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Herbicide Effects on the Feeding Behavior of the Wolf Spider Pardosa milvina

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Abstract

Herbicides can potentially impact feeding behavior of beneficial predators in agricultural systems and subsequently compromise integrated pest management efficacy. We measured variation in feeding behaviors of an agriculturally abundant wolf spider, *Pardosa milvina*, when exposed to soil with field-relevant concentrations of five commonly used herbicides. Tested herbicides included atrazine, S-metolachlor, rimsulfuron, mesotrione, glyphosate, a mixture of all five herbicides, and a distilled water control. Spiders were housed individually in containers with topsoil previously sprayed with a recommended herbicide dosage or water control. Tested spiders were collected from two adjacent fields: one kept under continuous crop rotation for over twenty years and sprayed with various combinations of all these herbicides while the other was an alfalfa field with no pesticides applied for the last 12 years. Adult males and females from each plot were exposed to the seven treated soil substrates (N=1,214, n=43). Spiders were maintained on these treated substrates for 14 days and fed crickets (*Gryllodes sigillatus*). Their predatory behaviors toward an individual cricket were observed on untreated substrates. Individual spiders from each herbicide treatment were standardized for hunger then presented a cricket one week and two weeks after initial treatment exposure. We found no significant differences in prey capture latency for spiders across herbicide treatments during the first week of exposure, but large differences emerged by the second week. We also found large sex and collecting site differences in prey capture efficiency and weight change across treatments. Mesotrione and rimsulfuron-treated spiders showed the greatest weight loss between the first and second week of exposure while atrazine, glyphosate and s-metalachlor treated spiders gained more weight than the control group. Our results show that some herbicides can significantly reduce or increase feeding responses in this important agriculturally abundant predator and should be considered in integrated pest management decisions.

Introduction

- Both the quantity and diversity of herbicides used in commercial crops has increased over the decades as farmers turn to no-till and genetically-modified glyphosate-resistant crop systems. Although such shifts have reduced sediment loads into our aquatic systems, it has resulted in increases in herbicide-resistant crop weeds, increases in pesticide-laden run-off and possible unintended effects on beneficial non-target species.
- Spiders are among the most common non-target taxa and natural pest predators in agricultural systems. As a community, these predators contribute an essential role in pest reduction and population control (Symondson et al. 2002), but the effects of herbicides on this important group has been poorly documented (Pekár 2012). It also remains unclear if chronic exposure to herbicides has resulted in herbicide-resistant spiders or spiders with compromised health that leads to sub-lethal effects such as impaired prey capture.
- The wolf spider *Pardosa milvina* is among the most common ground predators in agricultural systems throughout the United States (Marshall et al. 2002). The genus *Pardosa* is the second largest genus of spiders comprising over 550 species and are found at high densities within agricultural systems on six continents.
- We tested the effects of five different commonly used herbicides (atrazine, S-metolachlor, rimsulfuron, mesotrione, and glyphosate) as well as a combination of all herbicides on spider prey capture behavior and weight changes after two weeks of exposure. We also compared spiders from a “no herbicide” field that had not been sprayed for 12 years to spiders collected that from a conventionally maintained field that had been sprayed annually with some combination of these herbicides over the last twenty years.

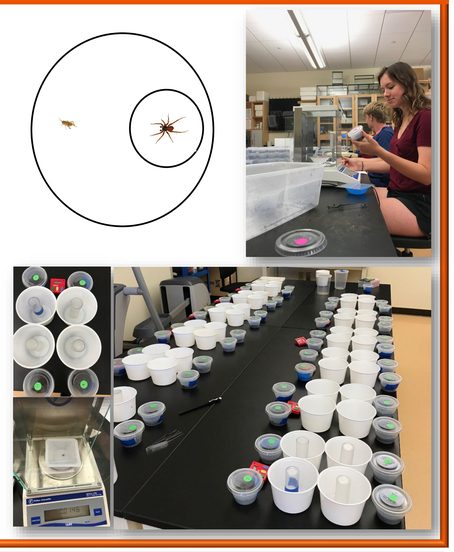
Questions

- **Does herbicide exposure affect prey capture behavior and weight of *Pardosa milvina*?**
- **Are spiders from fields historically sprayed with herbicides different in their prey capture responses compared to spiders from non-sprayed fields?**
- **Are male and female spider feeding behaviors differentially affected by herbicides?**

Methods

Feeding Trials

- A single *Pardosa milvina* spider was placed in a clean empty 473 ml deli dish underneath a clear plastic vial. The container also had one 2nd instar cricket (*Gryllodes sigillatus)*.
- After a short acclimation period, the vial was lifted and the time required to capture the cricket was recorded over a 20 minutes period.
- After the spider had captured the cricket or the trial time expired, the spider was fed 6 – 8 additional 2 instar crickets.
- All spiders were weighed prior to the start of the experiment, at one week and two weeks after herbicide treatment exposure. Hunger was standardized for all spiders.



Summary and Conclusions

- **Herbicide treatment, collecting site and sex all strongly affected prey capture behavior after two weeks (Fig. 1, Table 1)**
  - Mesotrione and rimsulfuron significantly impaired prey capture compared to the control while atrazine, glyphosate, and S-metalochlor improved it.
  - Females showed shorter capture latency than males but sexes didn’t vary by herbicide treatment
  - Spiders from the no herbicide field had significantly shorter prey capture latencies on average than the site with a history of herbicide spraying.
- **Herbicides significantly influenced weight changes in spiders. This effect varied by sex but not collecting site (Fig. 2, Table 2)**
  - Weight was significantly different across herbicide treatments after two weeks, but not one.
  - Females gained weight in the atrazine, glyphosate, and S-metalochlor treatments but this same effect was not found in males.
  - Rimsulfuron and mesotrione led to weight loss for both males and females.

Different commonly used herbicides have antagonistic effects on spider feeding behavior and weight. The mechanism for this is completely unknown but it is possible that some herbicides such as atrazine, glyphosate, and S-metachlor serve as stimulants while others such as mesotrione and rimsulfuron are depressants or otherwise toxic. Our results suggest that the choice and combination of herbicides can have dramatic effects on feeding behaviors for common ground spiders.

References

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Arach-knowledgements

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Results

Prey capture Latency

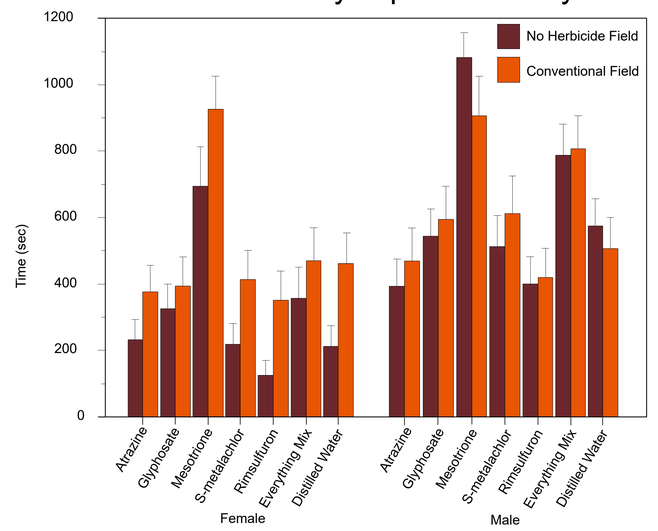

Figure 1. The average time (sec) to capture a cricket across each herbicide, site, and sex after 2 weeks herbicide exposure. (N = 1214, n = 43)

Treatment	F	P-value
Herbicide	15.21	0.0001*
Sex	42.5	0.0001*
Collection Site	7.18	0.0075*
Herbicide*Sex	0.85	0.5322
Herbicide*Site	0.205	0.9752
Sex*Site	6.643	0.0101*
Herbicide*Site*Sex	0.605	0.7261

Table 1. Three-way ANOVA for the main effects and interactions between herbicide treatment, collecting site, and sex of the spider on prey capture latency after two-weeks of exposure.

Change in spider weight between one week and two weeks of herbicide treatment exposure

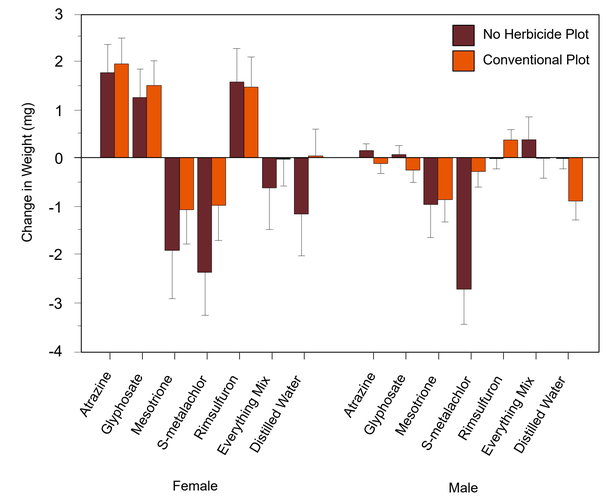

Figure 2: The average changes in weight (mg) between week one and week two of herbicide exposure across each herbicide, site, and sex factor (N = 1214, n = 43)

Treatment	F	P-value
Herbicide	11.06	0.0001*
Sex	3.59	0.0585
Collection Site	2.61	0.106
Herbicide*Sex	2.76	0.016*
Herbicide*Site	1.434	0.199
Sex*Site	1	0.315
Herbicide*Site*Sex	0.803	0.568

Table 2. Three-way ANOVA for the main effects and interactions between herbicide treatment, collecting site, and sex of the spider on weight changes between one and two weeks of exposure to each herbicide treatment