The Nitrogen Requirement and Use Efficiency of Sweet Sorghum Produced in Central Oklahoma.

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Introduction

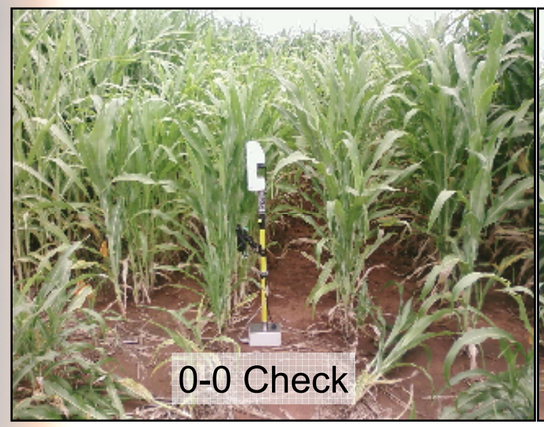
As the need for the production of bio-fuels becomes greater so does the need to better understand the appropriate practices needed for maximum production. A careful balance must be meet as a desire for maximum yields could lead to a mismanagement of nitrogen (N) fertilizer to the point that the benefits of the bio-fuel that's grown is off set by the N lost to the environment. On the other hand for Oklahoma farmers the allure of bio-fuel production is quite great as both switch grass and sweet sorghum are promoted as being good choices for marginal ground that and both are said to lack the high nutrient requirements of other high yielding crops. Many may be tempted to skimp on N fertilizer and lose out on yield and ultimately profit. For the producers of Oklahoma, research was needed to evaluate the yield potential of sweet sorghum grown in the central Great Plains and to validate the N requirements of a crop that has been reported by some to reach maximum yields at inputs of 45 kg ha-1. Other researchers suggested, through personal conversations that while there may be an increase in biomass at rates over 112 kg/ha it was very unlikely to see an increase in juice production.

This experiment, because of limited space, was designed not to identify specific economical optimum N rates but to answer the general question of sweet sorghum N fertilizer management. Specifically is there benefit to increasing the N rate above 56 or 122 kg N ha-1 and is there any benefit to split application of N.

Materials and Methods

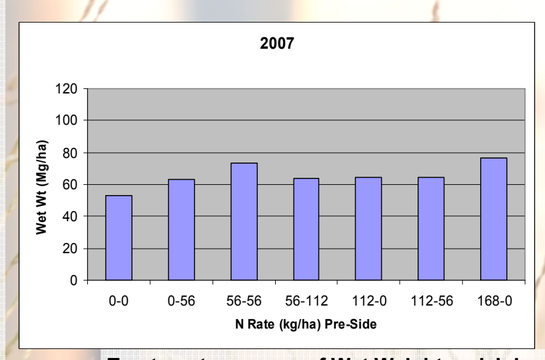
Trials were implemented as a RCBD
- 7 treatments
  - 2 timings, 4 total N rates
- First year 1 irrigated location, 1 variety
- Years 2 and 3:
  - 2 locations;1 irrigated and 1 dryland
  - 2 varieties under each system; Topper and M81
- Plots (3.058 m * 6.116 m)
- Row Spacing (30in) planting occurred Mid May, harvest occurred during the end of September through first of Oct.
- Planting:
  - Planted using a 4 row John Deer MaxEmerge2 Vacuum planter
- Fertilization:
  - N applied Pre-plant using UAN applied broadcast over the plots
  - Side dress N applied by dribbling UAN along the base of each row when plants were 1 to 1.5 meter in height.
- Harvest:
  - 3.05 m of row harvest from each plot when plants reached dough stage.
  - Plants cut by hand, weighed for wet weight, passed through squeeze press.
  - Volume of juice recorded, samples of juice and biomass collected for analysis.
- 2009 trials just recently harvested: wet weight and juice volume only data collected.

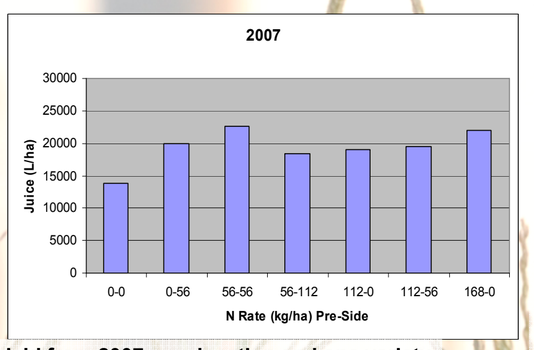
Results



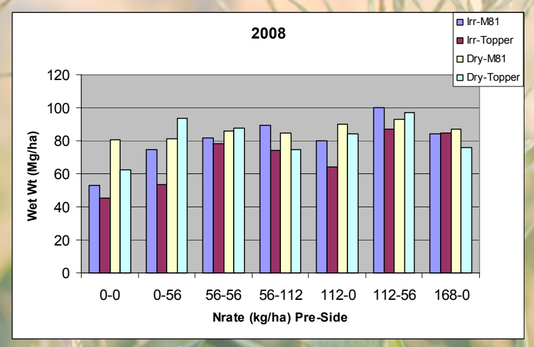
Preplant N kg ha^{-1}	Side Dress N kg ha^{-1}	Total N kg ha^{-1}	Wet Biomass Mg ha^{-1}	Juice Yield L ha^{-1}	Ethanol* L ha^{-1}	Profit ** $ ha^{-1}
0	0	0	62.99	16318	2069	1092.51
0	56	56	74.28	19561	2480	1260.27
56	56	112	81.73	21318	2703	1328.60
56	112	168	82.42	22586	2864	1364.13
112	0	168	79.79	20832	2642	1296.06
112	56	168	85.60	22161	2810	1335.69
168	0	168	82.39	20291	2573	1210.45

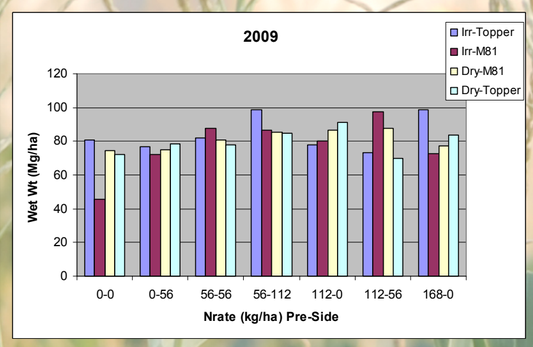
Treatment averages over five site years across two varieties.
* Ethanol Yield calculated as 12% of juice yield.
** Profit calculated as $0.523 L ethanol minus $0.881 kg N

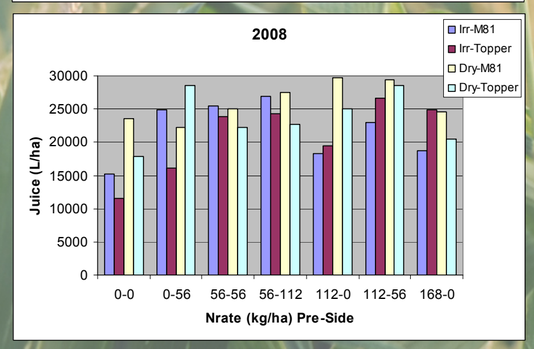


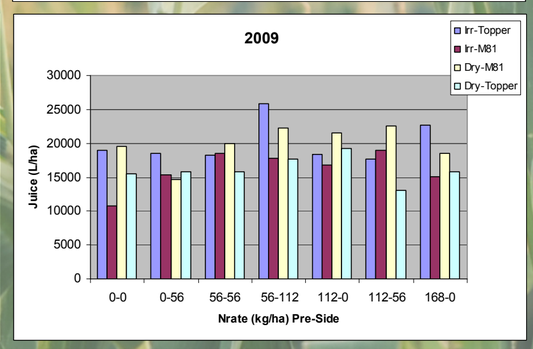


Treatment averages of Wet Weight and Juice yield from 2007, one location and one variety









Treatment averages of Wet Weight and Juice yield from 2008 and 2009, two locations and two varieties

Results

Nitrogen treatment effect on both wet weight and juice volume was significant in all instances with the exception of the 2008 dryland producer of Topper, in which there were no significant differences across treatments. Variety was only significant in one case and that was on the wet weight in 2008, however there was no significant influence by variety upon volume of juice extracted. In 2009 because of timing rainfall events irrigation had no impact upon either wet weight or juicing.

When comparing the economical return from the production of ethanol from the squeezing of sweet sorghum the 56 -112 kg N ha^{-1} rate application resulted in 7 out of 9 instances were this treatment was in the top 3 highest profited, only once did this treatment result in a profit that is in the lowest 3. The 112 – 56 kg N ha^{-1} treatment was the only other treatment that consistently resulted in a top 3 return, in this case 5 out of 9 site years had high profits with 2 sites years have lower earnings. Treatments of 112-0 and 56-56 kg N ha^{-1} resulted in an equal number site years with good and poor profit. The 0-0, 0-56, and 168-0 kg N ha^{-1} rates resulted in a majority of the site years having lower than average profit.

Discussion and Conclusion

The first observation that must be noted is that in all years, sites, varieties, and treatments', lodging was an issue. Every year just prior to antheisis a wind/rain storm would pass through causing severe lodging. However in all cases the plants survived and continued growth until maturity.

As was statement in the introduction this trial was not designed to specifically identify optimal economic N rate, however it was designed to test some common management suggestions identify general practices that will lead to the highest economical return.

This study at least indicated that the low input sticker placed on grain sorghum may not be completely valid. Yes large quantities of biomass and juice may be produced with very little input there is still significant economical benefit for fertilizer rate at or over 112 kg N ha^{-1}. While these rates may not be considered high by producers in the corn belt of the US, they are as high or higher than the traditional practices of the monoculture winter wheat producers of Oklahoma.

Other observations that can be made from this data are that it is beneficial to split apply nitrogen as the 168 kg N ha^{-1} rate was on the average significantly lower in yield and profit. In addition the 56 -56 kg N ha^{-1} rate resulted in higher yields and profits than the 112-0 kg N ha^{-1} rate.

The conclusion of this study is that as an agronomic recommendation for the nitrogen fertilization of sweet sorghum produced in central Oklahoma is a split application of 112 to 168 total kg N ha^{-1} including residual soil test N. Additional research is needed to identify specific optimum N rates.