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| Project Title: | **Evaluation of a novel drought-tolerant inoculant on soybean yield in the Mid-South (Year 2)** |
| 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: | **September 16, 2020 – December 15, 2020** |
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| The objective of our field work this year is to evaluate the cross-inoculation effects of our Texas-native TX-VA inoculant on the yield of different soybean varieties including drought-sensitive and drought-tolerant cultivars in TX, TN, MO, LA, MS, and AR. Thus, we determine its nodulation efficiency, plant growth, and the final yield. This is accomplished by comparing the growth and yield of our inoculant to the commercial bio-fertilizer Cell-Tech™ as well as a non-inoculated control under non-irrigated conditions. For the 2nd year trial (Year 2020), we set up the field trials in the 6 states. We have finished mid-sampling and harvesting, although data analysis are still underway. Detailed planting dates, mid-sampling dates, harvesting date, 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 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 first year trial (year 2019), three inoculation treatments (drought-tolerant inoculant TXVA, commercial inoculant Cell-Tech, and no inoculation) will be compared under irrigated vs. non-irrigated conditions at drought prone sties in the Mid-South. At the first sampling, the number of nodules per plant will be counted and nodule size will be measured. A second harvest of plants will be performed to evaluate final soybean seed production. The climate and weather factors (e.g., precipitation, temperature, and humidity) for each location will also be 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 James Grichar, a senior research scientist at Texas A&M AgriLife research. Planting was done on April 1st, the mid-sampling was done on June 8th, and harvest was done on September 2nd. The plot layout that we designed here has 3 treatments, 3 cultivars, and 4 replicates. The cultivars used here were last year’s variety TN-16, commercial seed CZ5515, and a Texas-specific variety Otoño. Plant dry weight and nodule enumeration are shown in Figs. 1 and 2, respectively.



**Figure 1.** Plant dry weight in Yoakum, TX. The mid-samples were taken 9 weeks after planting.

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**Figure 2.** Taproot and total nodule counts in TN-16, CZ5515, and Otoño. TX, CT, and NT indicate TX-VA strain inoculation, Cell-Tech inoculation, and no inoculation, respectively.

Table 1 shows the final yield in Yoakum, TX. Overall, TX-VA performed better than Cell-Tech, although no treatment appeared to be as much effective as TX-VA in both TN-16 and CZ5515 cultivars. Interestingly, in the case of the Texas-specific variety Otoño, TX-VA induces soybean yield more than 2 times compared to both Cell-Tech and no treatment under the non-irrigated condition.

**Table 1.** Soybean yield (Bu/A) in Yoakum, TX.

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| **Inoculants** | **Yield (Bu/A)** | | |
| **TN-16** | **CZ5515** | **OTONO** |
| **TX-VA** | 19.4 | 12.4 | **10.7** |
| **Cell-Tech** | 14.0 | 7.60 | 5.9 |
| **No Treatment** | 20.0 | 12.4 | 3.1 |

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

This site is in collaboration with Dr. Trey Price at Louisiana State University AgCenter. Planting was done on May 11th and the mid-sampling was done on July 14th. This is a non-irrigated site with 3 cultivars, 3 treatments, and 5 replicates. The cultivars used were TN-16, drought-sensitive USG-7496XTS, and commercial line CZ5515. At this site, all of the seeds were treated at once and packed so that there was 9 seeds/foot. On July 14th, a total of 6 plants per block were sampled, giving a total sample size of n=216. Plant dry weight and nodule enumeration are shown in Figs. 3 and 4, respectively. For Winnsboro, LA, the data analysis of the final yield is in progress.



**Figure 3.** Plant dry weight in Winnsboro, LA. The mid-samples were taken 9 weeks after planting.

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**Figure 4.** Taproot and total nodule counts in TN-16, CZ5515 (CZ), and USG-7496XTS (USG). TX, CT, and NT indicate TX-VA strain inoculation, Cell-Tech inoculation, and no inoculation, respectively.

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

This site is in collaboration with Dr. Avat Shekoofa at the University of Tennessee. Planting was done on May 15th and the mid-sampling was done on July 27th. The plot layout for TN is non-irrigated with 3 treatments and 2 cultivars with 4 replicates. The cultivars used were TN-16 and drought-sensitive line USG-7496XTS. On July 27th, a total of 4 plants per block were sampled, giving a total sample size of n=96. Plant dry weight and nodule enumeration are shown in Figs. 5 and 6, respectively.

**Figure 5.** Plant dry weight in Jackson, TN. The mid-samples were taken 10 weeks after planting.

Table 2 shows the final yield in Jackson, TN. In TN-16, somehow no treatment showed the highest yield, even though TX-VA performed better than the commercial inoculant Cell-Tech. More interestingly, for the drought-sensitive line USG-7496XTS, TX-VA strain enhanced soybean yield compared to both Cell-Tech and no treatment under the non-irrigated condition.

**Figure 6.** Taproot and total nodule counts in TN-16 and USG-7496XTS (USG). TX, CT, and NT indicate TX-VA strain inoculation, Cell-Tech inoculation, and no inoculation, respectively.

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| **Inoculants** | **Yield (Bu/A)** | |
| **TN16** | **USG** |
| **TX-VA** | 53.3 | **51.9** |
| **Cell-Tech** | 51.7 | 43.4 |
| **No Treatment** | 56.3 | 46.4 |

**Table 2.** Soybean yield (Bu/A) in Jackson, TN.

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

This site is in collaboration with Dr. Pengyin Chen at the University of Missouri. This site was planted on June 2nd and sampled on July 28th. The plot contains 3 cultivars, 3 treatments, and 6 replicates. The cultivars used were TN-16, S11-20242C drought-tolerant line, and S14-9017R drought-sensitive line. Mid-harvest sampling was performed, giving a total sample size of n=324. Plant dry weight and nodule enumeration are shown in Figs. 7 and 8, respectively. The final soybean yield results are in process.

**Figure 8.** Taproot and total nodule counts in TN-16, S11-20242C (S11), and S14-9017R (S14). TX, CT, and NT indicate TX-VA strain inoculation, Cell-Tech inoculation, and no inoculation, respectively.

**Figure 7.** Plant dry weight in Portageville, MO. The mid-samples were taken 8 weeks after planting.

**Stoneville USDA Agricultural Research Site – Leland, Mississippi.**

This site is in collaboration with Dr. Tessie Wilkerson with Mississippi State. This site was planted on June 29th and sampled on September 9th. The plot layout reflects the same RCB design with 2 cultivars, 3 treatments, and 6 replicates. The cultivars used were TN-16 and drought-sensitive S14-9017R. Each block contains 4 rows of 15’ with a 5’ spacer row between blocks and a 38” row width. Mid-harvest sampling was performed so that 4 plants from each outside row were taken, giving a total sample size of n=144. Plant dry weight is shown in Fig. 9. Nodule enumeration and the final yield data are in process.

**Figure 9.** Plant dry weight in Stoneville, MS. The mid-samples were taken 9 weeks after planting.

**Rice Research and Extension Center- Stuttgart Arkansas.**

Our Arkansas site is in collaboration with Dr. Leandro Mozzoni from the University of Arkansas. Planting was done on July 1st and sampling was done on September 10th. The plot layout reflects the same RCB design with 2 cultivars, 3 treatments, and 5 replicates. The cultivars used were TN-16 and drought-sensitive S14-9017R. Each block contains 4 rows of 15’ and 30” row width. Mid-harvest sampling was performed such that 4 plants from the outside rows of each plot were taken. Plant dry weight is shown in Fig. 10. Nodule enumeration and plant yield data are in process.

**Figure 10.** Plant dry weight in Stuttgart, AR. The mid-samples were taken 10 weeks after planting.

In summary, we have completed planting, mid-sampling, and harvesting in all six states (TX, LA, TN, MO, MS, and AR) for testing our novel Texas-native drought-tolerant *Bradyrhizobium* inoculant with numerous soybean cultivars under the non-irrigated condition across drought prone regions. We have also finished yield calculation for TX and TN, showing that the TX-VA inoculant improved soybean production in the cultivars Otono and USG-7496XTS. More interestingly, TX-VA strain performed better than Cell-Tech for all cultivars used in this trial. For the other states, we are in progress to analyze yield data. Below is a summary of planting dates, mid-sampling dates, and harvesting dates (Table 3).

**Table 3.** Summary of each filed site in 2020.

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| **Location** | **Planting date** | **Nodule Sampling** | **Harvest** | **Cultivar used** | **Maturity Group** |
| Yoakum, TX | 4/1 | 6/6 | 9/2 | TN16, CZ5515, Otoño | 4L, 5, N/A |
| Winnsboro, LA | 5/11 | 7/14 | 9/16 | TN16, USG-7496\*, CZ5515 | 4L, 4L, 5 |
| Jackson, TN | 5/15 | 7/27 | 10/21 | TN16, USG-7496\* | 4L, 4L |
| Portageville, MO | 6/2 | 7/28 | 11/4 | TN16, S1120242C\*\*,  S14-9017R\* | 4L, 5, 5 |
| Stoneville, MS | 6/29 | 9/9 | 10/29 | TN16, S14-9017R\* | 4L, 5 |
| Stuttgart, AR | 7/1 | 9/10 | 11/7 | TN16, S14-9017R\* | 4L, 5 |
|  |  |  |  | \* = drought-sensitive |  |
|  |  |  |  | \*\* = drought-tolerant |  |