Amaranthus palmeri and *A. tuberculatus* survey, confirmation, and resistance testing in Idaho and Oregon sugar beet growing regions.

SUGAR BEET RESEARCH

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Introduction

Palmer amaranth (*Amaranthus palmeri* S. Watson) and Waterhemp (*Amaranthus tuberculatus* (Moq) J.D. Sauer) are two of the most troublesome weeds in United States crop production systems - mainly due to herbicide resistance. Until recently the two were not believed to have had a presence in Pacific Northwest (PNW) cropping systems. In July 2023, both Palmer amaranth and waterhemp were confirmed in Idaho. A coordinated extension effort by Amalgamated Sugar, University of Idaho, and Oregon State University was launched to survey the main cropping areas of southern Idaho and eastern Oregon to identify the distribution of these invasive weeds.

Research Objectives

- Identify the presence and current distribution of Palmer amaranth and waterhemp in Idaho and Oregon.
- Screen Palmer amaranth and waterhemp samples for resistance to herbicides commonly used in the PNW.

Figure 1. Current know distribution map for Palmer amaranth and waterhemp in Idaho and Oregon.

Methodology

Survey. Crop consultants employed by Amalgamated Sugar were recruited to aid in locating suspect plants. Visual aids were developed and given to each consultant for proper identification of Palmer amaranth and waterhemp (Figure 2). GPS locations of suspected Palmer amaranth and waterhemp plants were then sent by the consultants to the survey team upon discovery. The survey team visited each site, confirmed the presence or absence of the invasive plant, and collected tissue and seed samples where possible.

Figure 2. Identification guides for Palmer amaranth and waterhemp.

Sample Collection and Testing. Tissue samples of various populations were collected and sent to Colorado State University for Kompetitive allele specific PCR (KASP) genotyping. Since many of the plants had survived multiple glyphosate applications, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene duplication analyses were conducted to confirm possible glyphosate resistance in Palmer amaranth and waterhemp populations.

Resistance Screening (glyphosate). Three suspected glyphosate-resistant biotypes (Res-1, Res-2, and Res-3) were grown in the greenhouse at the University of Idaho and sprayed with different doses of glyphosate (0X, 0.125X, 0.25X, 0.5X, 1X, 2X, 4X, 8X, and 16X, where 1X is the field-use rate of glyphosate (1,260 g ae ha-1)(Photo 1, Figure 4).

Resistance Screening (various). Palmer amaranth biotypes were grown in the greenhouse at University of Idaho and sprayed with different the field use rate of selected postemergence herbicides (2,4-D, dicamba, glufosinate, mesotrione, saflufenacil).

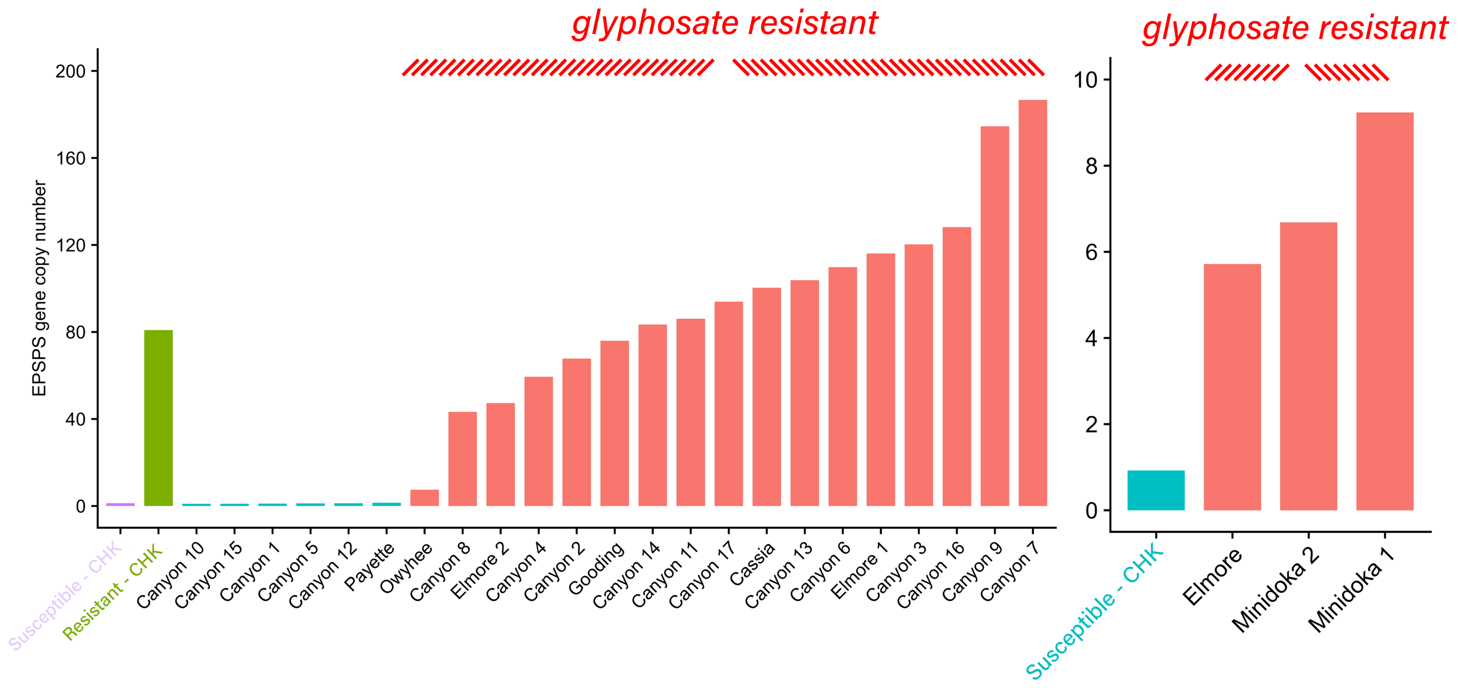

Figure 3. Glyphosate-resistance screening results for Palmer amaranth and waterhemp tissue samples collected from multiple counties in southern Idaho in 2023.

Table 1. Visible control of different Palmer amaranth biotypes (AMAPA-2 to AMAPA-10) from Idaho and Oregon compared to a known susceptible (SUS) population from Nebraska at 21 DAT of selected postemergence herbicides.

	2,4-D	dicamba	glufosinate	mesotrione	saflufenacil
Biotype		----------------------	%	----------------------	
SUS	98 a[z]	76 ab	99	92 a	99
AMAPA2	75 bc	69 abc	88	61 bc	99
AMAPA3	69 c	47 d	95	70 abc	98
AMAPA4	75 bc	58 cd	99	81 ab	99
AMAPA6	75 bc	76 ab	93	80 ab	98
AMAPA7	84 b	78 a	96	70 abc	77
AMAPA8	78 bc	63 bcd	90	86 a	99
AMAPA9	74 bc	69 abc	96	51 c	98
AMAPA10	81 b	76 ab	97	70 abc	99
P-value	*.002*	*.006*	*.24*	*.04*	*.49*

[z]Means followed by the same letter are not significantly different (P=.05, Tukey's HSD).

Photo 1. Visible control of the suspected glyphosate Palmer amaranth biotype (Res-2) at 21 DAT with various doses of glyphosate (from left to right, 0X to 16X rate of glyphosate).

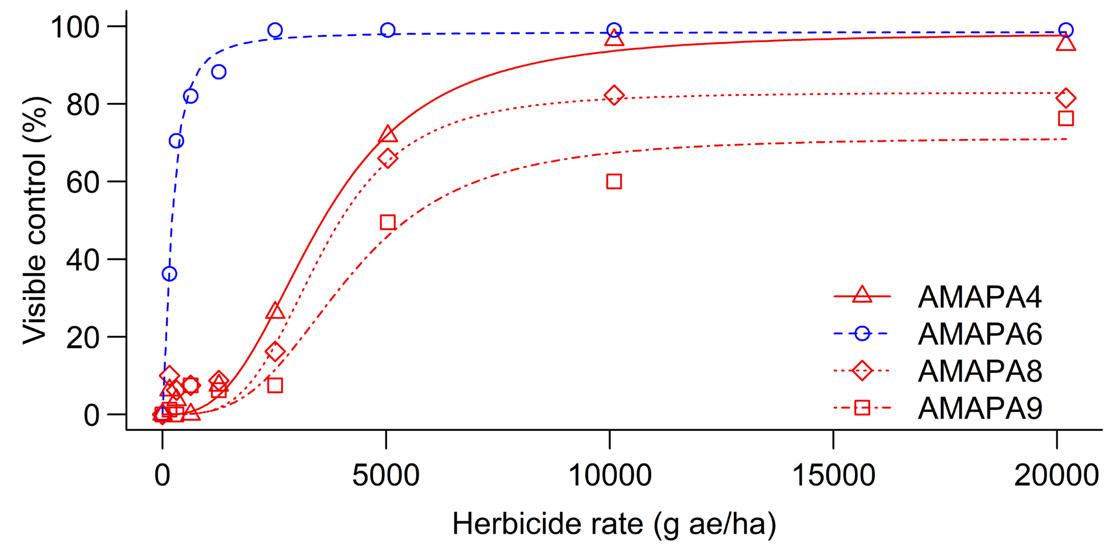

Figure 4. Glyphosate dose-response curves for glyphosate susceptible (Sus) biotype from Nebraska and suspected resistant (Res-1, Res-2, Res-3) biotypes from the PNW. The three-parameter log-logistic model was fitted on visible Palmer amaranth control at 21 DAT using the equation *Y=d*-exp(b*(log(x)-e))*, where Y is the visible control (%), d is the upper limit asymptote, X is the rate of the herbicide applied in g ae ha^{-1}, e is the value of X at the inflection point of the curve, and b is the slope of the curve at e.

Results

Approximately 119 GPS points were sent to the survey team from August 2023 to October 2024 (Figure 1). One hundred thirteen locations were confirmed to be Palmer amaranth and the remaining six were waterhemp.

Palmer amaranth populations were confirmed across 300 miles of southern Idaho roadways (Figure 1) and was also found in potatoes, corn, dry beans, sugar beet, small grains, alfalfa, watermelons, and along railways. Waterhemp populations were found primarily in sugar beet.

- 23 of 33 (~70%) Palmer amaranth and all waterhemp samples showed gene amplification indicative of glyphosate resistance (Figure 3).
- Some Palmer amaranth biotypes collected showed reduced sensitivity to 2, 4-D, dicamba, and mesotrione (Table 1).
- Preliminary greenhouse screenings suggest ALS resistance in Palmer amaranth populations in Idaho (data not shown).
- Preliminary greenhouse screenings suggest 75% of waterhemp samples in Idaho showed resistance to both glyphosate and ALS herbicides (data not shown).
- Survey results are being shared with the Pacific Northwest Herbicide Resistance Initiative.

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