NUTRIENT DRAWDOWN IMPACT ON YIELD IN A LONG TERM COTTON FERTILITY STUDY IN SOUTHWEST OKLAHOMA

Raedan Sharry
Brian Arnall
Oklahoma State University
Stillwater, OK

Abstract

Experiment 439 is a long term cotton fertility study initiated in 1972 near Altus, OK. Annual applications of Nitrogen (N), Phosphorus (P) and Potassium (K) have been applied at various rates to evaluate the long term effects of fertilization on cotton. A severe drought event during the 2011-2014 growing seasons resulted in subsequent crop failures. In response, fertilizer applications ceased in 2013. After 6 growing seasons and nearly 6000 lbs. of lint production N alone was applied according to historical treatments to evaluate response to fertilizer N in 2021. Lint yields in 2021 showed a significant response above the 0 N check only ($p>0.05$). In the 2016 and 2017 seasons response was similar with significant differences not being observed outside of the 0 N check. Experiment 439 provides substantial evidence of significant contribution of N from sources other than that of applied fertilizer.

Introduction

Experiment 439 is a long term continuous cotton fertility study located within the Altus-Lugert irrigation district near Altus, Oklahoma initiated in 1972 by Dr. Billy Tucker. This area has high yield potential due to the availability of surface water from Lake Lugert. However, drought can put significant stress on the irrigation district as it did in 2011 leading to widespread crop failure not only in 2011, but up until 2015 when enough water was allocated to provide a harvestable crop for most producers including the Southwest Research and Extension Center. For reference there is no yield averages for Jackson County for the years 2011 to 2013 through the USDA NASS database indicating near total crop failure during that period. Many producers over this period continued to put in a crop and apply fertilizers as they would traditionally. For many producers this likely led to over-fertilization. This analysis looks to evaluate the influence of nutrient drawdown on yield following a stoppage in fertilizer application in a long term fertility study.

Materials and Methods

Experiment 439 was initiated in 1972 to evaluate the effect of continuous application of N, P and K on cotton lint yield in a continuous irrigated cotton system. Fertilizers used in this study consist of ammonium nitrate (34-0-0), triple super phosphate (0-46-0), and potassium chloride (0-0-60). The study is planted on 40 inch row spacing and was furrow irrigated until the installation of drip in 2018. Plots are 6 rows wide and 60 feet long. Experiment 439 utilizes a randomized complete block design with 14 treatments replicated 4 times. The middle two rows are harvested using a two row cotton stripper. Due to repeated crop failure in the 2011-2014 cropping seasons, fertilizer application was stopped in 2013. In 2021 nitrogen alone was applied according to treatment N rates to assess N response. Long term treatments are listed in table 1 as N-P-K in lbs. per nutrient. This table also includes available soil test analysis results. Analysis of selected treatments (2-7) was completed in SAS 9.4 using an analysis of variance with a Dunnett's Test MCC at an alpha level of 0.05 utilizing treatment 2 as the control.

Table 1. Treatments evaluated and associated fertilizer rates (lbs. ac^{-1} N-P-K) and mean soil NO_3- levels at 0-6" sampling depth for 1988 and 0-6" and 6-18" sampling depth 2018 (lbs. ac^{-1}). 0-24" and 24-48" samples for 2019 are also reported in lbs. ac^{-1}. 2018 samples were only taken from 2 replications while the 2019 sampling was taken from selected plots from a range of 1-3 replications.

Treatment	Rate	1988 0-6"	2018 0-6"	2018 6-18"	2019 0-24"	2019 24-48"
2	0-40-80	6.25	8.5	6	2.0	3.5
3	40-40-80	8.5	6	3.5	6.5	278
4	80-40-80	11.25	5	4.5	2.5	21
5	120-40-80	21.25	7	6	5.2	31.2
6	160-40-80	21	8	6.5	5.5	186
7	200-40-80	26	7.5	4.5	4.5	57

Results and Discussion

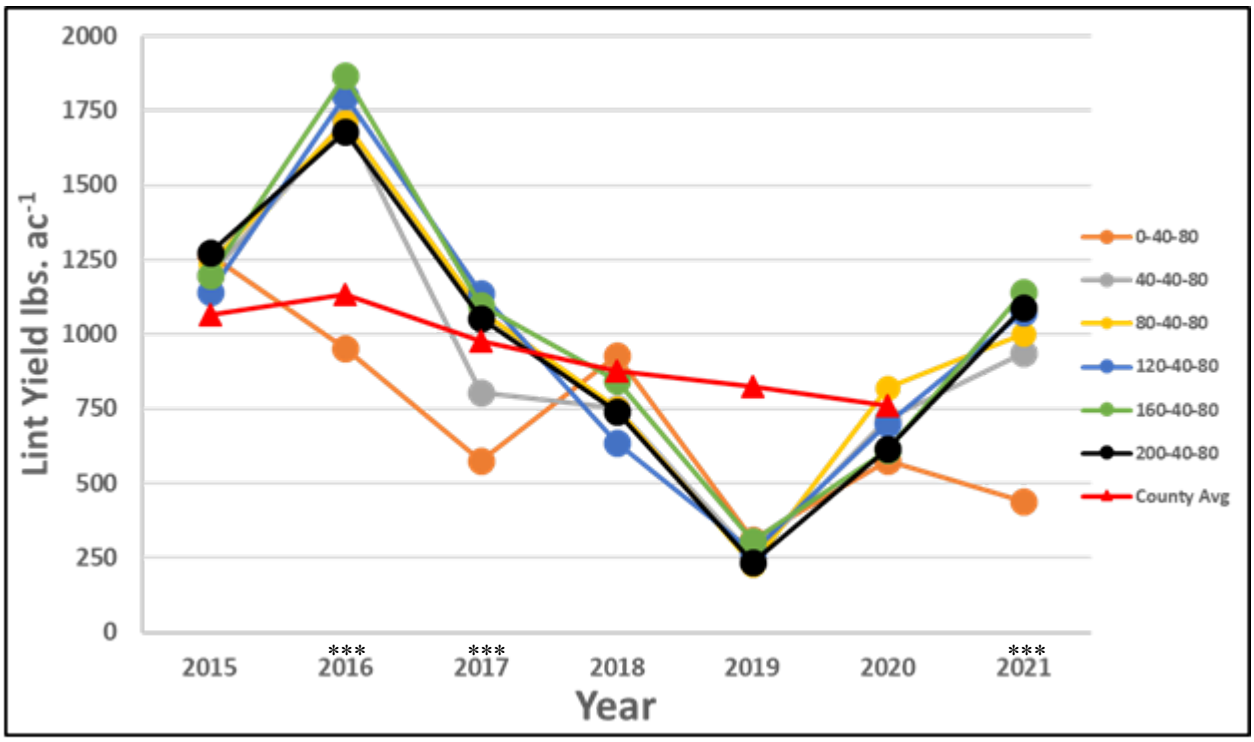

Figure 1. Mean yields from experiment 439 in Altus, OK for treatments 2-7. Years with significant response to N are denoted by ***. (2021 Jackson County average lint yield is unavailable at this time)

Soil sample data provided little in terms of applicable information as soil NO_3- concentrations were believed to fall well below required levels to maximize yield most seasons based on both the 2018 and 2019 samplings. Deep soil sampling data from 2019 taken from selected plots showed considerable accumulation of NO3- in the 24-48" sample depth in some plots. This is believed to be creditable to movement of solutes along a restrictive layer.

In the analysis expressed by figure 1 lint yield response to historical N rate was significant in only 2 of the 6 unfertilized years at an alpha level of 0.05. However, in no year was a significant difference found between N rates greater than 0 lbs. ac^{-1}. The 2021 (fertilized) season continued to show a similar trend in that no significant increase in yield was observed from N applications greater than 0 lbs. N ac^{-1} indicating significant contribution of N from sources other than the applied fertilizer. Girma et al., (2006) previously showed similar results from experiment 439 observing critical N rate to be approximately 60 lbs. of applied N. The relationship between critical N rate and yield

levels indicate that atmospheric deposition, mineralization and residual N makeup almost half of N uptake at an estimated rate of 59 lbs. of N per acre. The lack of significant response to N rates greater than zero comes even after approximately 5-6 thousand lbs. of lint production under unfertilized conditions.

Summary

Substantial drought events can have a significant and long lasting impact on cropping systems that have historically relied on high rates of pre-applied nitrogen such as reservoir fed irrigated continuous cotton in southwest Oklahoma. The observations discussed here provide substantial evidence for further exploration of this experiment to evaluate the impacts of historical fertilizer application in these conditions. Experiment 439 has shown that consideration should be given to alternative N management strategies to optimize nitrogen use efficiency in these systems particularly in response to irregular climatic patterns such as the extended drought in the early 2010's.

References

Girma, K., Teal, R., Freeman, K., Boman, R., and Raun, W. 2006. Cotton lint yield and quality as affected by applications of N, P, and K fertilizers. Journal of Cotton Science. 11.