Effects of Pesticides and Tillage on Weed Seedling Emergence over a Growing Season

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Introduction

Seed coatings of insecticides and fungicides—pesticide seed treatments (PST)—are commonly used in crops including maize (*Zea mays* L.) and soybean (*Glycine max* (L) Merr.). PST have been demonstrated to cause both target and non-target impacts on soil food webs; however little is known about how PST may affect the natural enemies of weeds and weed population dynamics. Little, too, is known about how the effects of PST may vary with tillage. In no-till systems where PST are used, we have observed reductions in weed seedbank diversity, the diversity of the soil fungal community that colonizes weed seed coats, ground beetle activity-densities, and weed seed predation rates. We hypothesize that these effects of PST on weed seed banks and their natural enemies may be capable of driving changes in weed abundance.

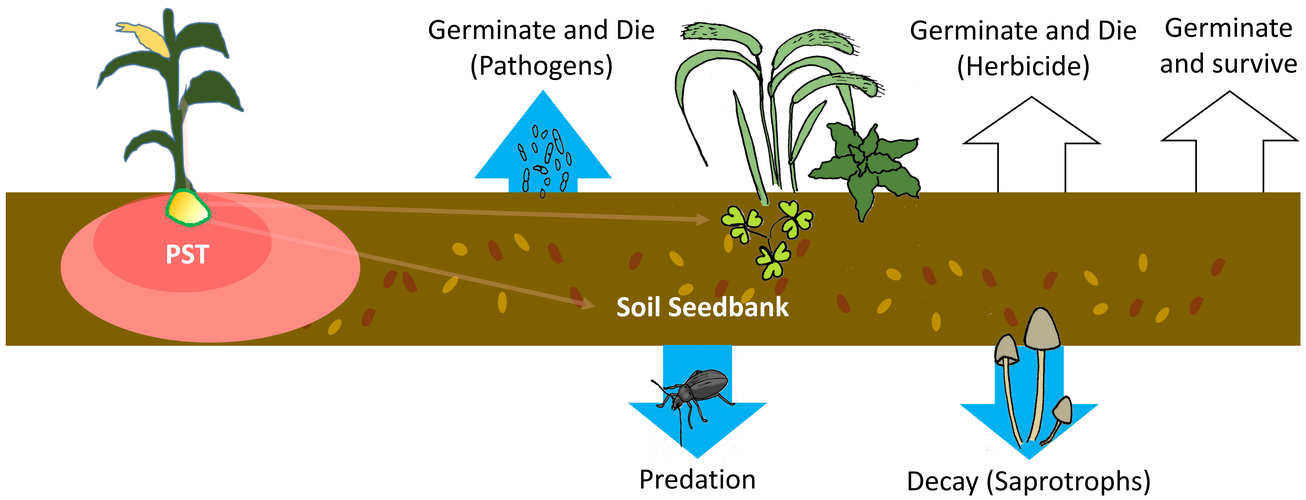

Figure 1. Are weed seed fates altered by pesticide seed treatments?
There are multiple pathways (represented by arrows) by which weed seeds are lost from the soil seedbank. Soil-borne pathogens and saprotrophs, weed seed predators, and other soil-dwelling natural enemies can damage or destroy weed seeds, leading to a reduction in viable weed seeds in the soil. PST components are mobile and can directly or indirectly alter the populations of these natural enemies. These pathways may also be affected by tillage. If PST and tillage alter the efficacy of these pathways, we should expect to see changes in the number of weed seedlings that emerge from the soil seed bank.

Methods

- We conducted a 4-year field experiment from 2016 to 2019 at the UNH Kingman Research Farm in Madbury, NH to evaluate the effects of PST and tillage on weeds and their natural enemies.
- Treatments were maize and soybean (in rotation) grown with PST (PST) and without PST (No-PST) under three tillage systems (full-till, strip-till, and no-till). The experimental design is a RCBD and all treatments are replicated 4 times. Plots are 6m x 26m.
- We quantified weed seedling emergence weekly throughout the 2019 growing season (May through September) in two permanent quadrats established in each plot.
- Seedling density data were summed across relevant agronomic periods (here we show only the period from the final glyphosate application through September) and analyzed with mixed factor ANOVA.

Results

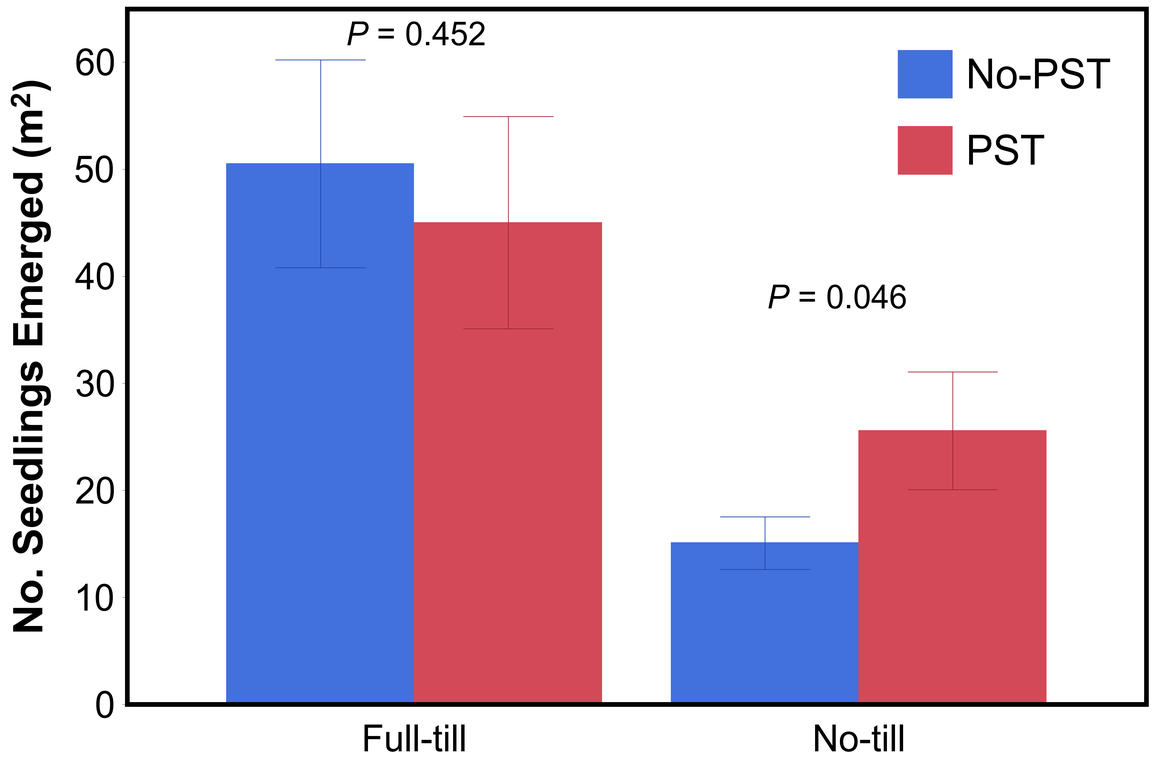

Figure 2. Weekly weed seedling emergence after last glyphosate application
We detected an interaction between PST and tillage (ANOVA, PST*Tillage interaction: P = 0.029). Analysis of each tillage system separately indicated that fewer total weed seedlings emerged over the growing season after the final glyphosate application in the no-till system without PST compared to the no-till system with PST. We did not detect an effect of PST in the full-till system. Data are means ± SE, n = 4.

Conclusions and Future Research

- Results from this study suggest PST use has the potential to affect the density of weed seedlings that emerge from the soil seed bank and that tillage may alter this effect.
- Reductions in critical ecosystem services, such as biological weed control, provided by soil food web communities could translate to increased reliance on physical and chemical weed control.
- Research is currently underway to determine the mechanism(s) by which PST alters weed seed bank and emergent weed population and community dynamics.

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