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| Project Number:  | USB# 1620-732-7235 |
| Project Title:  | Research to Integrate Best Management Practices for Glyphosate-Resistant Weeds in Soybean Production Systems (Year 1 of 3) |
| Organization:  | Purdue University |
| Principal Investigator Name: | Bryan Young |
| Project Overview - What key activities were undertaken and what were the key accomplishments during the life of this project?  |
| This project was a coordinated research effort among eight states to provide foundational knowledge and practical solutions to U.S. soybean growers regarding the continued threat and expanding occurrence of herbicide-resistant weeds, with a significant focus on glyphosate-resistant waterhemp and Palmer amaranth. More specifically, some of the field research conducted was an extension of a previous project funded by USB on the persistence of waterhemp and Palmer amaranth in the soil seedbank and the success of integrated Best Management Practices (BMPs) for herbicide-resistant weeds. The majority of the proposal was focused on new research initiated during the 2016 growing season that investigates other factors that may limit the adoption of BMPs by farmers. The new research included: the influence of spray tank contamination of 2,4-D and dicamba on injury to Roundup Ready and Roundup Ready Xtend (dicamba-resistant) soybean varieties; assess the impact of herbicides used to terminate cover crop growth in the spring and potential carryover of residual herbicides to fall planting of cover crops; determine the effectiveness of harvest weed seed control tactics; and explore how established BMPs for pigweed species may be adapted to other problematic weed species.Research for all project areas were conducted as planned in 2016. At the time of this report field data collection on soybean yield is still in progress with data analysis to follow. The only project that will conclude this fall is the project managed by the University of Wisconsin on the success of integrated Best Management Practices (BMPs) for herbicide-resistant weeds. A concluding report for that project will be provided during the next quarterly report due to USB for the current Year 2 project. All other research in this USB project was intended to continue through Years 2 and 3 and not conclude with this report.One objective of this project was to coordinate outreach efforts among the principal investigators and the USB-funded outreach program on “Take Action”. Bryan Young (lead PI on this research proposal) and Bill Johnson (lead PI on the outreach proposal) have worked closely to integrate research findings into the communication channels created through the “Take Action” program. As a result, we are currently working on two webinar recordings with the Plant Management Network to integrate our research findings into deliverables to educate soybean farmers. The webinars are “Soybean row spacing and seeding rate effects on weed management” by Shawn Conley and “The impact of cover crops on suppression of weeds” by KevinBradley. |
| Deliverables - List each deliverable and indicate whether or not it was supplied and if not supplied, please provide an explanation as to why. |
| The six deliverables included in the proposal for this project as listed below followed immediately by an explanation of whether the deliverable was supplied.*1) Documentation of persistence or loss of pigweeds from the soil seedbank across vast geographies and use of this information to promote draw-down of the soil seedbank.* Supply: The research to date for this project has been completed as described in the proposal. Since this research is still in progress the supply of this deliverable will not be complete until the conclusion of the research. Palmer amaranth viability averaged between locations and burial depth was reduced by almost half for each year of burial (49% vs 25% for year 1 and 2, respectively). These results are related directly to Palmer amaranth’s transient and short-term persistent seedbank dynamics. A similar trend was observed for waterhemp. No statistically significant differences were detected on Palmer amaranth seed viability between burial depths when averaged across other treatments (i.e. 38% vs 36% for 0 and 6 inches, respectively). Nevertheless, Palmer amaranth seeds left on the soil surface were found to be significantly more damaged compared to those buried at 6 inches below the soil surface (a=0.05), with direct implications on tillage management. Palmer amaranth was found to exhibit higher viability (45%) compared to waterhemp (33%) when averaged across origin (state of collection), burial and year treatments. The viability in both species was influenced by the origin of each species. In descending order the viability of Palmer amaranth, for example, originating from Missouri (45%) was higher than that from Indiana (39%), Arkansas (36%) and Tennessee (33%) indicating a higher adaptability of the seed material originating from Missouri. The project is still in progress; hence, interactions observed between treatments are not included in this report. The final year of burial and extraction from the soil will occur by December 2016 with the analysis of the seed, final data analysis, and development of reports and educational materials to be completed by fall 2017.*2) Optimization of a soybean production “system” for each state or region in terms of weed control and economic returns through integration of BMPs defined as successful in the previous proposal.*Supply: The research to date for this project has been completed as described in the proposal. Since this research is still in progress the supply of this deliverable will not be complete until the conclusion of the research. Final data collection, analysis, and integration of information into educational materials will continue through spring 2017. A concluding report for this research will be provided in a quarterly report due to USB for the current Year 2 project. The USB Systems project has been collaborated by Ohio State University (2015), the University of Arkansas (2015 & 2016), University of Wisconsin-Madison (2015 & 2016), University of Missouri (2016), and the University of Tennessee (2016). The main goal of this project is to determine how different combinations of weed management strategies (i.e. herbicide program, tillage, cover crop use, etc.) affect weed populations, most importantly Amaranthus species, in soybean production. Soybean density at emergence and weed densities at the V3, R1, and R8 soybean growth stages were recorded as well as soybean yield. There was insufficient pigweed pressure in Wisconsin, but based on data from Arkansas it appeared the best results in minimizing pigweed density during the growing season came from the use of extensive tillage management. Yield data from 2015 also shows that these treatments yielded similarly to most no-till treatments. Using non-metric multidimensional scaling (NMDS) to look at how populations are affected by specific treatments has also shown some promise in analyzing the weed community data. Preliminary results indicate that herbicide program, and more specifically the use of a pre-emergence herbicide, has the most significant effect on weed communities and must be an integral part of any weed management program.*3) Alleviating some of the herbicide challenges associated with managing cover crops used as a cultural weed management tactic.*Supply: The research to date for this project has been completed as described in the proposal. This research is still in progress and has not yet completed one full year of active research for both field experiments. In addition, this research was planned for a minimum of two years to assess the influence of environmental factors on herbicide activity. Thus, the supply of this deliverable will not be complete until the conclusion of the research. Termination of Cover Crops: A variety of cover crop species were planted by each participating researcher in the fall of 2015, and a series of glyphosate-, glufosinate-, and paraquat-based treatments and combinations were applied to cover crop stands in the spring of 2016. Fresh weight biomass reduction of all cover crop species was generally higher with glyphosate-based herbicide programs than glufosinate- or paraquat-based programs (see Table 1 below). The addition of dicamba or saflufenacil to glyphosate improved the biomass reduction of leguminous cover crops compared to glyphosate alone. However, the addition of 2,4-D to glyphosate was antagonistic for control of grass cover crops. A second year of data will be gathered in 2017. Results will be analyzed across locations and years in order to develop appropriate recommendations for the successful termination of cover crops prior to soybean planting when considering the broad geography and environmental conditions present in the major soybean production regions of the U.S.**Table 1. Efficacy of herbicide treatments used for spring termination of cover crops prior to soybean planting in 2016.**Herbicide Carryover Injury on Cover Crops: Data for this experiment has not been collected yet at the time of this writing as the cover crop species have just recently been planted following the soybean herbicide applications performed during the 2016 growing season. The initial assessment of herbicide carryover injury will take place at 28 days after cover crop emergence, and in mid- to late-March of 2017.*4) Documenting the effectiveness of harvest weed seed control strategies for waterhemp and/or Palmer amaranth.*Supply: The research to date for this project has been completed as described in the proposal. This research is still in progress and has not yet completed one full year of active research at all locations. In addition, this research was planned for a minimum of two years to assess repeated use of these weed management strategies on the depletion of the soil seed bank for these weed species. Thus, the supply of this deliverable will not be complete until the conclusion of the research. The following deliverables have been met for year 1: Spring soil core grow out; pigweed densities after soybean emergence, after the POST treatment, and prior to harvest; biomass of soybean in the narrow windrows; pigweed density and male:female ratios have been established; and pigweed plants have been collected and will be assessed for seed retention. The following activities are currently ongoing for year 1: soybean grain yield and moisture; burning of the narrow windrow plots; and determine the length/duration of burn. Planting of cereal rye has been performed at research sites for the initiation of year 2 of this research.*5) Characterization of the potential off-target soybean injury from 2,4-D and dicamba that may result with the future adoption of Enlist and RR2 Xtend soybean technologies.*Supply: As mentioned in the previous quarterly reports for this research, the inclusion of Enlist soybean in this research was not possible due to the delayed commercialization of that technology. The inclusion of Enlist soybean in year 2 of this field research will be evaluated based on commercial availability of this technology in 2017. The research to date for this project has been completed as described in the proposal with an emphasis on possible tank contamination of 2,4-D and dicamba when performing herbicide applications to Roundup Ready 2 Yield (RR2Y) and Roundup Ready Xtend soybean. This research is still in progress and has not yet completed one full year of active research at all locations. In addition, this research was planned for a minimum of two years to assess the influence of environmental factors on the soybean injury and yield reductions caused by these auxin mimic herbicides. Thus, the supply of this deliverable will not be complete until the conclusion of the research. Field research was conducted at cooperating universities in Arkansas, Illinois, Indiana, Missouri, Mississippi, Nebraska, Tennessee, and Wisconsin. As stated above, a complete data analysis and summary is not possible at this time since data collection is still ongoing for year 1 of this research. A preliminary data analysis for the field site in Indiana suggests that the soybean injury and yield loss from 2,4-D and dicamba was similar to previous reports on RR2 soybean. In addition, the potential tank contamination of 2,4-D with a planned application of glyphosate and dicamba on RR2 Xtend soybean did not influence overall soybean injury and yield loss beyond what would be expected from 2,4-D on RR2 soybeans. Again, this is just a preliminary analysis based on one of eight field sites in 2016 and a more complete analysis will be performed when all the data has been submitted at the end of the harvest season in 2016. Since the subject matter of this research is highly sensitive given the off-target problems with dicamba commercially in 2016, we will seek opportunities to integrate our findings into educational materials as soon as possible in 2017.*6) Determination of how the developed BMPs utilizing diverse herbicide sites of action for management of pigweed species may be adapted to other problematic or herbicide-resistant weeds.*Supply: The research to date for this project has been completed as described in the proposal. However, this field research is still in progress and has not yet completed one full year of active research. In addition, this research was planned for a minimum of two years to assess the influence of environmental factors on herbicide activity. Thus, the supply of this deliverable will not be fully completed until the conclusion of two years of field research. A preliminary analysis of data provided from three of the five research sites suggests that a number of different herbicide programs can be effective for suppressing early-season germinating weeds. This was true for Amaranthus species, as the experimental treatments were designed for these species, but also for other small-seeded broadleaf and grass weeds. Larger seeded broadleaves such as morningglory and giant ragweed may be more challenging for residual herbicides and required an effective postemergence herbicide such as dicamba or Flexstar. Although limited data was available to analyze at the time of writing this report, the preliminary results would suggest that slight modifications may be necessary for the BMPs developed for control of Amaranthus species if the target weeds are large-seeded broadleaf species. However, the core BMP strategies of planting into a weed-free seed bed, utilizing soil residual herbicides at planting and in the POST application, and having an effective foliar active herbicide for a POST application are still necessary for effective management for problematic weed species, especially those species that geminate later in the growing season. |
| Did this project meet the intended Key Performance Indicators (KPIs)? List each KPI and describe progress made (or not made) toward addressing it, including metrics where appropriate.  |
| The proposal listed two KPIs for this project (listed below) and the progress made towards meeting these KPIs is described for each below.*KPI #1) Improved weed management recommendations based on this research will be incorporated into the Take Action outreach initiative materials and distributed to over 50 meetings or field days annually to a minimum of 2,000 soybean growers. The goal of this activity would be to increase the adoption of Best Management Practices for herbicide-resistant weeds by at least 20% for those growers that receive the information. Ultimately, this should improve the sustainability of soybean production in regards to weed management.*All of the research proposed for this project involved field experiments in 2016 which have not been fully completed by the time of writing this report. Since the field research necessary to fulfill this KPI has not been completed we have not been able to make significant progress on meeting the KPI. However, data analysis and summarization will occur over the next several months which should allow us to incorporate some of our preliminary findings into education delivery channels such as the Take Action initiative and traditional Extension outlets.*KPI #2) Web-based videos on practical weed management tips generated from this research will be viewed by 1,000 weed management practitioners per year. The goal of this effort would be to pull out specific aspects of weed management that are critical components within the Best Management Practices that we develop based on our research. An example of a desired outcome would be that greater than 25% of soybean farmers who adopt the use of the growth regulator technology for soybean (Enlist or RR Xtend) will integrate at least three effective herbicide sites of action into their weed management program.*We are currently working on two webinar recordings with the Plant Management Network to integrate our research findings into deliverables to educate soybean farmers. The webinars are “Soybean row spacing and seeding rate effects on weed management” by Shawn Conley and “The impact of cover crops on suppression of weeds” by Kevin Bradley. Once these videos are made publicly available we can then assess the distribution and viewing by farmers and the potential/measured impact of these efforts. |
| What, if any, follow-on steps are required to capture benefits for all US soybean farmers?Describe in a few sentences how the results of this project will be or should be used. |
| The primary objective of this research is to provide the foundational knowledge and practical solutions to U.S. soybean growers regarding the continued threat and expanding occurrence of herbicide-resistant weeds. The information generated must be critically scrutinized on a regular basis to 1) continually identify opportunities to incorporate key messages into educational efforts, 2) identify how these findings can be adapted to all soybean production regions, and 3) identify future research that stems from this project to address current and future weed management challenges for U.S. soybean farmers. |
| **Describe any unforeseen events or circumstances that may have affected project timeline, costs, or deliverables.** |
| Two unforeseen circumstances occurred in year 1 of this project, but will not have an overall negative impact on this project. The use of Enlist soybeans in this research was not possible in year 1 since the soybean trait was not commercialized. In response to this change in plans, the research protocol was revised to investigate the interaction of 2,4-D and dicamba on RR2 Xtend soybeans which was an addition to our previous objectives. Thus, we feel our research on RR2 Xtend soybeans was strengthened by this change. We will re-evaluate the use of Enlist soybean in field research for 2017 depending on successful commercialization of the soybean trait.Actual expenditures for this research will be less than anticipated as a result of a change in staffing at the University of Wisconsin to conduct this research. Shawn Conley at UW was still able to perform the research as necessary to meet the expected deliverables, but the change in personnel resulted in a cost savings to the overall project. |
| **List any relevant performance metrics not captured in KPI’s.** |
| No other performance metrics beyond the stated KPIs have been identified at this point of the project. |