | 3 | Oct. 24 | 42.2$^{c}$ | 9.4 | 5.1 | 87$^{ab}$ | .74 |

[1]Harvest stage 1, late-milk to early-dough; stage 2, late-dough; and stage 3, hard-grain.
[2]100% dry matter basis.
[3]Adjusted to 12.5% moisture basis.
[4]Half bloom, days.
[5]Plant height at harvest stage 1, inches.
[abc]Means within a hybrid with different superscripts differ ($P<.05$).

Table 38.5. Harvest Dates, Days to Half Bloom, Plants Heights, Dry Matters (DM), Crude Proteins (CP), and Whole-plant Forage and Grain Yields for Eight Forage Sorghums and Five Grain Sorghums in Trial 3 (May 31 planting date)

| Hybrid or Variety | Harvest Date | Half Bloom[1] | Plant Height[2] | Whole-plant DM | Whole-plant CP[3] | Whole-plant DM Yield | Grain Yield[4] | Grain: Forage |
|---|---|---|---|---|---|---|---|---|
| | 1986 | | | % | % | Tons/A. | Bu/A. | |
| Forage Sorghum | | | | | | | | |
| Canex | Aug. 20 | 57 | 108 | 25.3 | 6.6 | 5.5 | 51 | .30 |
| Pioneer 956 | Aug. 20 | 57 | 105 | 30.5 | 7.5 | 6.0 | 93 | .63 |
| DeKalb FS 5 | Aug. 30 | 60 | 106 | 27.9 | 7.2 | 6.6 | 87 | .50 |
| Pioneer 947 | Sept. 4 | 61 | 108 | 34.4 | 7.4 | 7.3 | 105 | .57 |
| Atlas | Sept. 4 | 64 | 103 | 27.5 | 6.3 | 6.9 | 52 | .23 |
| Supersile | Sept. 24 | 83 | 125 | 27.4 | 6.8 | 8.0 | 70 | .28 |
| Silomaker | Oct. 6 | 85 | 112 | 30.0 | 6.8 | 8.2 | 98 | .43 |
| DeKalb 25E | Oct. 6 | 87 | 131 | 27.9 | 7.4 | 7.0 | 68 | .32 |
| Grain Sorghum | | | | | | | | |
| Funk's G 522 | Aug. 21 | 51 | 59 | 33.7 | 8.8 | 5.6 | 106 | .92 |
| Pioneer 8493 | Aug. 21 | 51 | 54 | 35.1 | 8.9 | 5.2 | 99 | .91 |
| NC+ 174 | Aug. 23 | 52 | 62 | 34.0 | 8.1 | 5.6 | 106 | .92 |
| Asgrow Topaz | Aug. 26 | 53 | 55 | 33.6 | 8.4 | 5.5 | 113 | 1.08 |
| DeKalb 41Y | Aug. 29 | 55 | 51 | 33.6 | 8.4 | 5.7 | 110 | .96 |

[1] Half bloom, days.

[2] Plant height, inches.

[3] 100% dry matter basis.

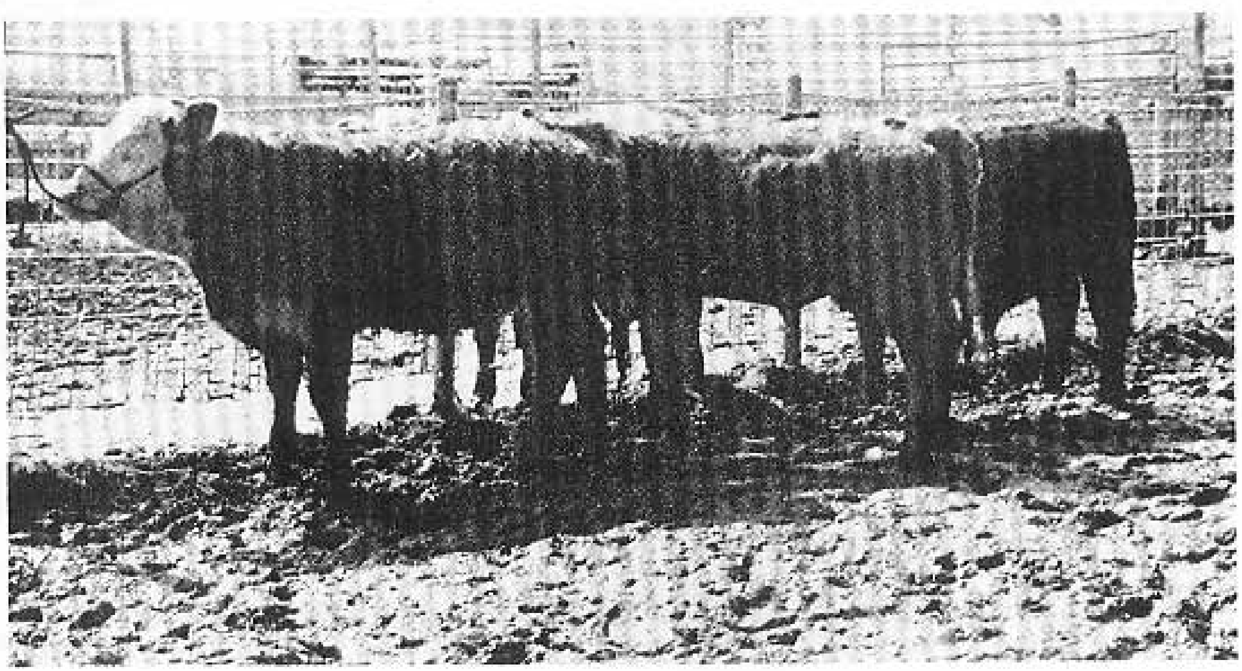
[4] Adjusted to 10.0% moisture.

# Weather Data, 1985 - 1986

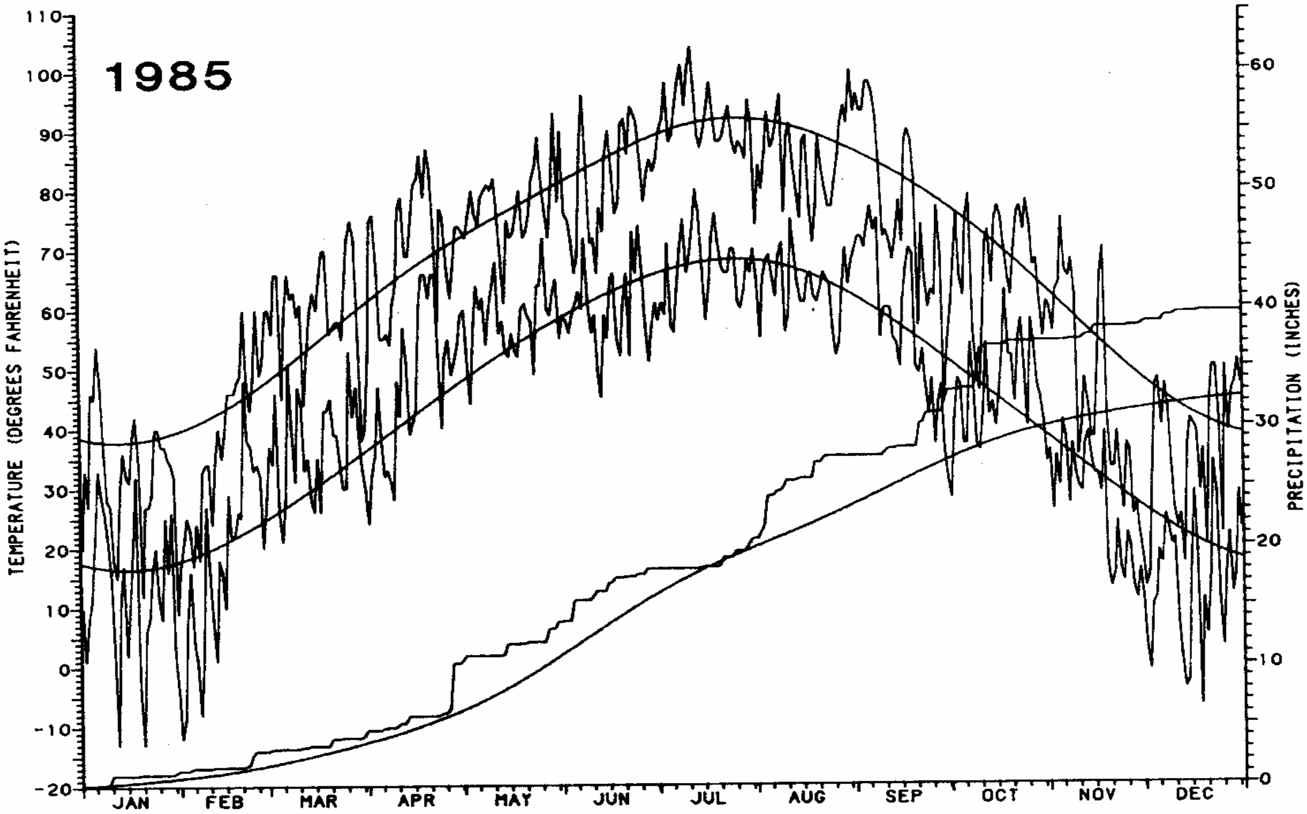
On the following page are graphs of 1985 and 1986 Manhattan weather, produced with the aid of the Kansas Agricultural Experiment Station Weather Data Library. The smooth line that starts in the lower left hand corner of each graph is the normal accumulated precipitation. The rough line represents actual precipitation. A long horizontal section of that line represents time during which no precipitation occurred. A verticle section represents precipitation.

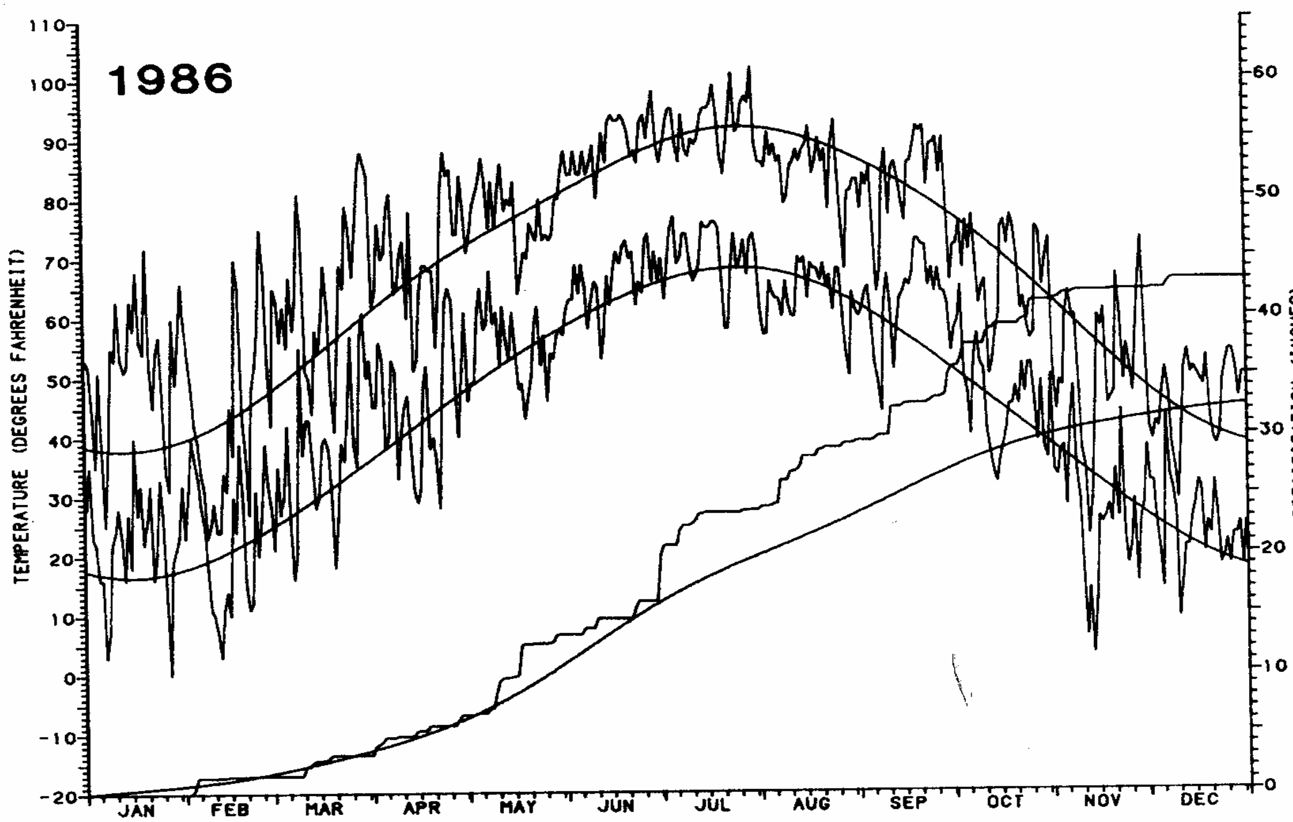
The other two smooth lines represent average daily high and low temperatures, and the rough lines represent actual highs and lows.

These graphs are included because much of the data in this publication, especially data on cow maintenance requirements, and forage yields can be influenced by weather. Weather graphs have also been included in Cattlemen's Day publications for the past three years.



Mud, a weather variable that influences animal performance.




Graphical Weather Summary for Manhattan, Kansas