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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. Pengyin Chen |
| Other investigators: | Drs. M. Liakat Ali, Leandro Mozzoni, Daryl Chastain, Tessie Wilkerson and Blair Buckley |
| Report Period: | September 16, 2020 to December 15, 2020 |
| 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).  |
| **Missouri:****1. Evaluation of breeding lines for flooding tolerance and yield to develop commercial varieties**i**) Advanced yield trials**: A total of 32 breeding lines in two groups ̶ MG-4 (16 lines) and MG-5 (16 lines) were evaluated in advanced yield trials in flooded and non-flooded condition. **In MG-4 set,** under flooded condition, breeding line S17-1146 and S16-7922 yielded 17. 4 b/a and 11.7 b/a, respectively, and had flood injury scores of 1.3 and 2.6, respectively, while the commercial checks (AG 43X7, AG 46X6 and AG 4835) had mean yield of 2.3 b/a only with flooding injury scores from 4.0 to 5.0). On the other hand, in non-flooded field, the test line S16-7922C yielded 67.0 and the other line S17-1146 yielded 58.0 b/a while the commercial checks mean yield was 73.0 b/a. **In MG-5 set**, breeding lines S12-1362, S16-3747R, S16-3739RY, S11-20124C, S18-9258 and S16-15896C yielded 18.4, 17.6, 16.1, 11.6, 11.2 and 11.2 b/a, respectively, and had flooding tolerance response with injury score of 2.0 to 2.8. As opposed to the test lines performance, the commercial checks (AG43X7, AG46X6, AG4835, AG5335, AG55X7, P55A49X) had mean yield of 2.3 b/a only with mean flooding injury score of 5.0. But in non-flooded conditions, these test lines had yield from 68.0 to 61.0 b/a while the checks mean yield was 71.0 b/a. In flooded field, the experiments were under severe flooding stress this year because of 4 days of continuous rain before completely draining the flooding water out after stress treatment, subjected the plants an extended period of saturated conditions.**ii) Preliminary yield trial:** A total of 44 breeding lines in two sets were evaluated for flooding tolerance and yield in flooded and non-flooded conditions. In set 1 (24 entries) breeding lines, S19-17313, S19-17667, S19-17382 and S19-17693 yielded 28.0 to 16.0 b/a with flooding tolerance scores from 1.3 to 2.0 while commercial checks (AG46X6, AG4835) mean yield was only 4.0 b/a and had mean flood tolerance score of 4.5. However, in non-flooded field these breeding lines yield varied from 52.0 to 49.0 b/a whereas checks mean yield was 60.0 b/a. In set 2 (28 entries), in flooded field, breeding lines S19-17893, S19-17887, S18-3616 and S18-3555 had yield of 16.9, 15.8, 9.6 and 8.3 b/a, respectively, with flooding tolerance scores of 2.8, 3.3, 1.5 and 2.5, respectively, while the commercial checks (AG 43X7, AG 46X6, and AG 52X9) had mean yield of 5.1 b/a with mean flooding tolerance score of 4.6. In the non-flooded condition, yield of breeding lines varied from 57.0 to 45.0 b/a as opposed to the checks mean yield of 63.0 b/a.**2. Flood yield trial for selected tolerant and sensitive lines:** A set of 20 lines (about one half was previously known to be tolerant and the other half was known to be sensitive) were tested for flood tolerance and yield (under flooded and non-flooded condition). Breeding lines, such as S17-1146, S16-7922C, S12-1362, S16-3739RY, S16-15170C, R04-342 and R11-6870 previously known to have flood tolerance, had mean yield of 11.1 b/a in flooded field with mean flood tolerance score of 2.5 while the mean yield of previously known sensitive lines (S13-2743C, S14-9051R, S13-10592C, S13-1955C, R01-581F, R01-2731F and UA5014C was 3.7 b/a only with mean flooding tolerance score of 4.1. In flooded field, the mean yield of commercial checks (AG 49X6, AG52X9 and AG55X7) was 1.4 b/a only with mean flood tolerance score of 4.6. In non-flooded conditions, this tolerant set had mean yield of 50.0 b/a while sensitive group had yield of 38.0 b/a and the checks mean yield was 56.0 b/a. The seed composition (protein and oil content) of these comparing sets will be provided in next report.**3. Screening recently developed elite lines for flood tolerance:** A set of105 breeding lines, recently developed at the University of Missouri-Delta Research Center and at the University of Arkansas and five commercial cultivars as checks, were evaluated for flood tolerance in 2020. Seven Missouri lines (S16-14730C, S16-14801C, S11-20124, S16-8852C, S17-1980C, S18-3463, and S16-7922, and 3 Arkansas lines (R17-3393, R13-11034 and R17-4177) exhibited flood tolerance response with flooding injury scores from 1.0 to 2.0. As opposed to the test lines, the commercial checks (AG 4835, AG 43X7, AG 46X7, AG 5335 and AG 52X9) had injury scores from 3.7 to 4.8. This set of lines was tested in Arkansas, Mississippi, and Louisiana. The main objective is to identify most stable flood tolerant lines across different environments.**4. Missouri commercial variety testing for flood tolerance:** A set of 70 commercial varieties developed by 17 seed companies were evaluated for flooding tolerance. Several test varieties, such as 46-E50 (Armor), 49CK6 (Blue River Organic Seed), DG45E28 (Delta Grow), DG51E60 (Delta Grow), 39E00 (FS HiSOY) and ZS5098E3 (Local Seed) exhibited flooding stress tolerance with injury scores from 1.3 to 2.0. **5. Selection of new breeding lines from progeny row testing**: About 240 single plant progenies (F4:5) from 3 populations were evaluated in flooded field. Only 21 progeny lines were selected at maturity based on visual phenotypes and flooding tolerance scores. These lines will be tested for yield and other agronomic traits in 2021 season.**6. Creation of new breeding populations:** Thirteen crosses made in 2019 to develop new flooding tolerant high yielding soybean varieties are in generation advance (F1 to F4) in winter nursery in Costa Rica (CR) and Puerto Rico (PR). The F4:5 lines will be returned to home station for progeny testing and lines selection in 2021 season. The list of the crosses is given in Table 1.Table 1. List of the crosses made in 2019 and are under generation advance.

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| Cross # | Parentage | Generation | Year of evaluation |
| S19-822 | S11-16653 x R04-342 (FT) | F3 | 2021 |
| S19-823 | S15-10879 x PI 597459 C (FT) | F3 | 2021 |
| S19-829 | S14-16331 (FT\_) x S15-10434C | F3 | 2021 |
| S19-832 | R07-6669 (FT) x S15-3772RY | F3 | 2021 |
| S19-833 | S14-16235 (FT) x S16-8898C | F3 | 2021 |
| S19-836 | R10-4892 (FT) x S13-3851C | F3 | 2021 |
| S19-837 | RIL 48 (FT) x S11-20356GT | F3 | 2021 |
| S19-838 | S13-15999 (FT) = x S11-20337GT | F3 | 2021 |
| S19-839 | R11-6870 (FT) x S11-20195GT | F3 | 2021 |
| S19-851 | S13-3851C x PI 597459 (FT, *G. soja*) | F3 | 2021 |
| S19-853 | S15-5904RY x PI 597459 ((FT, *G. soja*) | F3 | 2021 |
| S19-854 | S15-5904RY x PI 407229 (FT, *G. soja*) | F3 | 2021 |
| S19-855 | S13-2743LL x PI 424102A (FT, *G. soja*) | F3 | 2021 |

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**7. New crosses made in 2020 season:** A total of 9 new crosses have been made between flood tolerant lines and elite high-yielding breeding lines during the 2020 season. Three crosses involved flood tolerant and high protein parents. The F1 seeds of these crosses have been sent to the winter nurseries in Puerto Rico and Costa Rica for generation advance.**Arkansas:** **1. Evaluation of Arkansas breeding lines for yield and flood tolerance**A total of 164 intermediate and preliminary lines derived from high-yielding and flood tolerant pedigrees (N94-7440 x UARK-5896, R10-4892 x UA 5014C, R10-4892 x 91210-350, and RA-452 x Walters) were evaluated for yield with three 1-rep tests (FLM5L, FLP1, and FLP2) in four Arkansas locations (Marianna, Rohwer, Pine Tree, and Stuttgart). These lines were also evaluated for flood tolerance at R1/R2 stage in three separate 5-reps tests in Stuttgart, AR. For the FLM5L test, nine lines (R18-7546, R18-7571, R18-7514, R18-7582, R18-7623, R18-7526, R18-7769, R18-7779, and R18-7710) have good yield with 96.0 –102.6% check mean yield (61.7 bu/ac). Line R18-7546 have the best yield 63.2 bu/ac. The grand mean of test, CV, and LSD were 55.0 bu/ac, 12.3%, and 9.5, respectively. Three lines (R18-7594, R18-7769, and R18-7542) showed high flood tolerance with lower flood severity score (FSS) between 3.2 and 4.0 and 24 lines showed moderately flooding tolerance (FSS= 4.0-5.9). Ground mean of test FSS was 6.1, and the CV and LSD were 27.8% and 2.1, respectively. Four commercial check FSS mean was 7.5 and no commercial cultivar showed flooding tolerance. In the FLP1 test, eight lines (R19-1030, R19-1061, R19-1020, R19-1056, R19-1062, R19-1058, R19-1046, and R19-1055) have good yield performance with 91.1-98.2% check mean 66.9 bu/ac. The grand mean of test, CV, and LSD were 56.9 bu/ac, 17.2, and 12.9, respectively. Flooding test showed that there was not flood tolerant lines with lower FSS (< 4.0). Grand mean of FSS of the test, CV, and LSD were 8.0, 13.9%, and 1.3, respectively. For the FLP2 yield test, three top lines (R19-1123, R19-1100, and R19-1141) yields were up to 90.0-91.6% check mean 69.8 bu/ac. The grand mean of the test yield, CV, and LSD were 55.4 bu/ac, 10.0%, and 7.8, respectively. No line showed flood tolerance in this test. Grand means of FSS of the test, CV, and LSD were 7.7, 15.8%, and 1.4, respectively. Analysis of Variance of three tests FSS showed significant differences with p<.0001 (FLM5L), p=.0001 (FLP1), and p<.0001 (FLP2), respectively.**2. Evaluation of Arkansas historical varieties, germplasm, and lines for yield and flood tolerance**A total of 59 Arkansas historical varieties, germplasm, and lines were evaluated for yield in three 2-reps tests (ARVE, ARVM, and ARVL) at three Arkansas locations (Pine Tree, Rohwer, and Stuttgart). In the same season, all these entries were also evaluated for flood tolerance at early growth stage (V2/V3 stage) in three separate 5-reps tests in Stuttgart, AR. In the ARVE test, two lines (R13-9687 and R13-13997) have good yields with 97.0-98.7% check mean 68.3 bu/ac and R13-13997 also showed high tolerance to flooding at V2/V3 stage with FSS 3.4. Grand mean of test was 60.4 bu/ac and the CV and LSD were 10.4% and 7.3, respectively. Ten lines of ARVM test (R05-235, R11-7999, R01-976, UA5612, UARK-5896, R11-6870, R11-171, R10-5086, R07-6614RR, and R10-230) have good yields with 95.2-100.4% commercial check mean (64.7 bu/ac). Grand mean, CV, and LSD of test were 58.8 bu/ac, 8.8% and 5.9, respectively. Six lines (R05-235, R11-7999, R11-171, R07-6614RR, R10-230, and R11-6870) showed high flood tolerance with FSS between 2.0-3.8. For the ARVL test, three lines (R01-327, R04-572, and R98-209) have good yields 59.8, 58.7, and 58.0 bu/ac comparing check mean 60.3 bu/ac. The test mean, CV, and LSD were 56.8 bu/ac, 15.0%, and 9.9, respectively. R04-572 showed high flood tolerance with the lowest FSS 1.6 at early growth stage.**3. Evaluation of MO and AR high-yielding and multiple-traits lines for flood tolerance:** In 2020, 105 advanced breeding lines from MO and AR and five commercial checks were evaluated for flood tolerance at R1/R2 stage in 5-rep test (MSSB) in Stuttgart, AR. Flood severity scores (FSS) of the test were collected and analyzed. Analysis of Variance of FSS showed that 110 lines responses to flooding stress were significantly different with p < .0001. Seventeen lines (S16-7922, R17-1079, R17-928, R17-3393, S16-14801C, R17-2056, R17-423, R17-885, S17-1494C, R16-1445, S16-9090C, R16-45, S16-14161C, S16-15896C, S17-1946C, R17-417, and S16-7922C) showed high flood tolerance with lower FSS < 4.0. Ground mean of test FSS was 5.6 and the CV and LSD were 43.8% and 2.6, respectively. FSS mean of five commercial checks was 5.8 and no commercial variety showed good flood tolerance. R16-45 with both high-yielding and flood tolerant traits is being selected as a flood-tolerant germplasm for potential release.**4. Evaluation of Arkansas commercial varieties for flood tolerance:** A set of 54 commercial varieties (40 MG4 and 14 MG5) from Arkansas Variety Test were evaluated in two 5-rep tests (VT4 and VT5) for flood tolerance at R1/R2 stage in Stuttgart, Arkansas. Two varieties Petrus Seed 4916 GT (FSS = 5.0) and S16-3747RY (FSS = 5.6) showed moderately tolerance to 10-day flooding stress. Grand means of FSS of the two tests were the same as 7.6. The CVs and LSDs of both tests were 15.1% and 1.1 for VT4, and 20.4% and 1.7 for VT5. Analysis of Variance of two tests FSS showed significant differences with p<.0001 (VT4) and p=0.0129 (VT5), respectively.**5. Evaluation of yield and seed composition under flooding and irrigation conditions**Ten flood-tolerant and 10 flood-sensitive varieties/lines from MO and AR and four high-yielding commercial checks were evaluated for flood tolerance, yield, and seed quality and composition under both 4-day flooding stress at R1 stage and normal irrigation conditions. The flooding damage score data have been collected in this summer. The yield and seed composition data are being collected and will be reported in next quarterly season.**Mississippi:**Dr. Daryl Chastain: All objectives were met in our site. We are entering yield data and flood injury ratings. We should be able to send out data next week. Dr. Tessie Wilerson: The flood trial located at the Delta Research and Extension Center consisting of the MSU variety entries was flooded at v2-v3 growth stage for 72 hours. Severity and incidence ratings were taken 7 days post flood and disease observations were also recorded. Due to late planting and unseasonable cool temperatures towards the end of the season plots remained green longer than expected. The trial was harvested on November 11, 2020. Green leaves and stems caused harvest to be challenging especially with the group V maturity group. Data is being compiled and analyzed. |
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