Nebraska Soybean Board
Year-End Research Findings Report

Please use this form to summarize the practical benefits of your research project and what has been accomplished. Your answers need to convey why the project is important and how the results impact soybean production.

Project Title: Soybean Breeding & Genetics Studies for Nebraska

Contractor & Principal Investigator: George Graef

Please check/fill in appropriate box: ■ ***Continuation research project***
☐ ***Year __ of __ research project (for example: Year 1 of 2)***

1. What was the focus of the research project or educational activity?

This project involves applied research and development to (1) Produce high-yielding soybean varieties adapted to Nebraska and the Midwest; (2) Develop germplasm and cultivars for use in specialty markets; (3) Develop germplasm and cultivars with improved compositional quality; and (4) Evaluate and develop germplasm and cultivars that are resistant to iron deficiency chlorosis, soybean mosaic virus, bean pod mottle virus, phytophthora root rot, sclerotinia stem rot, and soybean cyst nematode.

2. What are the major findings of the research or educational activity?

From October 2015 through September 2015 we shared seeds from over 20 of our new high-yield lines for testing and evaluation by companies, USDA, and other universities through Material Transfer Agreements (MTAs) for evaluation and crossing.

We continue to make great progress improving yield in soybeans for our Nebraska production environments and across the north central region. Four new soybean varieties were released and increased at Foundation Seed during 2016. (1) **U11-920017** soybean was the #1 line in the USDA Uniform Regional Tests for MG2 for 2015 and the 2014-15 2-year average and is now a check in those tests across the region. It has excellent resistance to phytophthora root rot. (2) **U11-614119** soybean has the same yield and is about 3 to 4 days later in maturity compared with U11-920017. Both lines do well in the region and in NE, and have excellent phytophthora resistance. (3) **U11-911079** soybean has excellent SCN resistance and yields well in both SCN and non-SCN infested fields. The line was evaluated in both the USDA Uniform Regional tests and the SCN regional tests on infested fields. We are targeting that line for north east Nebraska because of its yield and combination of excellent SCN resistance and IDC tolerance. It also has good resistance to phytophthora root rot. (4) **U11-917032** soybean is a later MG1 line with excellent SCN resistance, in addition to SDS resistance and IDC tolerance. That line also was tested in both the Uniform and SCN tests, and is now a yield check in the MG1 tests for both the Uniform and SCN tests.

We advanced 58 lines in the 2016 USDA Uniform Regional Tests. For advanced lines in the increase and purification process, we grew 16 increase plots, 11 variety purification plots, and 3 breeder seed increase plots.

Four graduate students completed their research this year and graduated in May and August, with two of them aiming for December 2016 graduation. Their work involved projects with resistance to rhizoctonia rot, drought, and seed compositional quality. We have lines from several populations in

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the early stages of the program that have other seed composition traits, including reduced allergens and increased total protein and oil. A new graduate student working with a colleague has as part of her Ph.D. research some of our IDC tolerant lines, looking at interactions in high-pH and normal soil conditions, and evaluating the root microbiome on different genotypes in both soil conditions.

3. ***Briefly summarize, in lay terms, the impact your findings have had, or will have, on improving the productivity of soybeans.***

The progress in yield is important because we continue to develop and select from our Nebraska environments top-yielding lines for Nebraska that yield significantly better than the high-yield checks. Their performance holds up over years in Nebraska and is superior across the northcentral region, as shown by the Uniform Soybean Test results. With our multi-location evaluation program at high-yield farm sites in Nebraska, we identify high yield potential and are able to make significant gains in yield with each breeding cycle. Our high-yield lines are used by other programs as parents, and thus contribute to increasing genetic gain and expanding the genetic base in those programs as well.

Our seed composition results are important because we have shown that 60% seed protein concentration and 26% seed oil concentration are obtainable, the lines were used to expand the NIR calibrations available to researchers throughout the US, and we are following up with more detailed evaluation of the extreme seed compositions and effects on yield and other important agronomic traits. The multiple, large populations, recently evaluated as part of graduate student research projects, have produced hundreds of lines with increased total protein and oil together, with reduced carbohydrates in the seeds. During 2016 we grew seed increases of more than 100 of the lines with the most extreme composition traits to follow up with extensive, multi-location tests during 2017 and 2018 to evaluate seed yield and composition in these new phenotypes.

We also have developed a collection of some of the most IDC-tolerant soybean lines available. Together with improved yield and seed composition, resistance to IDC will improve productivity and value on millions of soybean production acres. Many of our high-yield lines have other resistances, like phytophthora root rot, SCN, SMV, and BPMV as well.

4. ***Describe how your findings have been distributed to (a) farmers and (b) public researchers. List specific publications, websites, press releases. etc.***

We share our performance data with Nebraska Crop Improvement, NuPride and others, including companies and germplasm suppliers, who request information on our new soybean lines. The data for advanced lines in regional tests is shared with all public researchers through the USDA Uniform Soybean Tests Northern States, the SCN Regional Test, and the Soybean Quality Traits Test reports.

5. Did the checkoff funding for your project leverage any additional state or Federal funding? Please list sources and dollars approved.

We developed an industry-university partnership that returned significant revenues to the university and the soybean board to strengthen and support ongoing soybean breeding research

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and development. We lead and participate in several important regional and national soybean research projects with NCSRP and USB funding. A group of us in the North Central region received funding for "Increasing the rate of genetic gain for yield in soybean breeding programs." In addition, a colleague submitted a proposal to USDA-NIFA for funding that uses our IDC tolerant soybean germplasm and builds on our results and successes to date, made possible through continued funding from the Nebraska Soybean Board. Funding decisions on those proposals are due in November.

This form must accompany the fourth quarter (final report)