Mid-Cycle Report Template
Submit: research@indianasoybean.com

Project Title:	Support for the Purdue Soybean Breeding Program
Principle Investigator(s):	Dr. Katy Martin Rainey
ISA Project Number:	SU3-SFY23020
Date:	3/15/2023
Current Project Period:	10/01/2022 to 09/30/2023
Date Final Report Due:	09/30/2023

1. Outputs - Explain what you did, what was discovered, and what was learned because of the research project.

- **Be specific about which KPIs from your proposal are met/unmet and why**
- Report outputs completed during the reporting period that contribute to the goals and objectives of the project (**DO NOT** include publications here, they are to be reported separately in Item 2 below).
- For a project just initiated, please note the status.
- Narrative is limited to 3,200 characters and spaces.

Explanation:

We have fulfilled or are making progress on the majority of KPIs. Please see the attachment for specifics (This box does not expand when I copy and paste into it, and most of the text is lost).

2. Publications/Extension/Outreach - Describe how findings and results were shared. Report number of website hits, number of meetings where results shared, number of people attending meetings, etc.

- List publications, documents, meetings, or events that are specific to the project during this reporting period.
- Include only those publications, documented meetings not previously reported.
- Include research and extension publications, handouts, electronic publications, websites, etc.
- If there are no publications, documents, or meetings to report for the period, leave this field blank.
- Include a description of how the results have been disseminated to communities of interest or how the product is being shared. This report narrative is required of all projects.

Narrative is limited to 3,200 characters and spaces.

Explanation:

Since September 2022, Dr. Rainrey and her students have presented three posters at two separate meetings, and two invited talks at two separate meetings. Over her career, Dr. Rainey has published 48 peer-reviewed manuscripts, one book chapter, 51 abstracts, 1 patent, several other intellectual property items, and has been invited to present 37 talks.

3. Project Modifications - Describe any significant changes to project content from original funded project proposal.

Select one of the following options:

☑ Not applicable for this period, nothing significant to report.

☐ Report narrative entered in the box below.

Explanation:

4. Completion Date - Describe any foreseen possibility of a no cost extension request. Be specific as possible as to why a no cost extension might be requested. Please note a No Cost Extension request must be sent to ISA no later than 90 days before end of project.

Select one of the following options:

☑ Project expected to be completed on schedule.

☐ Project delay expected, report narrative entered in box below.

Explanation:

5. Attachments: Attach any copies of graphs, charts, publications, reports, field day flyers, etc. regarding project.

Rainey lab FY23 Mid-Cycle Report KPI updates.

A typical breeding pipeline is advanced annually and provides education to future soybean breeders and supports innovation in soybean genetics & breeding, and is leveraged for discovery in soybean.
KPI: Genetic variation is utilized and created through cross-pollination, and early-generation populations are managed appropriately.
KPI: Multivariate genomic and phenomic selection is used to select high-yielding lines.
KPI: Valid statistical methods are used to adjust for field variability and comparisons to controls.
KPI: Phenotypic variability for yield is observed and associated with UAS-derived metrics compiled over time.
All fulfilled. We selected among ~7,000 experimental lines using combinations of sources of information, including yield measured from the plot combine, measurements of canopy coverage and biomass predicted from RGB UAS images and compiled over time, and genome-wide markers collected on thousands of lines, all statistically adjusted based on various experimental designs and several students contributed to the efforts. We observed preliminary resets that genomic prediction of yield using markers was made more accurate when using biomass predicted from RGB UAS images and compiled over time. Approximately 120 UAS flights were completed.

New varieties are selected based on yield, agronomics and resilience to stressors.
KPI: Variable growth curves of UAS phenotypes in response to herbicide treatments and field conditions are described.
Partially fulfilled: we are still making selections for 2023.

KPI: Replicated yield trials are conducted in multiple environments.
Fulfilled: We grow replicated field trials across locations every year.

KPI: Trials are managed to replicate farmer practices.
Fulfilled: Mainly through tillage and nutrient management.

Experimental lines are shared with the private sector.
KPI: Performance data are summarized and distributed.
Fulfilled via the USDA Northern Uniform test.

PPO inhibitor-resilient germplasm is identified.
KPI: Variability in stress response is observed and repeatable across environments.
KPI: Valid statistical methods are used to adjust for field variability and comparisons to controls.
Above KPIs are partially fulfilled: All of our results indicated 1) UAS-acquired RGB methods can measure field herbicide resilience, 2) there is genetic variation for resilience, and 3) our methods are repeatable. We have identified Purdue germplasm lines that are likely resilient, but need to confirm this with a greenhouse screen. Currently, we are focused on the upcoming field season, and will complete a greenhouse screen at a later date.

A validated method for high-throughput field screening for resilience to PPO inhibitors is deployed to screen diverse germplasm.

KPI: Corteva Agriscience contributes to experimental design and refinement of objectives.
Not yet fulfilled: Drs. Rainey and Young need to meet with Corteva to show results.

KPI: Visual scores of herbicide damage and quantified image-derived phenotypes correlate with acceptable precision and accuracy.
Fulfilled: At ACRE in 2021 and 2022, we designed and implemented a PPO-inhibiting herbicide screening nursery with several hundred entries of Purdue germplasm, and collaborated with Corteva to use lines expressing relatively high and low resilience to PPO-inhibiting herbicides as positive and negative controls. We observed visual damage on treatments, and collected bi-weekly UAS high-resolution RGB imagery throughout the season, which we used to quantify canopy coverage and canopy color, for which we generated growth curves for each treatment combination, see Appendix below. We then used logistic regression and nonlinear mixed models theory to predict whether lines would be resilient after training models with the visual observations of control plots. We observed a range of variation for herbicide resiliency, and the correlation between 2021 and 2022 predictions was 0.95 for controls.

KPI: 600 plots are planted at ACRE, sprayed with Dicamba, and imaged with high spatial and temporal resolution.
Partially Fulfilled: We have identified control lines and are making plans to use the experimental designs from the PPO inhibitor nursery for a Dicamba screen at ACRE in 2023.

KPI: Students and collaborators present results to colleagues and stakeholders outside the project.
Fulfilled: These results have been presented at the several conferences and meetings including the Soybean Breeders' Workshop.