Alternatives to Glyphosate Herbicides for Monarch Butterfly Recovery in North America

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INTRODUCTION

Glyphosate is a non-selective, translocated herbicide and crop desiccant that interrupts a metabolic pathway necessary for plant growth (Neal& Senesac, 2018). Following the introduction of glyphosate-tolerant soybeans in 1996 and glyphosate-tolerant corn in 1998, glyphosate use in these agricultural fields increased to 47. 8 million kg and 28.5 million kg per year, respectively (Pleasants& Oberhauser, 2012).

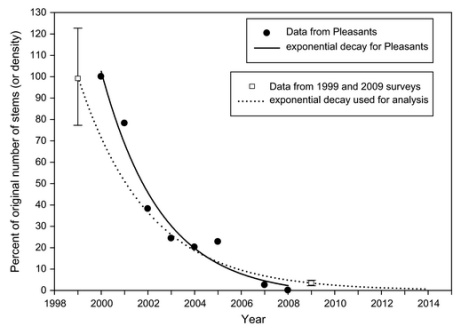

Figure 1: Milkweed populations following the introduction of glyphosate in the Midwest (Pleasants& Oberhauser, 2012).

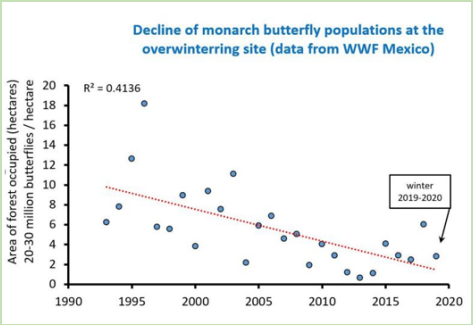

Figure 2: Monarch butterfly populations from 1993-2020 (Agrawal, 2020).

MOTIVATION

Populations of milkweed, a perennial flowering plant and singular food source of monarch butterfly larvae, have suffered an exponential decline from 1999-2014 in the Midwest, where 80% of corn and soybeans are grown (Pleasants& Oberhauser, 2012). This resulted in a correlative monarch population decline of 80% within the same time period (Agrawal, 2020).

The Midwest accounts for a large portion of the monarch's annual migration territory (Figure 3). Additionally, milkweed in corn and soybean fields typically have 3.9 more monarch eggs per stem, thus linking the heavy glyphosate usage and subsequent milkweed decrease to the drastic decline in monarch populations since 1995 (Pleasants, 2016).

OBJECTIVE

The objective of this study is to determine if alternatives to glyphosate herbicides would effectively control weed growth in Midwestern agricultural fields while allowing for the survival of milkweed for monarch conservation efforts.

HYPOTHESIS

We hypothesize that a decrease in glyphosate use in favor of alternative herbicides such as post-emergence contact herbicides or manual tactics such as tilling will result in an increase in milkweed density, thus indicating a negative correlation.

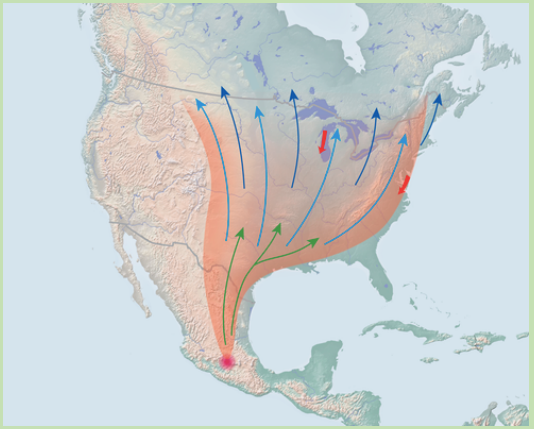

Figure 3: Territory of annual monarch migration (Agrawal, 2020).

METHODS

Study Design

In a manipulated field experiment, eight Midwestern soybean fields will be chosen at random and treated with different means of weed control. The first two fields will serve as a control and will not be treated with any type of weed preventative. The second two fields will be treated post-emergently with the non-glyphosate herbicide glufosinate, a locally-systemic contact herbicide with no root uptake potential to avoid dispersal (Neal& Senesac, 2018). The third two fields will be treated post-emergently with a natural acetic acid-based herbicide, and the last two fields will be treated with manual tilling. The independent/predictor variable in this experiment is the method of weed control, and the dependent/response variable is the amount of surviving milkweed. Quantitative data on the amount of milkweed present after the maturation period will be collected.

Intended Analysis

Due to the multiple categorical predictor variable and continuous response variable, an ANOVA test will be run based on milkweed presence to determine statistical significance. The inferences of this experiment can be applied to other Midwestern soybean fields due to random selection and randomization of treatment.

EXPECTED BENEFITS

The 2021 Monarch Conservation Implementation Plan has set a goal of 6 hectares of land occupied by monarchs in their overwintering site in Mexico. This would require the addition of 1.3 billion milkweed stems (Conservation Implementation Plan, n.d.). Figure 4 illustrates the positive effect of milkweed increase on monarch populations.

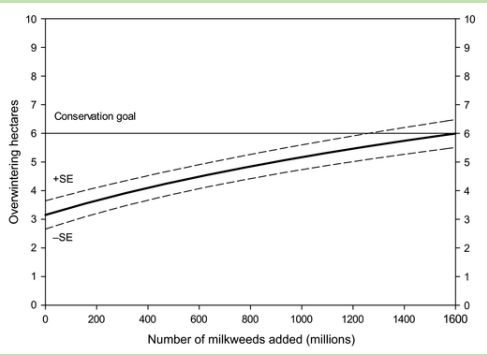

Figure 4: Expected size of overwintering monarch population with milkweed increase (Pleasants, 2016).

References

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