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| Project Title: | **Evaluation of a novel drought-tolerant inoculant on soybean yield in the Mid-South (Year 3)** |
| Organization: | **University of Texas at Arlington** |
| Principal Investigator Name: | **Woo-Suk Chang** |
| Collaborators | **James Grichar (TX), Pengyin Chen (MO), Leandro Mozzoni (AR), Trey Price (LA), Avat Shekoofa (TN), Tessie Wilkerson (MS)** |
| Report Period: | **June 16, 2021 – September 15, 2021** |
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| The objective of this project is to evaluate the effects of the TXVA strain (a drought-tolerant inoculant) on soybean nodulation and yield in comparison to the commercial inoculant Cell-Tech™ and a non-inoculated control under non-irrigated conditions. For the 3rd year trial (Year 2021), we has set up the field trials in 6 states including TX, TN, MO, LA, MS, and AR. As of September 15, 2021, we finished planting and mid-sampling for all 6 states. The mid-sampling has been completed and currently we are analyzing plant dry weight and nodule properties (i.e., nodule numbers, location, and size). For the TX site, we harvested soybeans on August 20th, and we have been analyzing yield data. Detailed planting dates, mid-sampling dates, and experimental conditions are described in the Technical Report attached.  It has been well established that the microorganism *Bradyrhizobium japonicum* has a beneficial impact on soybean plants. Previously, we isolated the TXVA strain that showed outstanding performance in nodulation, nitrogen fixation, and enhancing plant growth and production. To improve the inoculants’ performance and optimize the benefits of biological nitrogen fixation in the Mid-South, we set up field trials to evaluate the effects of the drought-tolerant inoculant on soybean yield at drought-prone sites. For the 1st year trial (year 2019), three inoculation treatments (drought-tolerant inoculant TXVA, commercial inoculant Cell-Tech, and no inoculation) were compared under irrigated vs. non-irrigated conditions at drought prone sties in the Mid-South. For the 2nd year trial (year 2020), we tested the same three inoculation treatments, but with more soybean cultivars including a drought-tolerant variety. At the first sampling, the number of nodules per plant were counted and nodule size was measured. A second harvest of plants was performed to evaluate final soybean seed production. The climate and weather factors (e.g., precipitation, temperature, and humidity) for each location were also monitored.  At the completion of the proposed research, we expect to provide positive effects of the drought-tolerant inoculant on soybean profitability and aid Mid-South producers in better understanding of the potential benefits for biological nitrogen fixation. We believe that providing such information will allow soybean producers to advance the management of soybean plants and inoculants for economical and ecological benefits. | |

**Technical Report**

**Texas A&M AgriLife Research Plot – Yoakum, Texas.**

This site is in collaboration with Dr. James Grichar, a senior research scientist at Texas A&M AgriLife research. Planting was done on March 18, the mid-sampling was done on June 23, and harvest was done on August 20. The plot layout that we designed here has 3 treatments, 3 cultivars, and 4 replicates (Fig. 1). The cultivars used here were last year’s variety TN16-520R1, drought-tolerant S11-20242C, and drought-sensitive S14-9017R. Each block contains 2 rows, and each row is 20’ with a 5’ spacer row between blocks and has 38” row spacing. The planter used was set at 10 seed/foot. All varieties are RR, but the S11 variety is conventional, so we lost 1/3rd of our plots here. All 24 remaining plots were sampled by taking 4 plants from each respective treatment for biomass (Fig. 3) and nodule enumeration. Final harvest was performed on August 20th by cutting 7’ of the most continuous row and bagged for threshing by our collaborator.

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**Figure 1.** Plot layout in Yoakum, TX (2021).

**Figure 2.** Yoakum, TX field site at planting, mid-sampling, and harvest (2021).



**Figure 3.** Comparison of plant dry weight at Yoakum, TX (2021).

**Tennessee Agricultural Experiment Station – Jackson, Tennessee.**

This site is in collaboration with Dr. Avat Shekoofa at the University of Tennessee. Planting and mid-sampling were done on May 19 and July 22, respectively. This research station is on Iuka fine loamy sand, which is moderately well drained and permeable. This station is the only in our trials that uses a no-till management system. The plot layout for TN (Fig. 4) contains 2 cultivars, 3 treatments, and 4 replicates. The cultivars used here were TN16-520R1 and the drought-sensitive USG-7496XTS line. Each block contains 4 rows, and each row is 20’ with a 3’ spacer and 30” row spacing. The planter was set at 8 seeds/foot. Sampling occurred 64 days after planting on July 22nd. All 24 plots were sampled by taking 4 plants from the outside rows of each respective treatment for biomass (Fig. 6) and nodule enumeration.

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**Figure 4.** Plot layout in Jackson, TN (2021).

**Figure 5.** Jackson, TN field site at planting (left) and mid-sampling (right) (2021).



**Figure 6.** Comparison of plant dry weight at Jackson, TN (2021).

**T.E. “Jake” Fisher Delta Research Center – Portageville, Missouri.**

This site is in collaboration with Dr. Pengyin Chen at the University of Missouri. Planting and mid-sampling were done on May 20 and July 20, respectively. The plot layout contains 3 inoculant treatments, 3 cultivars, and 6 replicates (Fig. 7). The cultivars used here remained the same as last year’s; TN16-520R1, drought-tolerant S11-20242C, and drought-sensitive S14-9017R. Each block has 4 rows of 12’ with a 4’ spacer row with 30” row width. The planter was set at 10 seeds/foot. Sampling occurred 62 days after planting on July 20th. All 54 plots were sampled by taking 4 plants from each respective treatment for biomass (Fig. 9) and nodule enumeration.

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**Figure 7.** Plot layout in Portageville, MO (2021).

**Figure 8.** Portageville, MO field site at planting (left) and mid-sampling (right) (2021).



**Figure 9.** Comparison of plant dry weight at Portageville, MO (2021).

**Macon Ridge Research Station – Winnsboro, Louisiana.**

This site is in collaboration with Dr. Trey Price at Louisiana State University AgCenter. Planting and mid-sampling were done on May 26 and August 5, respectively. The soil type at the Macon Ridge research station is Jigger-Gilbert silt loam, which is a very deep slowly draining soil with very slow permeability. The plot layout for Winnsboro is shown below (Fig. 10) and has 3 inoculant treatments, 3 cultivars, and 4 replicates. The cultivars used here were TN16-520R1, drought-sensitive S14-9017R, and drought-sensitive USG-7496XTS. Each block has 4 rows of 20’ with a 3.5’ spacer row with 40” row width. The planter was set to 11 seeds/foot. Sampling occurred 72 days after planting on August 5th. All 36 plots were sampled by taking 4 plants from each respective treatment for biomass (Fig. 12) and nodule enumeration.

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**Figure 10.** Plot layout in Winnsboro, LA (2021).

**Figure 11.** Winnsboro, LA field site at planting (left) and mid-sampling (right) (2021).



**Figure 12.** Comparison of plant dry weight at Winnsboro, LA (2021).

**Stoneville USDA-ARS – Leland, Mississippi.**

This site is in collaboration with Dr. Tessie Wilkerson at Mississippi State University. Planting was done on June 3, and the mid-sampling was performed on August 4. The soil type at the Stoneville research station is Commerce silty clay loam, which are somewhat poorly drained soils with moderately slow permeability but a constant soil saturation in lower layers. The plot layout for our MS plot is shown below (Fig. 13) and reflects 3 cultivars, 3 treatments, and 6 replicates. The cultivars used here were TN16-520R1, a drought-sensitive S14-9017R, and a drought-tolerant S11-20242C. Each block contains 4 rows of 12’ with a 5’ spacer row between blocks and a 38” row width. The planter was set at 11 seeds/foot. Sampling occurred 62 days after planting on August 4th. All 36 plots were sampled by taking 4 plants from each respective treatment for biomass (Fig. 15) and nodule enumeration.

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**Figure 13.** Plot layout in Leland, MS (2021).

**Figure 14.** Leland, MS field site at planting (left) and mid-sampling (right) (2021).



**Figure 15.** Comparison of plant dry weight at Leland, MS (2021).

**Stuttgart Research Station – Stuttgart, Arkansas.**

Our Arkansas site is in collaboration with Dr. Leandro Mozzoni from the University of Arkansas. Planting was done on June 24, and the mid-sampling was performed on August 25. The plot layout contains 3 cultivars, 3 treatments, and 5 replicates (Fig. 16). The cultivars planned are TN16-520R1, drought-sensitive S14-9017R, and drought-tolerant S11-20242C. Each block contains 4 rows of 20’ with a 5’ spacer row between blocks and a 30” row width. The planter was set at 11 seeds/foot. Sampling occurred 62 days after planting on August 25th. All 56 plots were sampled by taking 4 plants from each respective treatment for biomass and nodule enumeration.

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**Figure 16.** Plot layout in Stuttgart, AR (2021).

**Figure 17.** Stuttgart, AR field site at planting (left) and mid-sampling (right) (2021).

In summary, we have planted soybean research plots and collected mid-samples in all six states (TX, TN, MO, LA, MS, and AR) for testing the novel Texas-native drought-tolerant *Bradyrhizobium* inoculant with drought-tolerant and sensitive cultivars under the non-irrigated condition across drought prone regions. We also completed harvesting soybeans for the TX plot on August 20th. For the other states, we are completed plant dry weight measurement except for AR. Currently, nodule property data are being processed. Below is a summary of planting dates, mid-sampling dates, and harvesting dates (Table 1).

**Table 1.** Summary of each field site and soybean cultivars planted and sampled in 2021.

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| **Location** | **Planting date** | **Sampling date** | **Harvest date** | **Field** | **Cultivars used** |
| **Yoakum, TX** | **3/18/21** | **6/23/21** | **8/20/21** | Grichar Farm | TN16-520R1, S14-9017R\*, S11-20242C\*\* |
| **Jackson, TN** | **5/19/21** | **7/22/21** | **TBD#** | West TN AgResearch | TN16-520R1, USG-7496XTS\* |
| **Portageville, MO** | **5/20/21** | **7/20/21** | **TBD** | Lee Farm | TN16-520R1, S14-9017R\*, S11-20242C\*\* |
| **Winnsboro, LA** | **5/26/21** | **8/5/21** | **TBD** | Macon Ridge | TN16-520R1, S14-9017R\*, USG-7496XTS\* |
| **Leland, MS** | **6/3/21** | **8/4/21** | **TBD** | Stoneville USDA | TN16-520R1, S14-9017R\*, S11-20242C\*\* |
| **Stuttgart, AR** | **6/24/21** | **8/25/21** | **TBD** | Stuttgart | TN16-520R1, S14-9017R\*, S11-20242C\*\* |

\* Drought-sensitive cultivar

\*\* Drought-tolerant cultivar

# To be determined