SCSB Final Report

General Information

Principal Investigator(s) Name(s): C. Nathan Hancock (USCA) and Kendall Kirk (Clemson)
Organization: University of South Carolina Aiken
Date: 6 Jan, 2021
Quarter: 4th (Final)

Proposal Information

Title: Strategies for identification and rescue of poorly nodulated soybeans
Amount Expended to Date: $3,550

Progress Assessment

Report the progress toward the situation described in the proposal summary. Include progress against budget, timeline and scope.

The research plot was planted on Tuesday, 16 June 2020, as described in the proposal. Twelve treatments (10 Nod- mutants and 2 controls, with three levels of nitrogen treatment) were arranged in 6 complete randomized replicates. Germination was pretty consistent, providing better data than last year.

At the R1 stage (20 July 2020) we measured leaf nitrogen, height, and NDVI (handheld Greenseeker). The leaf nitrogen results confirm that we successfully created a gradient of leaf nitrogen levels (Figure 1). Nodulation deficient plants with no additional nitrogen had about 3% leaf nitrogen, while at plant fertilization with 80# or more raised the leaf nitrogen content to the normal range (4-5%) as observed for the Williams 82 control (Figure 1). We also observed that the addition of nitrogen to the nodulation deficient plants resulted in taller and greener plants (Figure 2). The control (Williams 82) plants also were taller and greener from the nitrogen treatment, suggesting that they may not have had good nodulation. However we didn't see a significant change in leaf nitrogen content between Williams 82 with and without supplemental nitrogen.

Aerial images were also captured at the R1 stage, producing a single low resolution image of the field (Figure 3) and a mosaic of images captured from lower altitudes. We calculated Plant Volume Index from these images (Figure 4), which were consistent with higher leaf nitrogen levels corresponding to larger plants. Aerial NDVI showed no significant differences among treatments.

The plants were harvested from the field on 23 Sep 2020 and brought to the lab to dry and hand thresh. Due to the maturity group (III) of the Williams 82 soybeans used, they had a relatively short growing season, producing relatively low yields. However analysis of the data without any rescue nitrogen application shows the effects of insufficient leaf nitrogen (Figure

5). Plants with 3% leaf nitrogen showed approximately a 50% reduction in yield compared to plants with about 4% leaf nitrogen.

At R1 stage, a rescue application of fertilizer was applied to a subset of the plants with low nitrogen content (Nod-). Measurement of NDVI in the following weeks showed that the rescue application of nitrogen greened up the plants (Figure 6), with the lowest application rate (80 lbs/acre) giving the best result. This result together with our data from at planting application suggested that higher nitrogen application rates may be inducing stress or burning.

Yield analysis of the ability of rescue nitrogen application are shown in Figure 7. This analysis shows that application of 80 lbs or more per acre to plants with 3% R1 leaf nitrogen restores the yield back to levels observed for plants with 4% R1 leaf nitrogen levels. This doubling of yield is a significant result, as it indicates that poorly nodulated soybeans can be rescued as long as action is taken by the time the plants flower.

In addition to the plot described in our proposal, we were able to identify three chlorotic patches in SC growers' fields to perform nitrogen rescue tests. The initial leaf nitrogen levels in these chlorotic spots were 2.33% (G. Bates), 3.8% (JCO) and 3.5% (Sharpe), suggesting that nitrogen levels were playing a role in the poor health of these soybeans. In each field, we produced 4 replicates of three treatments (0, 120, and 240 lbs/acre N) applied at the V5-V6 stage. Observations of plant health at two of these plots a few weeks after treatment suggests that there are significant differences in plant health in those treated with nitrogen (Figure 8). The yield data from these test show that significant yield increases were achieved by the recue treatments at two of the sites, while the JCO site showed no improvement (Figure 9). These preliminary results suggest that there is potential for nitrogen rescue of chlorotic areas of the field where leaf nitrogen levels are 3.5% or lower.

Economic analysis of our results suggest that side dressing nitrogen deficient soybeans with moderate levels of nitrogen at R1 stage or earlier can be economically feasible depending on leaf nitrogen levels, nitrogen costs, and price of soybeans. At the Clemson Station with the nodulation deficient beans (~3% leaf nitrogen), we observed significant revenue increases for both 80 and 120 lbs/ac of rescue application. We also observed that nitrogen application increased revenue in two of the three grower plots. For example, the G. Bates nitrogen deficient patch (2.33% leaf nitrogen) produced significantly increased revenue per acre with application of 120 lbs/ac of nitrogen. Together our experiments suggest that when leaf nitrogen levels are below 3% you can increase yield and revenue with 80-120 lbs/acre of nitrogen. Additional experiments in grower's field are needed to needed to increase our confidence in prescribing rescue nitrogen applications.

We have observed that high levels of rescue nitrogen application (240 lbs/ac) has a high risk of burning the plants. This together with nitrogen costs make it inadvisable to apply these high amounts of nitrogen. We advise that growers carefully place any rescue nitrogen applications about 6-8 inches away from the plants so that the nitrogen is accessible but doesn't shock the plants. Smaller nitrogen applications may still have a have a large impact as it allows the plants to get the roots down to more nutrient rich soils. We also suggest that rescue applications only be given to areas that show clear signs of nitrogen deficiency. Our hope is to continue to develop mechanisms for easily identifying these areas and prescribing rescue application.

Key Performance Indicators

What KPI(s) are being used to measure project success? How are KPI(s) being measured? Will KPI(s) not be met? Are KPI(s) on track? Will KPI(s) be exceeded? Explain the key circumstances that are impacting achieving or not achieving KPI(s).

We have completed the aims of the project.

Next Steps

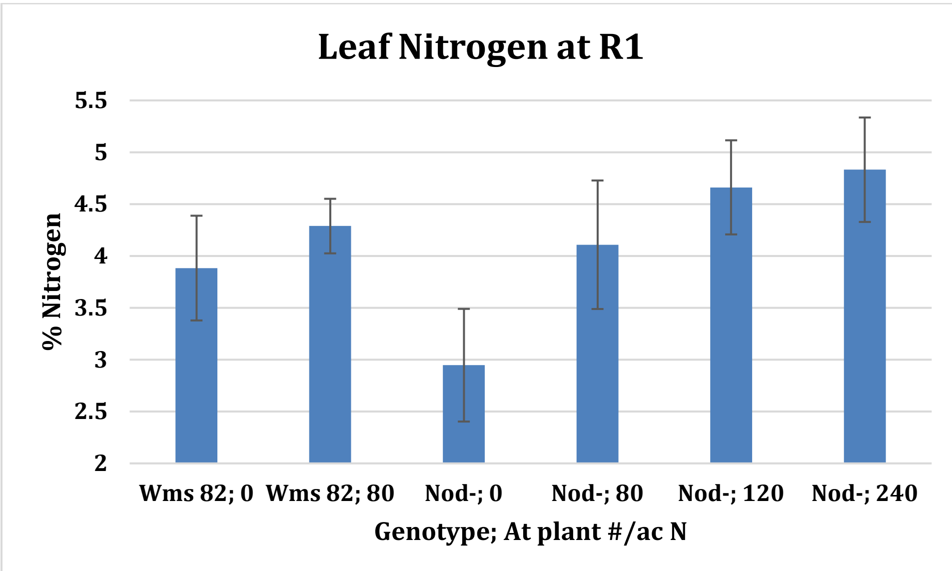
Explain the next steps of the projects and what you hope to achieve during the next quarter.

We plan to apply for 2021 funding to continue our experiments in the SC grower's fields. Our preliminary results were quite promising, thus we will identify additional fields and determine the rescue techniques that will work best for SC growers.

<u>Additional Information</u>

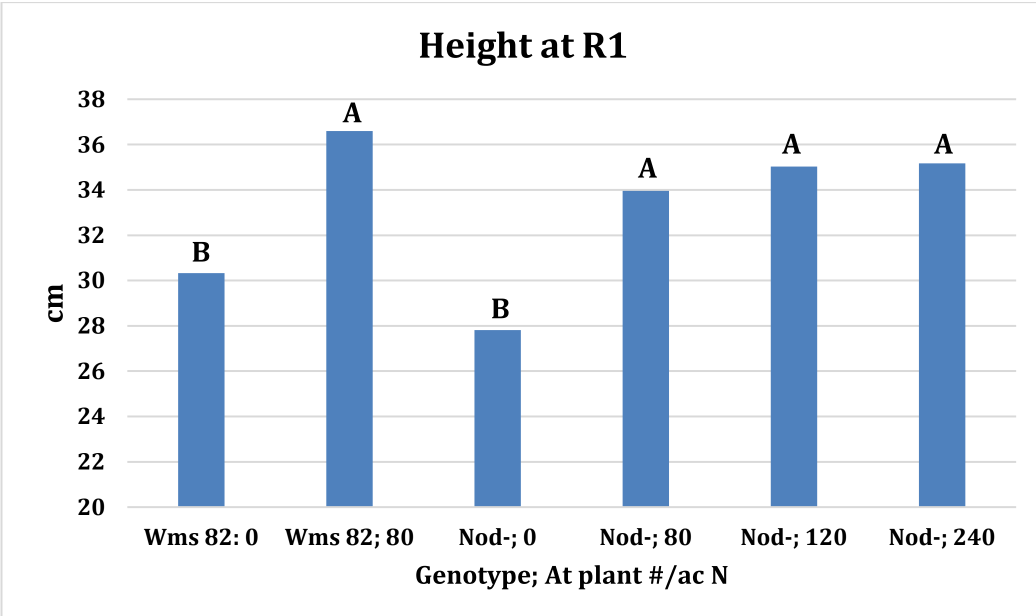
Provide all additional supporting information, facts or figures here.

Figure 1 – Leaf Nitrogen Levels



***** Error bars represent the standard deviation from the mean

Figure 2 – Height and NDVI Results



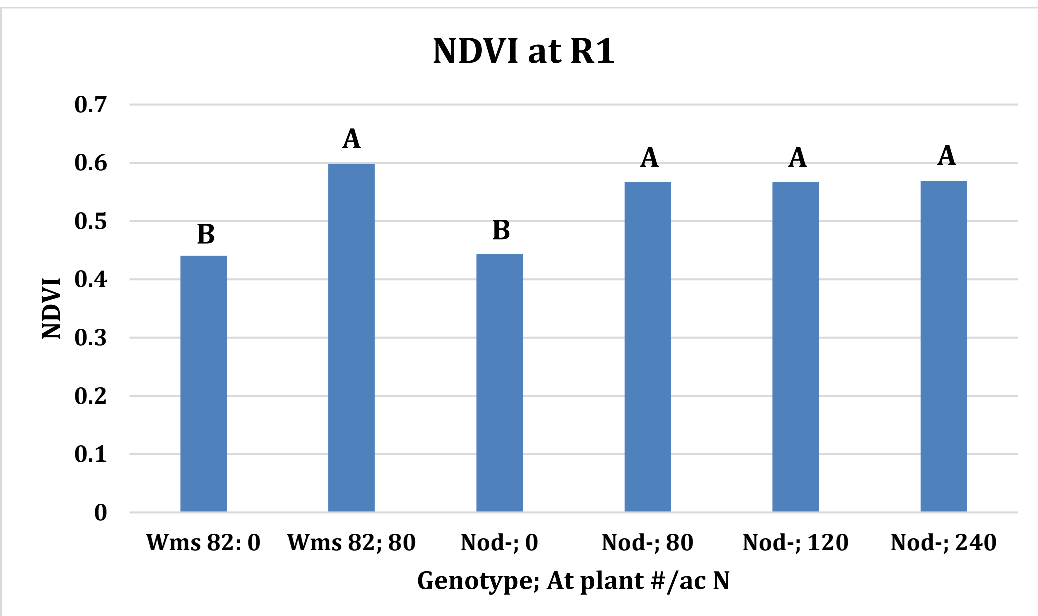


Figure 3 - Aerial Image of the 2020 experimental plot

Figure 4. Plant Volume Index

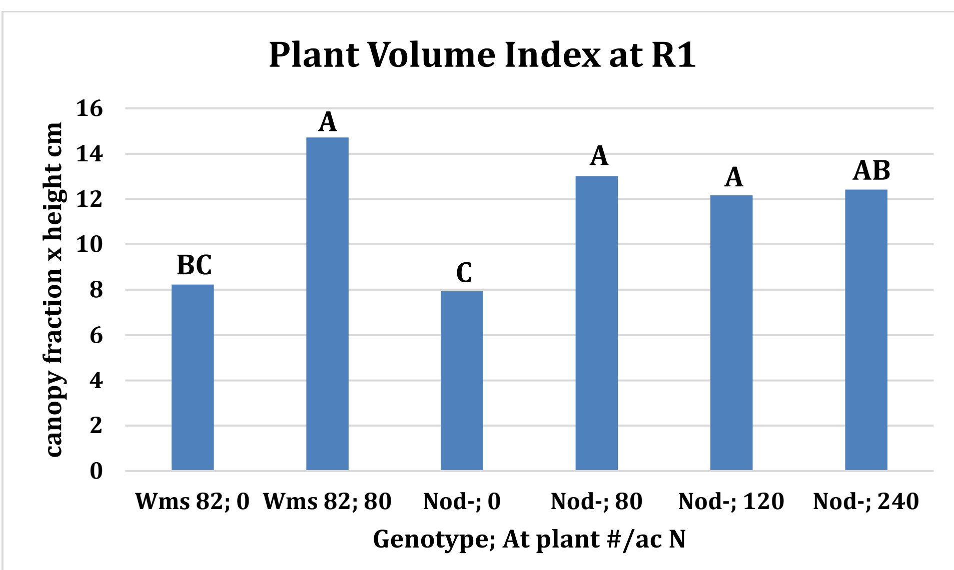


Figure 5. Yield (no rescue N application)

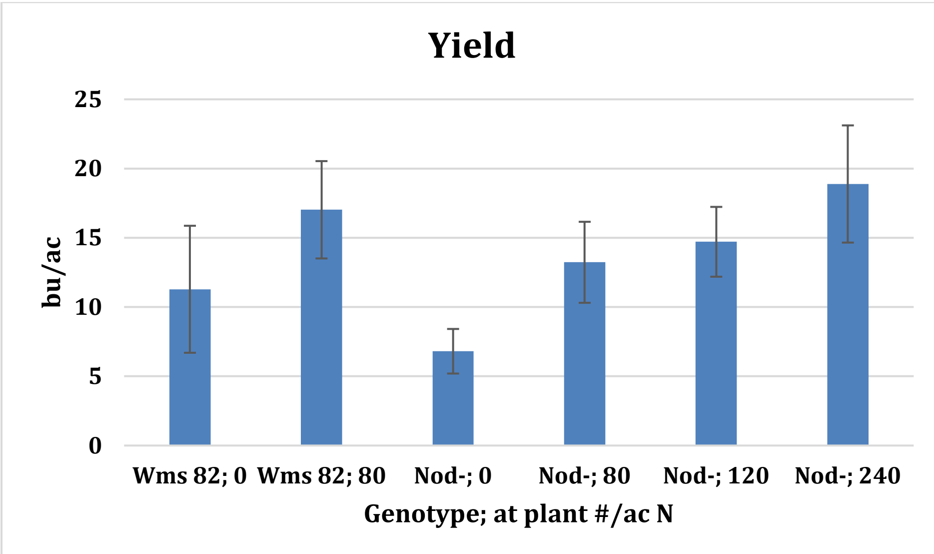


Figure 6. NDVI after Rescue application of Nitrogen

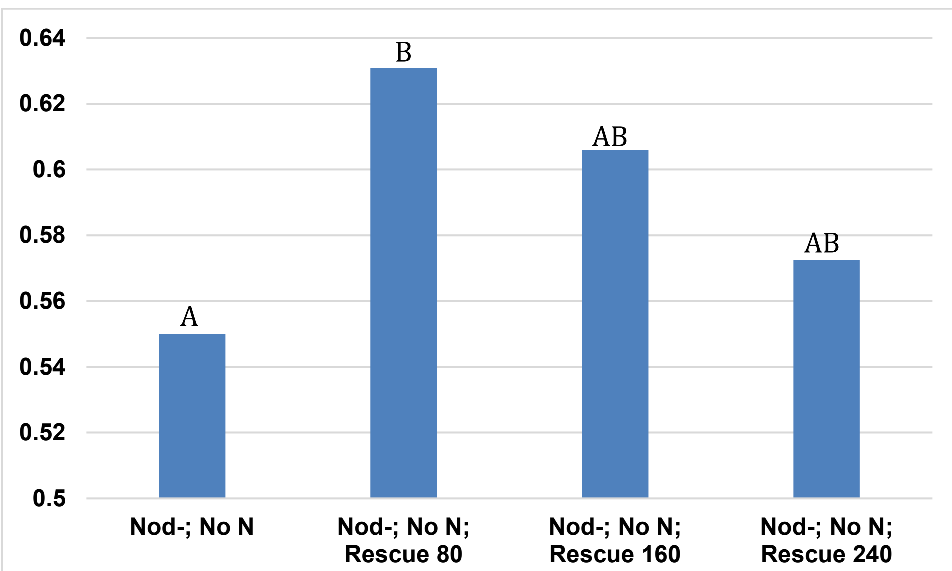


Figure 7. Yield after Rescue application of Nitrogen

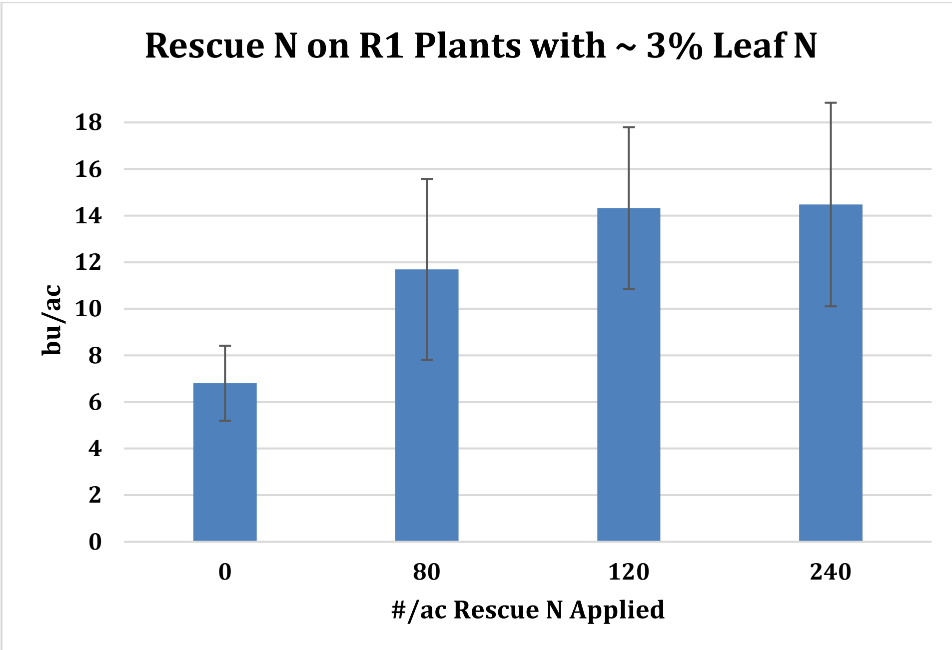
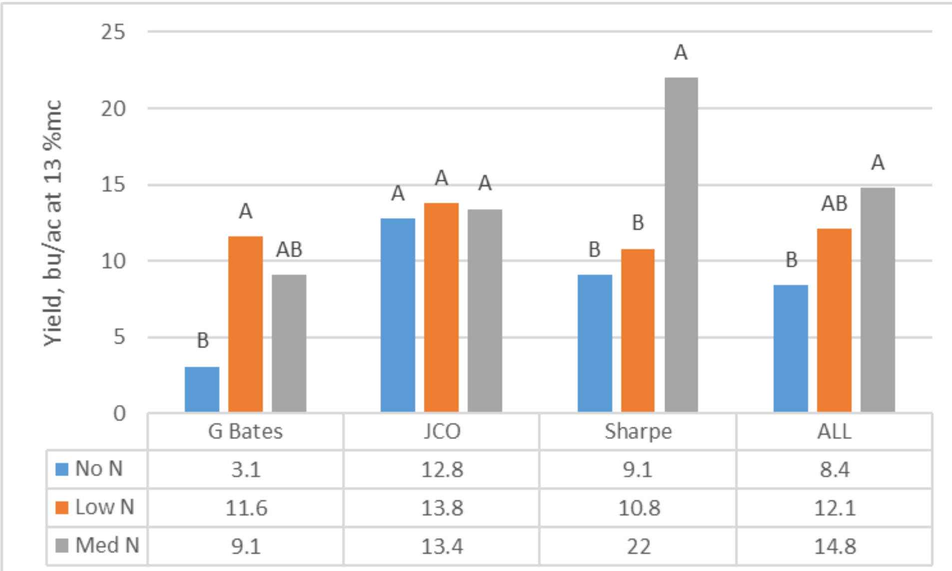


Figure 8. Image showing the effect of nitrogen application (right) to a grower's field

Figure 9. Yield response to rescue nitrogen application in grower's fields



*Low N = 120 #/ac rescue nitrogen
**Med N = 240 #/ac rescue nitrogen

Prior to submission, reports should be saved as a pdf document using the following naming convention; 2018Date(yrmoday)_(PI Last Name)_(Abbreviated Proposal Title)_Qtr1.