MSPB Project 31-2019 Final Report

Title of project: Evaluation of soybean breeding lines for resistance to Phomopsis seed decay and for high seed germinability

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Background and Objectives

Phomopsis seed decay (PSD) of soybean is a major cause of poor seed quality in most soybean production areas, especially in the mid-southern region of the United States. Breeding for PSD-resistance is the most cost-effective long-term strategy to control this disease. In recent years, new sources of resistance to PSD have been identified (Li et al., 2011, 2015), and lines with high germinability have also been identified (Smith et al., 2008). Crosses were made between these new sources, resulting in the development of multiple heterogeneous breeding lines with the potential of having both high germinability and resistance to PSD. Seed quality assays, including seed plating for percentage of Phomopsis seed infection and standard germination tests were conducted following the harvest of plants selected for improved agronomic traits. The objectives of this research are to:

1. Evaluate over 100 new heterogeneous soybean breeding lines for resistance to Phomopsis seed decay (PSD) under *Phomopsis* field-inoculated conditions.
2. Test PSD-resistant homogeneous breeding lines with resistance to PSD and high seed quality in multi-year trials.
3. Identify agronomically-improved PSD-resistant homogeneous lines with high germinability.
4. Provide information to soybean breeders, growers, and others in the seed industry interested in disease resistance and seed quality.

Report of Progress/Activity

Phomopsis seed decay is one of the most economically important soybean diseases in the midsouthern U.S.A. Identification of new sources of resistance to Phomopsis seed decay (PSD) and breeding soybean for resistance to PSD with high seed quality is one of most effective ways to control the disease. This project started on April 1, 2019 and originally proposed to end on March 31, 2020. Due to the COVID-19 pandemic, experiments were delayed. The project was no-cost extended to June 30, 2021 with approval from MSPB and USDA, ARS.

In 2019, 123 rows of new F_2 soybean plants were planted on May 16 in Stoneville, MS for evaluation of resistance to PSD and desirable plant type. Twenty $F_{3:4}$ lines, 12 $F_{2:3}$ lines, and resistant and susceptible checks were also planted. Harvest began on September 5, 2019. Over 325 single plants, that each became a new line for 2020 trials, were harvested and tested for seed quality. Additionally, approximately 10 lines were bulk harvested for potential replicated yield and stress trials in 2020.

Seed assays were conducted in 2020 after the harvested materials were organized and inventoried. Due to the COVID-19 pandemic, we are under a maximum telework policy. We developed and executed a new seed plating protocol and thereby eliminated the need for two individuals to work side-by-side, as in the traditional method, and thereby met the CDC guideline for social distance.

A total of 168 seed samples from 36 breeding lines and 26 checks obtained from ARS soybean breeders were tested twice in repeated assays. A total of 8,400 seeds with 1,680 medium plates were examined. We assayed 50 seeds for each seed sample, which was double the amount of seeds tested as proposed in the original proposal. Those breeding lines were derived from multiple pedigrees and, as a group, utilized at least six sources of PSD-resistance. They were delay-harvested from field trials inoculated with *P. longicolla* in 2019. Results showed that there were significant differences ($P \leq 0.05$) in seed infection caused by *P. longicolla* among soybean lines, with some lines having as little as 3.3 % infection (PI 594619, which is hardseeded) and 4% infection (DA1239-09), while others had levels as high as 83% infection (cultivar LD00-7620). Twelve breeding lines had levels of infection less than 10%, which were all significantly less than the infection levels of susceptible checks (Table 1). Results from correlation analysis indicated that percent seed infected by *P. longicolla* was significantly ($P < 0.05$) and negatively correlated with seed germination (Table 2).

Impacts and Benefits to Mississippi Soybean Producers

We expect this research will lead to the release of improved germplasm lines with PSD resistance, high seed germinability, and lower seed damage. The improved germplasm lines will be utilized in public and commercial breeding programs to develop high-yielding cultivars that have reduced elevator dockage caused by damaged seed, and thereby be a benefit to Mississippi Soybean Producers.

End Products–Completed or Forthcoming

List the five most important outputs (publications, presentations at conferences, field days, workshops, etc., and products or other technology) resulting from the project activity.

1. Smith, J. R., Gillen, M. A., Nelson, R. L., Bruns, A., Mengistu, A. Li, S., and Bellaloui, N. Registration of high-yielding exotically-derived soybean germplasm line LG03-4561-14. Journal of Plant Registrations. 13: 237-244. 2019. doi:10.3198/jpr2018.09.0061crg.
2. Li, S. and Smith, R. Evaluation of soybean breeding lines for resistance to Phomopsis seed decay and for high seed germinability. Presentation at the 2020 American Phytopathological Society Annual Meeting, (Virtual) August 8-12, 2020.
3. Smith, J. R., Gillen, M. A., Nelson, R. L., Bruns, A., Mengistu, A., Li, S., and Bellaloui, N. Notice of release of LG03-4561-14, Soybean. Docket Number 0057.18 (Germplasm Release).
4. Chen, P., Shannon, G., Crisel, M., Smothers, S., Clubb, M., Vieira, C. C., Ali, M. L., Selves, S., Lee, D. H., Scaboo, A., Klepadlo, M., Nguyen, H. T., Mitchum, M. G., Meinhardt, C., Bond, J., Robbins, R.T. Li, S., Smith, R. and Mengistu, A. Registration of 'S14-15138GT' soybean as a high-yielding RR1/STS cultivar with broad disease resistance and adaptations. Journal of Plant Registrations. 14: 311-317. 2020. DOI: 10.1002/plr2.20054.
5. Li, S. and Smith, R., Gillen, A., Crowley, E. Evaluating soybean breeding lines for resistance to Phomopsis seed decay: results from 2020 seed plating assays. Presentation at the 2021 American Phytopathological Society Annual Meeting (Virtual).

Table 1. Percent seed infection caused by *Phomopsis longicolla* of soybean lines and percentage of seed germination in replicated field tests inoculated with *P. longicolla* and delay harvested at Stoneville, Mississippi in 2019.

Entry	PSD (% ± S. D.) [a]	Germination (% ± S. D.) [b]
PI 594619	3.3	13.3[c]
DA1239-09	4.0	52.7
10049-142-31	4.7	47.3
11069-122-11	6.0	62.7
11069-333-11	6.0	47.3
11030-244-51	6.7	70.7
11069-323-11	6.7	52.0
12047-1-178	6.7	49.3
12047-1-160	8.0	57.3
DA13099-008F	8.0	42.0
DS25-1	8.0	72.7
12060-260-2	8.0	71.0
11030-242-22	8.7	61.3
11030-242-51	10.7	54.0
DA1221-01-597	13.3	51.3
11030-244-41	15.3	62.0
DB06x006-93	15.3	34.7
11069-512-34	16.0	48.7
12060-83-15	17.3	42.0
DA13086-011F	18.7	55.3
DA13086-048F	19.3	35.3
AG51X8	20.0	40.0
AG5335	20.7	38.0
DA10x30-09F	21.3	39.3
DA1134-015F	21.3	54.0
DT97-4290	22.0	32.0
10074-112	22.7	43.3
10031-243-12	23.3	45.3
11030-244-12	23.3	46.0
DA10x30-48F	23.3	58.0
DSR234	24.0	44.0
11030-541-28	25.3	48.7
DA13062-004F	25.3	41.3
Manokin	27.0	29.0
P48A32X	28.7	34.0
10061-236-11	31.3	38.0
13082-1315	31.3	42.7

11043-225-72	33.3	40.7
10061-236-12	34.0	49.3
SS93-6181	37.5	36.0
P46T59R	38.0	14.0
Y227-1	38.4	38.0
P48A60X	39.3	37.3
65-414-132-1	40.7	49.3
LD00-3309	43.0	25.0
AG4632	48.0	18.0
11043-224-91	48.7	30.0
PI 587982A	49.3	36.0
Pella 86	54.5	32.0
Progeny 4211	59.3	23.3
LG03-4561-14	61.5	26.5
CZ3841LL	74.0	13.3
LD06-7620	82.7	5.3
Mean	26.2±18.6	42.1±15.0

[a] Percentage of seed infection caused by *P. longicolla.*

[b] Percentage of seed germination.

[c] Hardseed line.

Table 2. Pearson correlation coefficients between percentage of seed infection caused by *Phomopsis longicolla* and seed germination in replicated field tests at Stoneville, Mississippi in 2019.

	PSD [a]	Germination [b]
PSD	1.0000	-0.6905 (< 0.0001) [c]
Germination		1.0000

[a] Percentage of seed infection caused by *P. longicolla.*

[b] Percentage of seed germination.

[c] Probability.