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| Please use this form to clearly and concisely report on project progress. The information included should reflect quantifiable results that can be used to evaluate and measure project success. Comments should be limited to the designated boxes. Technical reports, no longer than 4 pages, may be attached to this summary report. |
| Project Number: |  |
| Project Title:  | Screening soybean germplasm and breeding soybeans for flood tolerance |
| Organization:  | University of Missouri-Fisher Delta Research Center |
| Principal Investigator Name: | Dr. Feng Lin |
| Other investigators: | Drs. Caio Vieira, Tessie Wilkerson, David Moseley, Chengjun Wu, Francia Ravelombola |
| Report Period: | March 15, 2023 to June 15, 2024 |
| Project Status: On-going(What key activities were undertaken and what were the key accomplishments during this quarter? Please use this field to clearly and concisely report on project progress).  |
| **Research plan for 2024:** 1. Releasing conventional flood tolerant germplasm line
2. Converting high yield and flood tolerant lines into XtendFlex (XF) in Winter Nursery
3. Testing for flood tolerance at early vegetative and reproductive stages for advanced breeding lines from MO and AR and promising lines in the USDA Preliminary and Uniform Trials across 4 different states including AR, MO, LA, MS
4. Screening for flood tolerance at reproductive stage of different lines from different companies in MO, AR, LA, MS entered in the Variety Test
5. Developing new flood tolerant population to feed the flood breeding pipeline

**University of Missouri (Lin):** The 2024 Flood breeding pipeline at the University is summarized in Table 1.**Table 1**. 2024 Flood breeding summary in Missouri

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| Test/Line | Description | Entry |
| S12-1362 | Germplasm | 1 |
| S17-1146 | Germplasm | 1 |
| UT | USDA Regional Uniform trials | 1 |
| AYT-FLD | Flood advanced yield trials | 10 |
| PYT-FLD | Flood preliminary yield trails | 17 |
| MSSB\_FLD | Advanced breeding lines and promising lines | 108 |
| Progeny | Visual Selection | 480 |
| Population | F1 to F4 generation | 5 |
| New Crosses | Population development | 6-7 |

**1. 2024 Conversion flood tolerant line into herbicide trait:** S20-1492, identified as a potential flood-tolerant soybean line (FDS<2 at V2 and R1) was entered in the 2024 UT, and has been sent to the winter nursery for conversion to XF. It will undergo three backcrosses to incorporate the herbicide trait.**2. 2024 Flood-tolerant germplasm potential release:** The high-yielding and flood-tolerant line S12-1362 (MG5) will soon be available as conventional germplasm. Its registration manuscript is currently undergoing processing and will be published in the Journal of Plant Registrations. This line has been shared with various soybean programs via a Material Transfer Agreement (MTA). Similarly, the line S17-1146 (MG4L), high yields and flood tolerance, will also be released as conventional germplasm. Its registration manuscript is also in progress and scheduled for publication in the Journal of Plant Registrations. Like S12-1362, this line has been exchanged with different soybean programs under an MTA.**3. 2024 Regional trials**: We entered S20-1492, a potentially flood tolerant line in the USDA Southern Uniform Trials. S20-1492 exhibit a flood damage score FDS<2 at V2 and R1, with yield under flooded >20 bu/ac both at V2 and R1, and high yielding (70.1 bu/ac) that not significantly different from the commercial checks under non-flooded conditions.**4. 2024 Flood advanced yield trials**: A total of 9 MG4L, and 10 MG5E were planted in 4-row plots in a heavy clay, zero grade field with 3 replications for exposure to flooding stress beginning at both the V2 (early) and R1 (reproductive) growth stages. These lines will be evaluated under non-stress conditions in the same field at both the V2 (early) and R2 (reproductive) growth stages to determine lines with least yield reduction under flooding compared to popular commercial varieties of similar maturity. Those lines with least yield reduction from flooding will be classified as flood tolerant. One tolerant check (S17-1146) and sensitive commercial varieties (AG 43XF2, P45A81E, AG 48XF0) along with conventional check (S16-7922) have also been included. **5. 2024 Flood preliminary yield trials:** A total 17 MG4 breeding lines along with one flood tolerant check (S17-1146) and commercial checks (AG 40XF1, P42A84E, AG 43XF2, AG 48XF0) were planted for flooding tolerance and yield in 4-row plots in 2 replications in flooded (V2 and R1) and non-flooded fields. Among those 17 lines, four lines showed high protein concentration ranging from 32.5% to 37.7% (% 13 moisture). **6. 2024 Flood Tolerant Progeny rows:** Approximately 480 F4 plant rows from 4 crosses will be planted at Portageville, MO as a single row at the Lee Farm, Portageville, MO. Seeds have been processed and will be planted in the following week.**7. 2024 Breeding population advancement:** Five flood tolerant breeding populations were developed in 2023. The F1 seeds of these crosses were sent to the winter nurseries where the populations will be advanced to F4 for progeny row testing in 2025.**8. 2023 crosses for Flood tolerance:** We will attempt 6 to 7 new crosses for the season of 2024. **9. 2024 Missouri commercial variety testing for flood tolerance:** We planted 72 commercial varieties developed by different seed companies with 3 replications under flooding stress for at R1/R2 stages the at the Lee Farm Portageville, MO (heavy clay soil). These lines will be evaluated for flood tolerant at reproductive stages and yield loss due to flooding stress. **10. 2024 MSSB Flood screening for flood tolerance**: This test includes 245 entries including advanced breeding lines and promising lines in the regional tests from the University of Missouri and from the University of Arkansas. Tests have been planted as single row as 7 feet-long with 3 replications for V2 and those lines will be genotyped and screened for flood tolerance at V2 and R1 as 3 replications across different states including AR, MO, LA, and MS. **Arkansas (Vieira):****University of Arkansas, June 15 Season Update**: All field trials have been planted across testing locations in Arkansas including Stuttgart, Marianna, Pine Tree, and Rohwer. Crossing blocks and increases have been planted in Fayetteville, and progeny rows are scheduled to be planted this week. In the next few days, we will start flooding the early vegetative stage flooding trials in Stuttgart, Arkansas. Samples for all preliminary stage entries have been processed for molecular marker analysis and results are expected in the next two weeks. **2024 Development of flood-tolerant germplasm:** Flood-tolerant pre-commercial lines R19C-1012, R19C-1035, R19C-1081, R21KB-05522, R21KB-05122, and R20-1429 are being evaluated for yield and flood tolerance (early vegetative and reproductive growth stages) in regional USDA Preliminary Trial (UP5E) and AR Pre-commercial Test (PCM5E) in multiple locations. R19C-1012, R19C-1035, R19C-1081, and R21KB-05522 are also being tested in the Official Arkansas Variety Testing and are undergoing introgression of herbicide resistance (Enlist-E3 and XtendFlex). A total of 722 progeny rows with flood-tolerant pedigrees are being evaluated in Kibler, AR, and more than 30 flood-tolerant breeding populations are being advanced in off-season nurseries. Four flood-tolerant parental lines were included in the 2024 crossing block. These will be used to develop roughly 15 high-yielding bi-parental populations combining multiple biotic and abiotic stressors tolerance, as well as improved seed composition.**2024 Flood tolerance screening for advanced and pre-commercial lines:** Early vegetative stage flooding is expected to start in the next couple of days for approximately 2,000 plots. Visual flooding score (1-5 scale) will be recorded 7 days after draining the fields. Simultaneously, UAV-based imagery will be collected to develop new phenotyping strategies.**Publications and Presentations:** * Canella Vieira, C. May 2024 - University of Guelph Guest Speaker: Soybean Breeding in the Mid-South: Challenges and Opportunities
* Wu, C., Florez-Palacios, L., Acuna, A., Harrison, D., Rogers, D., Carlin, J., Mozzoni, L., Nguyen, T.H., Shannon, G., and Canella Vieira, C. 2024. Impact of Flooding at the Early Reproductive Growth Stage on Soybean Yield and Seed Composition. Crop Science (*under review*).

**Abstract:** Flooding stress is a growing threat to global soybean production as the frequency and intensity of extreme precipitations are increasing due to climate change. Soybean is highly sensitive to flooding and substantial yield losses are observed due to a cascade of negative physiological responses induced by hypoxia. Hence, there is a pressing need for the development of flood-tolerant genotypes. This study evaluated the grain yield and seed protein and oil content of 31 soybean genotypes over two years under both non-flooding and flooding conditions, where flooding entailed a 4-day water immersion during the early reproductive growth stages R1/R2. Mixed-effects linear models were utilized to assess the impact of flood damage scores (FDS, 1-4 scale) on observed phenotypes, as well as differences in observed phenotypes between tolerant, moderate, and susceptible genotypes across flooding and non-flooding treatments. No significant impact of FDS was observed for seed protein and oil content. In addition, no significant differences in these phenotypes were observed between flooding and non-flooding treatments across the various genotype categories. On average, for each unit increase in FDS, grain yield decreased by 432.7 kg ha-1 (17.4%). Tolerant genotypes experienced roughly 33% yield losses between flooding and non-flooding treatments, while moderate and susceptible genotypes experienced 44 and 51% yield losses, respectively. The advancements in genomics and phenomics are promising for the identification and incorporation of novel flood-tolerant alleles through plant breeding, potentially mitigating flooding-induced yield losses across diverse environmental conditions.**Mississippi State University (Wilkerson)**We are still trying to get things in the field as we have fought wet conditions for most of the plating season thus far.  The forecast looks good for the week of middle June and we are prepared to plant both the state variety test entries and the single row plots as soon as the field is dry.  **Louisiana State University (Moseley)** We are prepared for planting but have been waiting for suitable planting conditions since Mid-May. We have had constant rain. We hope to plant by middle June if possible.  |