

SC Soybean Board Final Report

General Information

Principal Investigator(s) Name(s): Zenglu Li

Organization: University of Georgia

Date: 2022 January 14

Quarter: Final Report

Proposal Information

Title: Accelerating development of soybean varieties with advanced herbicide-tolerant trait technologies and pest resistance using state-of-art genomic technology for Southeastern soybean growers.

Amount Expended to Date: Nothing to report on budget spending at this time.

Project Summary

Briefly summarize this project and your final results. Summaries should be brief (limit to one page) and should be written in a way that is easy for our farmer audience to interpret and apply.

With the support from SC Soybean Board, we have achieved a great progress in 2021. This year we completed backcrossing for two of four RR2 Xtend lines, with the other two finishing next year. Seventy seven RR2 Xtend plant rows derived from two backcrossing pedigrees were planted in 2021. Four lines were selected for seed increase in Puerto Rico during the winter of 2021-2022.

We encountered a major setback with the Enlist lines when we discovered the genetic material that were provided has a wrong maturity group that is tightly linked to the Enlist gene. We identified one line from 66 lines planted in 2021 that had broken the maturity linkage. This one row also was used for other crosses. We also requested and received new Enlist germplasm with a different maturity group for aggressive crossing efforts. The seed of selected one line was sent to Puerto Rico winter nursery for seed increase during the winter of 2021-2022.

These four RR2X lines and one Enlist line will be yield tested in the southeast and evaluated for nematode and disease resistance in 2022 for possible release. The breeders seed of these four lines will be increased during the summer of 2022 as well.

Key Performance Indicators

What KPI(s) were used to measure project success? How were KPI(s) measured? Were KPI(s) not met? Were KPI(s) exceeded? Explain the key circumstances that impacted achieving or not achieving KPI(s).

1) Complete backcrossing for 4 RR2 Xtend lines

This KPI focuses on breeding the RR2 Xtend trait into four high-yielding Georgia lines: G12-2062R2, G13-2114R2, G10PR-56444R2, and G13-2842R2. This project started in 2020, and in

2021 we were able to reach our goal of planting BC₃F₃ seed in the Summer 2021 field as plant rows for G12-2062R2 (4) x Dicamba RR2X and G13-2114R2 (4) x Dicamba RR2X. The other two lines are currently at BC₃F₂ and are being advanced over the winter of 2021-2022 in order to reach the goal of growing in the field as plant rows Summer 2022.

The year started with a cycle in the high-CO₂ growth chamber, when we genotyped RR2 Xtend seeds to make planting decisions and later genotyped leaf tissue to confirm the trait. We made additional BC₃F₁ G10PR-56444R2 (4) x Dicamba RR2X due to poor germination. New crosses and advanced seed were harvested RR2 Xtend seed from the Griffin Growth Chamber and planted accordingly for the summer.

Over the summer, BC₃F₃ seed from individual plants from G12-2062R2 (4) x Dicamba RR2X and G13-2114R2 (4) x Dicamba RR2X went into individual rows for field evaluation. Again, BC₃F₁ seed from G10PR-56444R2 (4) x Dicamba RR2X struggled to germinate in the greenhouse, but we managed to genotype and advance one true cross in the 2021 Summer greenhouse, and also made additional attempts at BC₃F₁ as backup. From the G13-2842R2 (3) x Dicamba RR2X cross, we genotyped and advanced 4 were confirmed true crosses.

During Fall, plants were harvested from the greenhouse and fields. We harvested BC₃F₃ which had been grown in individual rows for field evaluation, as well as five new BC₃F₁ seeds from G10PR-56444R2 (3) x Dicamba RR2X in our summer greenhouse. We also harvested our BC₃F₂ seed from G13-2842R2 (3) x Dicamba RR2X advancements. The end of the year saw the next generation planted in the first round of 2021-2022 winter growth chamber as appropriate.

2) Complete backcrossing for 3 Enlist E3 lines

This KPI focuses on breeding the Enlist E3 trait into three high-yielding Georgia lines: Woodruff, G17-11319, and G14-6063. This project started in 2020, and in 2021 we were able to reach our goal of planting BC₃F_{2:3} seed in the Summer 2021 field for Woodruff (4) x Enlist CTV-DVR-1001 and G17-11319 (4) x Enlist CTV-DVR 1002. The G14-6063 (4) x Enlist CTV-DVR-1001 is at BC₃F_{2:3} seed and will be ready to evaluate in the field Summer 2022. Unfortunately it was discovered Summer 2021 that the Enlist E3 gene is tightly linked to maturity from Enlist CTV-DVR-1001 and CTV-DVR 1002, meaning that the materials we were growing were not well suited. Fortunately through quick marker development and comprehensive genetic testing we identified several plants that had broken the maturity linkage and could be advanced in our area. We requested and received new Enlist germplasm with a different maturity group for aggressive crossing efforts which began in Puerto Rico Winter Nursery 2021-2022.

The year started with a cycle in the high-CO₂ growth chamber, when we genotyped Enlist seeds to make planting decisions and later genotyped leaf tissue to confirm the trait. We then harvested Enlist E3 seed from the Griffin Growth Chamber and planted accordingly.

Over the summer, BC₃F₃ seed from individual plants from Woodruff (4) x Enlist CTV-DVR-1001 and G17-11319 (4) x Enlist CTV-DVR 1002 went into individual rows for field evaluation. As

mentioned with the tight linkage between Enlist and early maturity, we quickly developed a genetic marker for maturity and screened for recombinant plants. Twenty-eight individuals from one field plot of G17-11319 (4) x Enlist CTV-DVR 1002 were found to be segregating for the maturity gene and so harvested seed was sent to PR for increase over the 2021-2022 Winter. Five individuals from one field plot of Woodruff (4) X Enlist CTV-DVR-1001 were found to be segregating for the maturity gene and harvested seed was seed chipped and selections planted in the Athens 2021-2022 Winter Greenhouse. From BC₃F₂ plants of G14-6063 (4) x Enlist CTV-DVR-1001 in Summer greenhouse, two plants were found to be segregating for the maturity gene and after harvest we seed chipped and planted selections in the Athens Winter Greenhouse.

3) Form additional crosses with best UGA germplasm

There is limited space in the accelerated Griffin Growth Chamber, therefore additional backcrossing advancement was limited to Athens Summer crossing block and greenhouses.

Additional RR₂ Xtend: The year began with BC₂F₁ seed harvested from the Athens Winter Greenhouse from G14-4364R₂ (3) x Dicamba RR₂X, G14-4396R₂ (3) x Dicamba RR₂X, and G15-1811R₂ (3) x Dicamba RR₂X, however, due to poor winter crossing conditions and limited crossing, very few seed were obtained from early generations. Seed was planted in the Athens summer greenhouse and genotyped, of which none were true crosses. We remade these crosses using trait-confirmed BC₁F₂ plants and harvested 47, 40, and 50 BC₂F₁ seed, respectively. We also had success crossing XtendFlex lines into [G12-2062R₂ (4) x Dicamba RR₂X] and [G13-2114R₂ (4) x Dicamba RR₂X] to generate 31 and 41 F₁ seeds, respectively. We also grew 39 trait confirmed BC₃F₂ plants from the G13-3461R₂ (4) x Dicamba RR₂X cross in the Summer Greenhouse. Harvested seeds were planted in the Griffin Growth Chamber round 1 and space allowed and also Athens Winter greenhouse, and tissue sampled to identify true crosses.

Additional Enlist E3: The year began with BC₂F₁ and BC₁F₁ seed harvested from the Athens Winter Greenhouse from G15PR-340 (3) x Enlist CTV-DVR-1001 and G17-11315 (2) x [Woodruff (3) x Enlist CTV-DVR-1001] respectively, however, due to poor crossing conditions and limited crossing, very few seed were obtained from early generations. Seed was planted in the Athens summer greenhouse and genotyped, of which none were true crosses. New Enlist germplasm with appropriate maturity group was sent to Puerto Rico winter nursery and crossed with our lines G18-11901, G19-12361, and G16-8779 starting at the end of 2021.

4) Advance 3 high yielding LibertyLink lines into USDA Uniform Tests

In 2021 we had four LibertyLink lines in USDA preliminary tests and eight LibertyLink lines in USDA uniform tests. We had one line, G18-8480LL, in USDA Preliminary Test MG7; three lines G18-8335LL, G18-8097LL, and G18-8508LL, in USDA Preliminary Test MG8; three lines, G17-8322LL, G17-8706LL, and G16LL-10015, in USDA Uniform Test MG6; two lines, G17-8737LL and G16LL-10193, in USDA Uniform Test MG7; and three lines, G17-8932LL, G15LL-9205, and G16LL-10180, in USDA Uniform Test MG8. Data summarized in Table 1. Two LibertyLink lines,

G15PRL-953 and G15PRL-989, were yield tested in GA SVT, with average yields of 69.3 and 69.1 bu/ac, respectively, across six locations in GA.

Next Steps

Explain the next steps of this project (if any) and the implementation of the findings from the project.

In 2022, with successful completion of backcrossing process for some of lines, we are increasing seed of four RR2X lines and one Enlist line in our Puerto Rico winter nursery during the winter of 2021-2022. These four RR2X lines and one Enlist line will be yield tested in the southeastern area. The agronomic notes including plant height, lodge, maturity and seed composition will be collected. These lines will be evaluated for nematode and disease resistance in 2022. The breeders seed of these four lines will be increased during the summer of 2022 as well. Application for three lines will be submitted for approval of release by the end of 2022

We will continue to cross with and advance other lines with RR2Xtend or Enlist traits in growth chambers, greenhouse, and field as per KPI 3. We expect to continue entering LibertyLink lines to USDA uniform yield trials as per KPI 4.

Additional Information

Provide any additional supporting information, facts or figures here.

Table 1. Summary of UGA LibertyLink 2021 USDA yield trials

| Line | Test | Reps | Average Bu/acre |
|-------------|-------------|-------------|------------------------|
| G18-8480LL | P7 | 6 | 94.7 |
| G18-8335LL | P8 | 6 | 102.9 |
| G18-8097LL | P8 | 6 | 98.2 |
| G18-8508LL | P8 | 6 | 92.9 |
| G17-8322LL | U6 | 3 | 96.7 |
| G17-8706LL | U6 | 3 | 111.0 |
| G16LL-10015 | U6 | 3 | 111.0 |
| G17-8737LL | U7 | 9 | 102.0 |
| G16LL-10193 | U7 | 9 | 102.1 |
| G17-8932LL | U8 | 9 | 82.4 |
| G15LL-9205 | U8 | 9 | 88.1 |
| G16LL-10180 | U8 | 9 | 95.1 |

Prior to submission, reports should be saved as a pdf document using the following naming convention; 2022Date(MMDD)_(PI Last Name)_(Abbreviated Proposal Title)_Final.