# Research Report

## Forage Sorghum Hybrid Yield and Quality at Maricopa, AZ, 2015

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## Summary

*Forage sorghum is commonly grown in Arizona for silage for dairy cattle and is valued for its lower nitrogen fertilizer and water requirements compared to corn. Five forage sorghum hybrids were evaluated in a study conducted at the Maricopa Agricultural Center in 2015. The hybrids tested did not differ in yield or overall feeding quality (TDN, total digestible nutrients) although some differences in heading, plant height, moisture content, and some specific quality parameters were detected.*

## Introduction

Forage sorghum is commonly grown for silage for dairy cattle in Arizona. This crop is typically planted in late June or July after small grains or silage corn. Sorghum has the advantage compared to corn in that it uses less water and fertilizer, but feeding quality of sorghum is usually less than corn. However, current sorghum hybrids typically carry the brown midrif leaf trait (bmr) which makes the fiber in the plant more digestible and many of these hybrids can approach the feeding quality of silage corn. The University of Arizona does not have a forage sorghum hybrid testing program and the only test completed in the past decade was reported by Loper and Ottman (2013). The purpose of this research is to compare the yield and quality of currently available sorghum hybrids in Arizona.

## Procedure

Forage sorghum hybrids were evaluated in a study conducted at the University of Arizona Maricopa Agricultural Center in 2015. The soil was a Casa Grande sandy loam soil and preplant soil chemical analysis is provided in Table 1. Dual Magnum herbicide was applied preplant at a rate of 1 pint/acre. The germination irrigation was applied on June 28 and subsequent irrigations applied as needed at an interval that averaged 10 days for a total water application of 53 inches (Table 2). Nitrogen fertilizer was applied preplant and twice during the season for a total N fertilizer application of 195 lb N/acre (Table 2).

The experimental design was a randomized complete block with 5 hybrids (Table 3) and 4 blocks. The row spacing was 40 inches and the seeding rate was 100,000 seeds/acre except for EJ7281 which was seeded at a rate of 57,000 seeds/acre. The plots were 93.3 ft wide and 585 ft long for an area of 1.23 acres.

Yield and other measurements were taken on a pre-harvest sample on October 26 and at final harvest on November 17, and heading date was noted when it occurred. Biomass samples were obtained on October 26 from a 1 m section of row. These samples were weighed wet, chopped, and a subsample removed that was weighed wet, dried at 65 C, and weighed dry for moisture content. Forage yield was calculated and adjusted to 72% moisture content. Plant height was also measured on these plants. A similar procedure was followed on November 17 for moisture content at final harvest, but the yield was measured using truck scales from the forage obtained from a 20 ft x 495 ft swath

through the middle of each plot with a commercial forage chopper. Days to maturity, or black layer of the grain, and bird damage to the grain was estimated at final harvest. The forage samples from October 26 and November 17 were submitted for estimation of quality parameters by near infrared spectroscopy (NIRS), and information from this analysis was used by MILK2006 (Schwab et al., 2003; Shaver et al., 2006) a feed quality calculator, to estimate TDN, $NE_l$, milk per ton, and milk per acre.

## Results and Discussion

The hybrids tested in this study were physically quite different from each other in appearance (Table 2). All the hybrids were BMR except for EJ7281. Most of the hybrids were also brachytic dwarfs except for EJ7281 and Silo 700D BMR. Brachytic dwarfs have shortened internodes only, without the loss of leaf number, giving the plant a compact and leafy appearance.

The hybrids did not differ in yield at harvest on November 17 nor for the sampling on October 26 (Table 4). The hybrid EJ7281 had the highest moisture content on both of these dates perhaps related to its later heading date. The hybrid EJ7281 was the tallest and 340BMR was the shortest in stature. Maturity, or estimated days to grain black layer, was similar for all hybrids. Bird damage or feeding on the grain was slight and averaged 3%, but there were nevertheless some differences among hybrids.

There were no differences in feed quality parameters calculated by MILK2006 (Table 5). Some differences in feed quality parameters as measured by NIRS were detected (Table 6 and 7), however, but did not contribute to the overall estimates of feed quality such as TDN or milk per ton. Abbreviations used for feed quality parameters are provided in Table 8.

## Acknowledgments

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## References

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Table 1. Soil chemical analysis preplant.

| Chemical measurement | Unit | Value | Unit | Value |
|---|---|---|---|---|
| Total Exchange Capacity | (meq/100 g) | 22.3 | --- | --- |
| pH | (pH) | 8.1 | --- | --- |
| Organic Matter | (%) | 1.0 | --- | --- |
| Estimated Nitrogen Release | (lb N/acre) | 38 | --- | --- |
| $NO_3$-N | (ppm) | 70.4 | --- | --- |
| $NH_4$-N | (ppm) | 11.5 | --- | --- |
| S | (mg/kg) | 50 | --- | --- |
| P | (mg/kg) | 16 | --- | --- |
| Ca | (mg/kg) | 3400 | (%) | 76.20 |
| Mg | (mg/kg) | 291 | (%) | 10.87 |
| K | (mg/kg) | 455 | (%) | 5.23 |
| Na | (mg/kg) | 226 | (%) | 4.40 |
| Fe | (mg/kg) | 5.00 | --- | --- |
| Mn | (mg/kg) | 10.00 | --- | --- |
| Cu | (mg/kg) | 3.51 | --- | --- |
| Zn | (mg/kg) | 1.95 | --- | --- |

Table 2. Irrigation and fertilizer schedule and amounts for a hybrid trial conducted at Maricopa, AZ in 2015.

| Date | Irrigation amount | Fertilizer amount | Fertilizer source |
|---|---|---|---|
| | inches | lb N/A | |
| 06/28 | 6.49 | 102 | Urea |
| 07/09 | 5.78 | --- | --- |
| 07/21 | 4.96 | --- | --- |
| 07/30 | 3.86 | 53 | UAN 32 |
| 08/07 | 4.29 | --- | --- |
| 08/20 | 4.98 | --- | --- |
| 08/28 | 4.21 | 40 | UAN 32 |
| 09/06 | 4.69 | --- | --- |
| 09/16 | 3.84 | --- | --- |
| 09/26 | 4.62 | --- | --- |
| 10/07 | 4.83 | --- | --- |
| Sum | 52.56 | 195 | --- |

Table 3. Hybrid distributor and source and whether or not BMR or brachytic dwarf.

| Hybrid | Distributor | Source | BMR | Brachytic dwarf |
|---|---|---|---|---|
| BMR 110 | Barkley | Advanta | Yes | Yes |
| EJ7281 | Ceres | Ceres | No | No |
| 340 BMR | Arizona Grain | Golden Acres | Yes | Yes |
| Great Scott | Desert Sun Marketing | Scott Seeds | Yes | Yes |
| Silo 700D BMR | Desert Sun Marketing | Richardson Seeds | Yes | No |

Table 4. Yield and other plant characteristics of forage sorghum harvested on November 17, 2015 and sampled on October 26, 2015 as affected by hybrid for a study conducted at Maricopa, AZ in 2015.

| | November 17 | | | | | October 26 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hybrid | Yield* | Moisture | Height | Days to maturity | Bird damage | Yield* | Moisture | Height | Heading |
| | T/A | % | inches | | % | T/A | % | inches | |
| BMR 110 | 27.2 | 69.0 | 105 | 3.75 | 0 | 24.4 | 77.6 | 91 | 4-Oct |
| EJ7281 | 27.4 | 75.9 | 154 | 4.00 | 7 | 20.3 | 84.6 | 136 | 11-Oct |
| 340 BMR | 27.3 | 68.2 | 94 | 4.25 | 0 | 27.1 | 76.7 | 87 | 5-Oct |
| Great Scott | 26.4 | 73.0 | 114 | 4.00 | 5 | 26.7 | 77.0 | 95 | 6-Oct |
| Silo700D BMR | 24.8 | 71.2 | 111 | 4.25 | 1 | 22.8 | 78.5 | 97 | 4-Oct |
| Avg | 26.6 | 71.5 | 116 | 4.05 | 3 | 24.2 | 78.9 | 101 | 6-Oct |
| $LSD_{.05}$ | ns | 4.0 | 16 | ns | 5 | ns | 4.2 | 8 | 2 |
| CV (%) | 7 | 4 | 9 | 4 | 118 | 17 | 3 | 5 | 0 |

* Yield adjusted to 72% moisture.

Table 5. Feed quality parameters calculated by MILK2006 for forage sorghum harvested on November 17, 2015 and sampled on October 26, 2015 as affected by hybrid for a study conducted at Maricopa, AZ in 2015.

| | November 17 | | | | October 26 | | | |
|---|---|---|---|---|---|---|---|---|
| Hybrid | TDN | $NE_l$ | Milk per ton | Milk per acre | TDN | $NE_l$ | Milk per Ton | Milk per acre |
| | % | Mcal/lb | lb/T | lb/A | % | Mcal/lb | lb/T | lb/A |
| BMR 110 | 57.3 | 0.547 | 2,251 | 17,059 | 54.1 | 0.511 | 2,013 | 13,641 |
| EJ7281 | 56.1 | 0.515 | 2,083 | 15,963 | 57.3 | 0.541 | 2,229 | 12,593 |
| 340 BMR | 58.6 | 0.562 | 2,349 | 17,903 | 52.9 | 0.497 | 1,922 | 14,538 |
| Great Scott | 57.0 | 0.546 | 2,240 | 16,496 | 54.3 | 0.505 | 1,998 | 15,026 |
| Silo700D BMR | 60.7 | 0.581 | 2,493 | 17,302 | 52.9 | 0.490 | 1,891 | 11,968 |
| Avg | 57.9 | 0.55 | 2,283 | 16,944 | 54.3 | 0.509 | 2,010 | 13,553 |
| $LSD_{.05}$ | ns | ns | ns | ns | ns | ns | ns | ns |
| CV (%) | 5 | 6 | 10 | 8 | 9 | 9 | 16 | 25 |

Table 6. Feed quality parameters measured by NIRS for forage sorghum harvested on November 17 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | NDF | ADF | Protein | Fat | SIP | ADF-CP | NDF-CP | UIP | Lignin | Starch | NFC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % | % |
| BMR 110 | 49.0 | 35.3 | 5.27 | 2.54 | 33.7 | 0.947 | 2.15 | 32.3 | 11.00 | 21.5 | 34.2 |
| EJ7281 | 51.0 | 34.1 | 5.73 | 2.46 | 43.3 | 0.747 | 2.05 | 28.5 | 7.57 | 12.0 | 36.4 |
| 340 BMR | 46.2 | 33.7 | 5.37 | 2.72 | 33.2 | 1.030 | 2.23 | 31.2 | 11.10 | 24.9 | 32.8 |
| Great Scott | 51.1 | 35.3 | 5.76 | 2.70 | 33.5 | 0.807 | 2.20 | 33.1 | 10.00 | 16.7 | 34.3 |
| Silo700D BMR | 48.6 | 35.6 | 4.39 | 2.93 | 34.3 | 0.986 | 2.12 | 31.3 | 10.30 | 23.7 | 32.9 |
| Avg | 49.2 | 34.8 | 5.30 | 2.67 | 35.6 | 0.903 | 2.15 | 31.3 | 10.00 | 19.8 | 34.1 |
| $LSD_{.05}$ | ns | ns | 0.57 | ns | 7.1 | 0.145 | ns | 2.0 | 1.31 | 4.3 | ns |
| CV (%) | 5 | 7 | 7 | 9 | 13 | 10 | 13 | 4 | 9 | 14 | 12 |

Table 6 (con'd). Feed quality parameters measured by NIRS for forage sorghum harvested on November 17 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | Soluble carbs | Simple sugars | IVTDM D24 | IVTDM D30 | IVTDM D48 | NDFD 24 | NDFD 30 | NDFD 48 | Lysine | Methi-onine | Lactic acid |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % | % |
| BMR 110 | 6.01 | 5.48 | 61.0 | 66.4 | 69.9 | 37.1 | 44.2 | 51.7 | 0.234 | 0.130 | 1.30 |
| EJ7281 | 5.70 | 4.60 | 64.6 | 70.1 | 73.6 | 43.1 | 50.1 | 57.6 | 0.210 | 0.121 | 1.36 |
| 340 BMR | 5.59 | 5.36 | 62.3 | 67.6 | 71.1 | 37.1 | 44.2 | 51.8 | 0.239 | 0.129 | 1.02 |
| Great Scott | 7.36 | 6.48 | 61.3 | 66.7 | 70.2 | 36.8 | 43.8 | 51.3 | 0.245 | 0.133 | 1.69 |
| Silo700D BMR | 3.44 | 3.26 | 63.2 | 68.7 | 72.1 | 40.0 | 47.1 | 54.6 | 0.220 | 0.125 | 1.02 |
| Avg | 5.62 | 5.04 | 62.5 | 67.9 | 71.4 | 38.8 | 45.9 | 53.4 | 0.229 | 0.128 | 1.28 |
| $LSD_{.05}$ | 2.35 | 1.88 | ns | ns | ns | 4.0 | 4.0 | 4.0 | ns | ns | ns |
| CV (%) | 27 | 24 | 4 | 4 | 4 | 7 | 6 | 5 | 10 | 7 | 35 |

Table 6 (con'd). Feed quality parameters measured by NIRS for forage sorghum harvested on November 17 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | Ash | Ca | P | Mg | S | K | Na | Cl | Fe | Mn | Cu | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | ppm | ppm | ppm | ppm |
| BMR 110 | 11.40 | 0.378 | 0.169 | 0.091 | 0.077 | 1.57 | 0.033 | 1.05 | 492 | 85.7 | 6.60 | 38.4 |
| EJ7281 | 7.59 | 0.344 | 0.158 | 0.210 | 0.077 | 1.73 | 0.016 | 1.39 | 153 | 78.8 | 6.55 | 35.5 |
| 340 BMR | 11.50 | 0.365 | 0.156 | 0.098 | 0.069 | 1.45 | 0.029 | 1.14 | 538 | 80.9 | 6.62 | 38.6 |
| Great Scott | 9.92 | 0.405 | 0.169 | 0.173 | 0.076 | 1.78 | 0.032 | 1.45 | 346 | 72.6 | 6.19 | 37.4 |
| Silo700D BMR | 9.94 | 0.310 | 0.138 | 0.054 | 0.058 | 1.40 | 0.025 | 1.00 | 266 | 74.6 | 5.79 | 37.9 |
| Avg | 10.10 | 0.360 | 0.158 | 0.125 | 0.071 | 1.58 | 0.027 | 1.21 | 359 | 78.5 | 6.35 | 37.6 |
| $LSD_{.05}$ | 2.31 | 0.043 | 0.019 | 0.054 | 0.010 | 0.21 | 0.010 | 0.20 | ns | ns | 0.60 | 1.0 |
| CV (%) | 15 | 8 | 8 | 28 | 9 | 8 | 25 | 11 | 52 | 11 | 6 | 2 |

Table 7. Feed quality parameters measured by NIRS for forage sorghum sampled on October 26 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | NDF | ADF | Protein | Fat | SIP | ADF-CP | NDF-CP | UIP | Lignin | Starch | NFC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % | % |
| BMR 110 | 50.6 | 35.1 | 7.18 | 2.05 | 36.5 | 0.865 | 2.13 | 34.5 | 9.97 | 15.6 | 30.8 |
| EJ7281 | 50.2 | 34.2 | 9.18 | 2.69 | 38.7 | 0.773 | 2.21 | 31.4 | 8.76 | 16.2 | 30.7 |
| 340 BMR | 52.8 | 35.9 | 8.20 | 2.13 | 34.3 | 0.870 | 2.41 | 34.1 | 9.91 | 13.1 | 26.5 |
| Great Scott | 54.3 | 37.1 | 7.57 | 2.38 | 37.2 | 0.795 | 2.07 | 31.9 | 8.28 | 11.0 | 29.2 |
| Silo700D BMR | 54.1 | 36.9 | 8.36 | 2.40 | 38.3 | 0.747 | 2.24 | 32.6 | 8.87 | 12.1 | 27.6 |
| Avg | 52.4 | 35.9 | 8.10 | 2.33 | 37.0 | 0.810 | 2.21 | 32.9 | 9.16 | 13.6 | 29.0 |
| $LSD_{.05}$ | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV (%) | 6 | 8 | 20 | 22 | 10 | 22 | 17 | 10 | 18 | 25 | 21 |

Table 7 (con'd). Feed quality parameters measured by NIRS for forage sorghum sampled on October 26 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | Soluble carbs | Simple sugars | IVTDM D24 | IVTDM D30 | IVTDM D48 | NDFD 24 | NDFD 30 | NDFD 48 | Lysine | Methi-onine | Lactic acid | Acetic acid |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % | % | % |
| BMR 110 | 7.48 | 7.09 | 60.4 | 65.8 | 69.2 | 36.2 | 43.2 | 50.8 | 0.258 | 0.135 | 1.88 | 0.715 |
| EJ7281 | 6.55 | 5.84 | 62.2 | 67.6 | 71.1 | 39.1 | 46.1 | 53.7 | 0.245 | 0.133 | 1.72 | 0.468 |
| 340 BMR | 8.64 | 8.31 | 60.1 | 65.4 | 68.9 | 35.9 | 43.0 | 50.5 | 0.288 | 0.150 | 2.14 | 0.348 |
| Great Scott | 7.07 | 5.96 | 61.7 | 67.1 | 70.6 | 39.3 | 46.2 | 53.8 | 0.268 | 0.140 | 1.83 | 1.170 |
| Silo700D BMR | 7.60 | 6.33 | 60.8 | 66.2 | 69.7 | 38.3 | 45.4 | 52.9 | 0.270 | 0.140 | 1.78 | 0.910 |
| Avg | 7.47 | 6.71 | 61.0 | 66.4 | 69.9 | 37.8 | 44.8 | 52.3 | 0.266 | 0.140 | 1.87 | 0.722 |
| $LSD_{.05}$ | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV (%) | 38 | 31 | 5 | 5 | 4 | 12 | 10 | 9 | 20 | 14 | 32 | 62 |

Table 7 (con'd). Feed quality parameters measured by NIRS for forage sorghum sampled on October 26 as affected by hybrid in a study conducted at Maricopa, AZ in 2015.

| Hybrid | Ash | Ca | P | Mg | S | K | Na | Cl | Fe | Mn | Cu | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | ppm | ppm | ppm | ppm |
| BMR 110 | 11.9 | 0.463 | 0.270 | 0.133 | 0.130 | 2.32 | 0.040 | 1.25 | 334 | 88.4 | 6.67 | 36.9 |
| EJ7281 | 11.9 | 0.438 | 0.315 | 0.138 | 0.128 | 2.07 | 0.020 | 1.40 | 179 | 83.0 | 7.51 | 35.8 |
| 340 BMR | 13.0 | 0.478 | 0.275 | 0.155 | 0.123 | 2.25 | 0.035 | 1.57 | 407 | 87.5 | 7.25 | 36.9 |
| Great Scott | 11.3 | 0.448 | 0.278 | 0.175 | 0.120 | 2.27 | 0.025 | 1.52 | 128 | 80.0 | 6.35 | 35.3 |
| Silo700D BMR | 12.3 | 0.463 | 0.305 | 0.168 | 0.130 | 2.31 | 0.025 | 1.52 | 143 | 80.6 | 6.85 | 35.8 |
| Avg | 12.1 | 0.458 | 0.289 | 0.154 | 0.126 | 2.24 | 0.029 | 1.45 | 238 | 83.9 | 6.92 | 36.1 |
| $LSD_{.05}$ | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| CV (%) | 16 | 10 | 16 | 47 | 9 | 11 | 57 | 16 | 126 | 13 | 12 | 4 |

Table 8. Abbreviations for various phrases used to define feed quality.

| Abbreviation | Phrase |
|---|---|
| ADF | Acid detergent fiber |
| ADF-CP | Acid detergent fiber crude protein |
| IVTDMD24 | *In vitro* dry matter digestibility after incubation for 24 hours |
| IVTDMD30 | *In vitro* dry matter digestibility after incubation for 30 hours |
| IVTDMD48 | *In vitro* dry matter digestibility after incubation for 48 hours |
| NDF | Neutral detergent fiber |
| NDF-CP | Neutral detergent fiber crude protein |
| NDFD24 | Neutral detergent fiber digestibility after incubation for 24 hours |
| NDFD30 | Neutral detergent fiber digestibility after incubation for 30 hours |
| NDFD48 | Neutral detergent fiber digestibility after incubation for 48 hours |
| $NE_l$ | Net energy for lactation |
| NFC | Non-fibrous carbohydrate |
| SIP | Soluble intake protein |
| TDN | Total digestible nutrients |
| UIP | Undegradable intake protein |
| VFA | Volatile fatty acids |