Nebraska Soybean Board
FINAL Research Report Form

DS SK 8/21/2020

Note: Submit this report no later than 90 days after the NSB-funded project officially terminates.
This post-project 90-day time-frame will allow the Lead PI time to complete any final data analysis and a final technical report, plus the drafting of any articles for submission to scientific journals. Note that this completed report will be provided to the National Soybean Checkoff Research Database, (soybeanresearchdata.com).

Project # and Title: Project #1733; Comparison of Herbicide Efficacy and Economics of Glyphosate-Resistant Weed Management in Multiple Herbicide Tolerant Soybean in Nebraska

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UNL

Project Date (Including Extension): 10/01/2017 ***to*** 03/31/2020 ***(For example: mm/dd/yyyy to mm/dd/yyyy)***

Total Budget for Project: $ 301,939.00

1. Briefly State the Rational for the Research:

Six broadleaf weeds in Nebraska have been confirmed resistant to glyphosate. A survey by 'Stratus' reported that about 5 million acres in Nebraska are infested with at least one glyphosate-resistant weed. In fact, several of glyphosate-resistant weeds are also resistant to acetolactate synthase (ALS) inhibitors (Pursuit®, Classic®, etc.), reducing effective post-emergence herbicide options for controlling multiple herbicide-resistant weeds such as common waterhemp and Palmer amaranth. Few three-way premixes applied pre-emergence are labeled in recent years for residual weed control in soybean. Additionally, herbicide-tolerant soybean cultivars such as, Liberty Link®, Roundup Ready 2 Xtend™, EnlistE3™ and Balance™ GT have been considered as an alternate to the Roundup Ready® soybean system for controlling glyphosate-resistant weeds. Scientific information is not available comparing efficacy of three-way premixes applied pre-emergence for broad-spectrum weed control, crop safety, and economics in Liberty Link®, Roundup Ready 2 Xtend™, and Balance™ GT soybeans. Field experiments will be conducted under dryland and irrigated environments in eastern (Lincoln), north-eastern (Concord), west-central (North Platte), south-central (Clay Center), and western (Scottsbluff) Nebraska in 2018 and 2019 to test several three-way premixes for weed control in herbicide-tolerant soybean systems and their economics (Objective 1).

Recent survey by the Weed Science Society of America listed Palmer amaranth as the most troublesome weed in the United States. A recent study conducted in Nebraska showed that a Palmer amaranth biotype from Carleton, Thayer County was 40-fold resistant to glyphosate compared to a known susceptible biotype. Therefore, integrated management strategies, such as: soybean row width, incorporating different herbicide-tolerant soybeans, and herbicide programs including residual herbicides should be considered for management of glyphosate-resistant Palmer amaranth. Field experiments will be conducted in 2018 and 2019 to manage glyphosate-resistant Palmer amaranth in Roundup Ready 2 Xtend™, Balance GT, and Enlist E3 in a grower's field infested with glyphosate-resistant Palmer amaranth at Carleton, Thayer County (Objective 2).

Field experiments will also be conducted to determine critical period of weed removal in soybean affected by residual herbicide application at Clay Center, Concord, and Scottsbluff (Objective 3). The outcome of the projects will be disseminated to soybean growers by organizing Extension Field Days for on-site project demonstrations, publishing NebGuide and CropWatch articles, developing time lapse videos, and presenting research results in Crop Production Clinics and other extension meetings.

2. Research Objectives: (copy from project, but keep in a brief bullet format)

(1) Compare weed control, crop safety, soybean yield, and gross profit-margins of different herbicide programs in Liberty Link, Roundup Ready 2 Xtend, LibertyLink GT27, and conventional soybeans.
(2) Determine the effect of soybean production practices and herbicide programs for control of glyphosate-resistant Palmer amaranth in Roundup Ready 2 Xtend, LibertyLink GT27, and Enlist E3 soybeans.
(3) Determine critical period of weed removal in soybean affected by pre-emergence soil applied herbicide.

3. General Approach Used and (if applicable) the Nebraska Test Locations:

Objective 1:
Field experiments were conducted in 2018 and 2019 under rainfed and irrigated environments in western, west-central, south-central, eastern, and north-eastern Nebraska. The experiments were conducted at five locations (Irrigated: Clay Center, North Platte, and Scottsbluff; Rainfed: Concord and Lincoln). The experimental sites were primarily infested with common lambsquarters, kochia, pigweeds (common waterhemp and Palmer amaranth), velvetleaf, and a mixture of foxtails (giant-, green-, and yellow foxtail), and crabgrass.

Objective 2:
Three separate field experiments were conducted in Roundup Ready 2 Xtend, Enlist E3 (tolerant to Enlist DUO + Liberty) soybeans, and LibertyLink GT27 soybean in 2018 and 2019 growing seasons. All the field experiments were conducted in a field infested with glyphosate-resistant Palmer amaranth near Carleton, Thayer County, NE. The experiments were established under no-till conditions.

Objective 3:
Field experiments were conducted in 2018 and 2019 at Concord (rainfed), Clay Center (irrigated), and Scottsbluff (irrigated). Study were arranged in a split plot design with 14 treatments (2 herbicide regimes x 7 weed removal timings). The two split-plots were consisting of an area without PRE herbicide application and an area with soil applied herbicide (Zidua PRO) immediately after planting soybean.

4. Describe Deliverables & Significance Attained for Each Research Objective:

(1) Compare weed control, crop safety, soybean yield, and gross profit-margins of different herbicide programs in Liberty Link, Roundup Ready 2 Xtend, LibertyLink GT27, and conventional soybeans.

Despite widespread adoption of dicamba/glyphosate-resistant (DGR) soybean by producers in Nebraska and across the United States, economic information comparing herbicide programs with glufosinate-resistant and conventional soybean is not available. The objectives of this study were to evaluate weed control efficacy, crop safety, gross profit margin, and benefit-cost ratios of herbicide programs with multiple sites of action in DGR soybean, glufosinate-resistant, and conventional soybean. Field experiments were conducted in 2018 and 2019 at three irrigated and two rain-fed locations across Nebraska. Herbicides applied pre-emergence (PRE) that included herbicides with three sites of action provided 85-99% control of common lambsquarters, kochia, Palmer amaranth, velvetleaf, and a mixture of foxtail and Poaceae species. Pre-emergence herbicides evaluated in this study provided 72 to 96% weed biomass reduction and 61 to 79% weed density reductions compared to the nontreated control at all locations. Herbicides applied postemergence (POST; dicamba plus glyphosate, glyphosate, glufosinate, and acetochlor plus clethodim plus lactofen) provided 93-99% control of all weed species except kochia 28 days after POST (DAPOST). Herbicide programs applied POST provided 89 to 98% weed biomass reduction and 86 to 96% density reduction at 28 DAPOST. For individual site years, yield was often similar for PRE fb POST herbicide programs in HR and conventional soybean. Gross profit margins and benefit-cost ratios were higher in HR soybean than conventional soybean, although price premiums for conventional soybean can help compensate increased herbicide costs.

(2) Determine the effect of soybean production practices and herbicide programs for control of glyphosate-resistant Palmer amaranth in Roundup Ready 2 Xtend, LibertyLink GT27, and Enlist E3 soybeans.

Three separate field experiments were conducted in Roundup Ready 2 Xtend, Enlist E3 (tolerant to Enlist DUO + Liberty) soybeans, and LibertyLink GT27 soybean in 2018 and 2019 growing seasons. All the field experiments were conducted in a field infested with glyphosate-resistant Palmer amaranth near Carleton, Thayer County, NE. The experiments were established under no-till conditions. Results of this stidy

4. Describe Deliverables & Significance Attained for Each Research Objective (continued)

(3) Determine critical period of weed removal in soybean affected by pre-emergence soil applied herbicide.

Widespread and repeated use of glyphosate resulted in an increase in glyphosate-resistant (GR) weeds. This led to an urgent need for diversification of weed control programs and use of PRE herbicides with alternative sites of action. Field experiments were conducted across three locations in Nebraska to evaluate the effects of PRE-applied herbicides on critical time for weed removal (CTWR) in GR soybean. The studies were laid out in a split-plot arrangement with herbicide regime as the main plot and weed removal timing as the subplot. The herbicide regimes used were either no PRE or premix of either sulfentrazone plus imazethapyr (350 þ 70 g ai ha−1) or saflufenacil plus imazethapyr plus pyroxasulfone (26 þ 70 þ 120 g ai ha−1). The weed removal timings were at V1, V3, V6, R2, and R5 soybean stages, with weed-free and weedy season-long checks. Weeds were removed by application of glyphosate (1,400 g ae ha−1) or by hoeing. The results across all years and locations suggested that the use of PRE herbicides delayed CTWR in soybean. In particular, the CTWR without PRE herbicides was determined to be around the V1 to V2 (14 to 21 d after emergence [DAE]) growth stage, depending on the location and weed pressure. The use of PRE-applied herbicides delayed CTWR from about the V4 (28 DAE) stage up to the R5 (66 DAE) stage. These results suggest that the use of PRE herbicides in GR soybean could delay the need for POST application of glyphosate by 2 to 5 wk, thereby reducing the need for multiple applications of glyphosate during the growing season. Additionally, the use of PRE herbicides could provide additional modes of action needed to manage GR weeds in GR soybean.

5. List where the Project Research Results/Findings were Publicized:

Knezevic SZ, Pavlovic P, Osipitan OA, Barnes E, Beirermann C, Lawrence N, Scott JE, Jhala AJ (2019) Critical time for weed removal in glyphosate-resistant soybean as influenced by pre-emergence herbicides. Weed Technology 33:393-399

Shyam C, Chahal PS, Jhala AJ, Jugulam M (2020) Management of glyphosate-resistant Palmer amaranth (Amaranthus palmeri) in 2,4-D choline/glufosinate/glyphosate-resistant (Enlist E3) soybean. Weed Technology (in press)

Striegel A, Eskridge K, Lawrence NC, Knezevic SZ, Kruger GR, Proctor CA, Hein GL, Jhala AJ* (2020) Economics of herbicide programs for weed control in conventional, glufosinate, and dicamba/glyphosate-resistant soybean across five locations in Nebraska. Agronomy Journal (Under Review)

Chahal PS, Barnes E, Jhala AJ (2020) Emergence pattern of Palmer amaranth (Amaranthus palmeri) influenced by tillage and residual herbicides in South-Central Nebraska. Weed Technology (Under Review)

Sarangi D, Jhala AJ (2019) Palmer amaranth (Amaranthus palmeri) and velvetleaf (Abutilon theophrasti) control in no-tillage conventional soybean using overlapping residual herbicide programs. Weed Technology 33:95-105

Note: The above boxes will automatically accomodate for your text inputs; HOWEVER, the Final Report comprised of the above listed items must be kept to THREE PAGES. A Technical Report of no more than TEN PAGES (preferably fewer) can be appended to this report.
Submit both reports as a single PDF with this file name format: #XXX > FINAL > Project Title > PI last name

Please email this completed form to the Agriculture Research Division (jmcmahon10@unl.edu) based on the reporting schedule given to you. If you have any questions, please call Jen McMahon at the ARD at 2-7082.