Effect of Cereal Rye Cover Crop Biomass on Waterhemp Emergence and Soil Abiotic Parameters

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INTRODUCTION

- Various studies have evaluated waterhemp (*Amaranthus tuberculatus* [Moq.]) Sauer) suppression from cereal rye (*Secale cereale* L.) cover crop (CC) as part of weed management programs (Bish et al. 2021). Nevertheless, a limited number of experiments have investigated the effects of CC biomass on soil abiotic parameters (soil temperature, moisture, and light incidence) which can greatly influence waterhemp germination and emergence.

OBJECTIVE AND HYPOTHESIS

- **Objective:** Elucidate the effect of CC biomass on waterhemp emergence and soil abiotic parameters (temperature, moisture, and light incidence).
- **Hypothesis:** The increase in CC biomass can delay waterhemp emergence and reduce soil temperature and light incidence but raise soil moisture.

MATERIALS AND METHODS

Establishment

- Dose-response field study (RCBD) with 4 replications conducted at two locations (Janesville & Brooklyn, WI) in 2022 (establishment May 30 and 31, respectively). Plots size: 0.91 by 2.13 m.
- CC biomass was harvested (at anthesis) and dried to constant weight at 60°C to meet the following doses of dry biomass: 0.0, 0.6, 1.2, 2.5, 4.9, 7.4, 9.9, and 12.4 Mg ha^{-1}. Biomass was evenly distributed over the plots.

Data collection and analyses:

- **Light incidence (µmol m^{-2} s^{-1})** was measured at the soil surface (underneath CC biomass) at 0 DAE (days after establishment) with a manual LightScout Quantum Meter.
- **Waterhemp cumulative emergence (%)** was estimated by weekly counting and pulling all emerged seedlings from 7 to 70 DAE on a 0.1 m^{-2} quadrat demarked within each plot.
- **Soil volumetric water content (m^3 m^{-3} [0-7.6 cm soil depth])** was measured weekly from 7 to 70 DAE with a handheld time domain reflectometry FieldScout TDR 300 Meter.
- **Soil temperature (°C [7.6 cm soil depth])** was monitored under the doses of 0, 4.9, and 12.4 Mg ha^{-1} of CC biomass from 0 to 70 DAE with a Watchdog 1650 Micro Station.
- Data from the two locations were pooled.
- Non-linear regression models (*drc* package) were fit to light incidence and cumulative waterhemp emergence and a linear regression model to soil volumetric water content using R software (version 4.2.1).

RESULTS AND DISCUSSION

- CC biomass significantly delayed and reduced waterhemp emergence over time (Figure 1).
- Increase in CC biomass doses provided higher light interception and soil moisture (Figures 2 & 4). Moreover, there was lower temperature amplitude in the soil under the levels of 4.9 and 12.4 Mg ha^{-1} of biomass compared to the absence of CC (Figure 3).
- The interception of light (Figure 2) and lower temperature amplitude (Figure 3) are likely two important mechanisms of weed suppression by CC, given the importance of light and temperature for waterhemp emergence and development (Leon et al. 2004; Steckel et al. 2003). However, the increase in soil moisture under low cover crop biomass during dry weather spells can stimulate waterhemp emergence, as previously reported (Teasdale & Mohler, 2000).

CONCLUSIONS AND FUTURE DIRECTIONS

- CC biomass presented a strong effect on soil abiotic parameters which can help better understand waterhemp suppression mechanisms behind CC given its biology.
- The study will be replicated in 2023.
- Future studies to investigate the long-term effect of the CC biomass on weed seed fate in the soil in addition to validating the current findings with large-seeded broadleaf weed species.

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Bish et al. 2021. Effects of cereal rye seeding rate on waterhemp (*Amaranthus tuberculatus*) emergence and soybean growth and yield. Weed Technology, 35(5), 838-844.
Leon et al. 2004. Effect of temperature on the germination of common waterhemp (*Amaranthus tuberculatus*), giant foxtail (*Setaria faberi*), and velvetleaf (*Abutilon theophrasti*). Weed Science, 52(1), 67-73.
Steckel et al. 2003. Effects of Shading on Common Waterhemp (*Amaranthus rudis*) Growth and Development. Weed Science, 51(6), 898-903.
Teasdale & Mohler 2000. The Quantitative Relationship between Weed Emergence and the Physical Properties of Mulches. Weed Science, 48(3), 385–392.

Acknowledgments: We would like to thank the members of the UW-Madison Cropping Systems Weed Science for their technical assistance with study establishment and data collection.

WATERHEMP EMERGENCE

CC biomass > 2.5 Mg ha^{-1} delayed waterhemp emergence

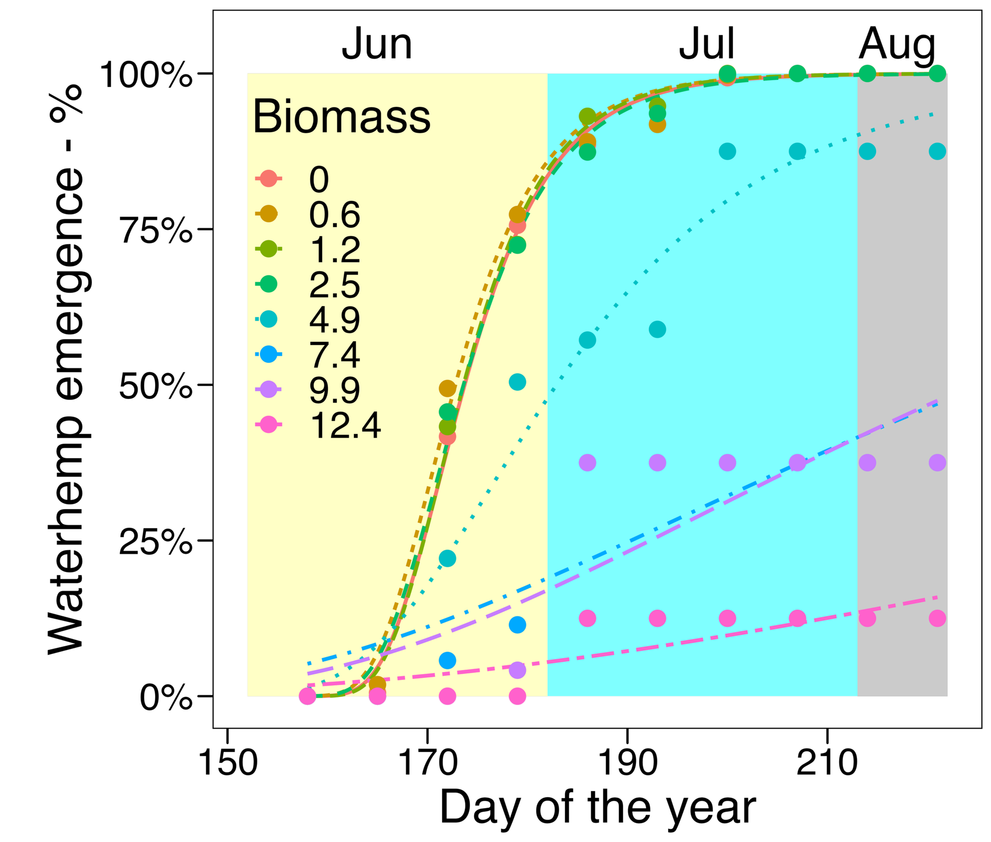

Figure 1: Waterhemp cumulative emergence over time.

LIGHT INTERCEPTION

0.7 Mg ha^{-1} intercepted 50% of the light reaching the soil level

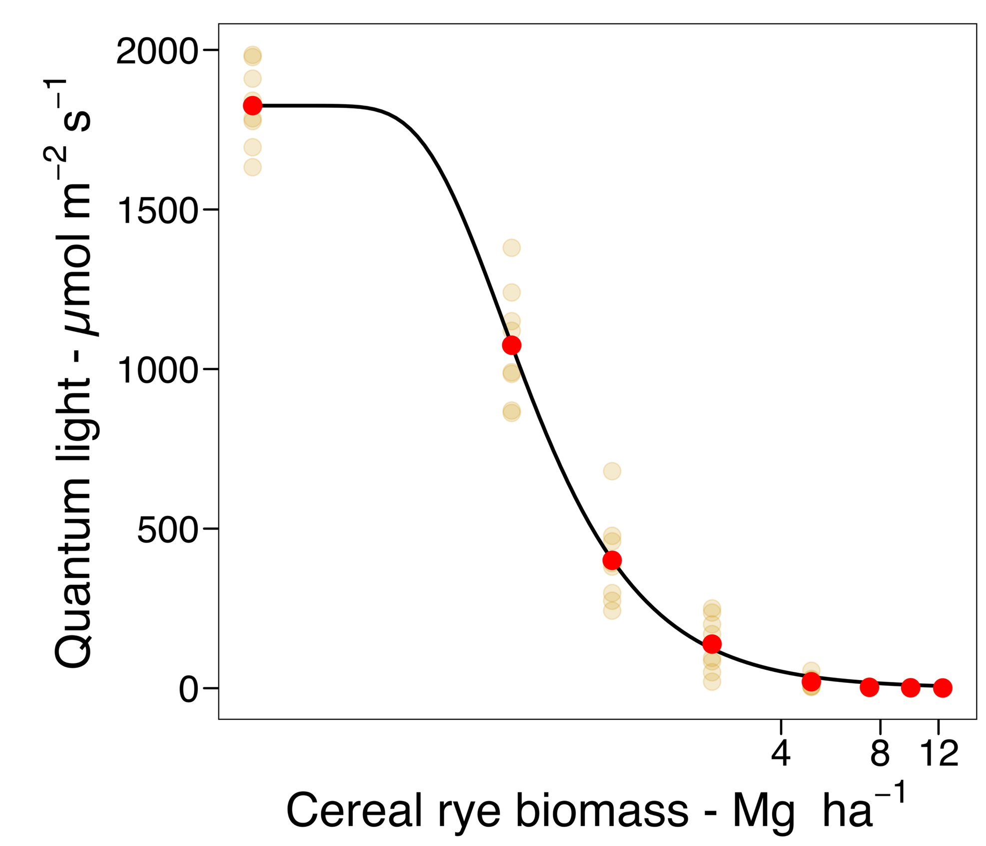

Figure 2: Quantum light at soil level in response to CC biomass at study establishment (0 DAE).

SOIL TEMPERATURE

Soil under CC biomass had lower temperature amplitude

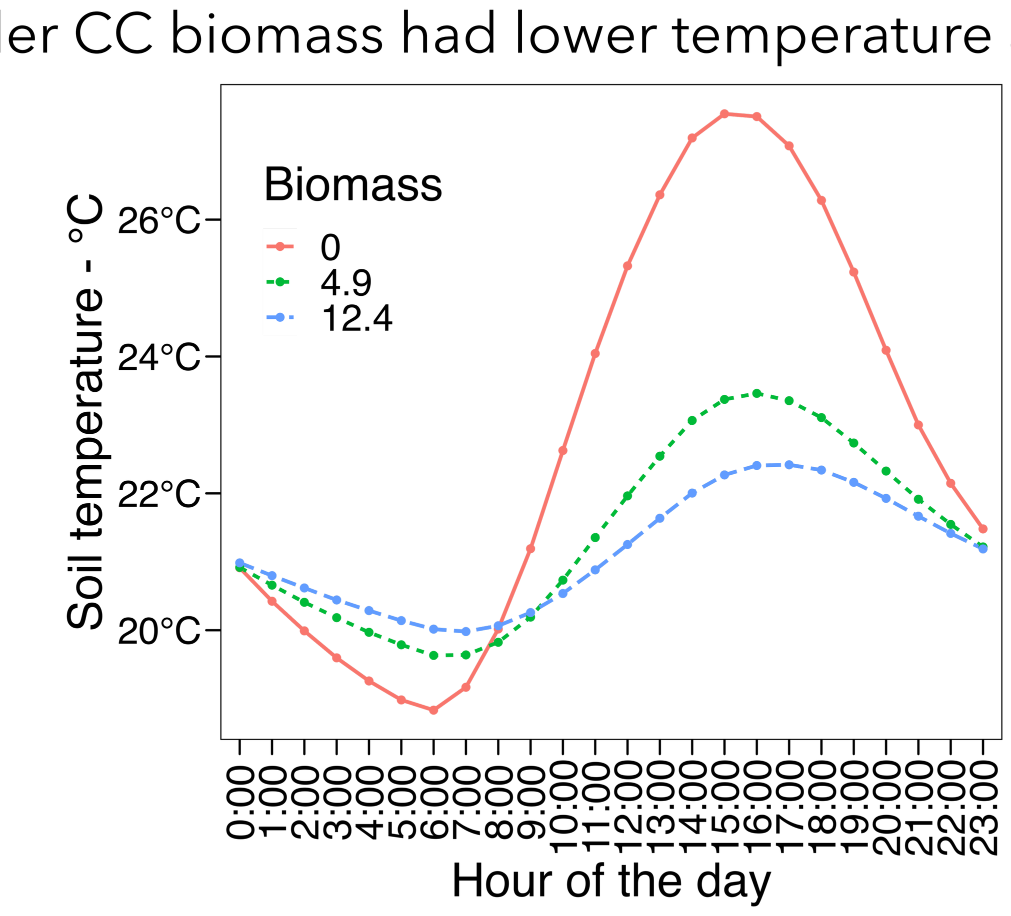

Figure 3: Average (0-70 DAE) hourly soil (0-7.6 cm depth) temperature under 0, 4.9, and 12.4 Mg ha^{-1} of CC biomass.

SOIL MOISTURE

The increase in CC biomass raised soil moisture

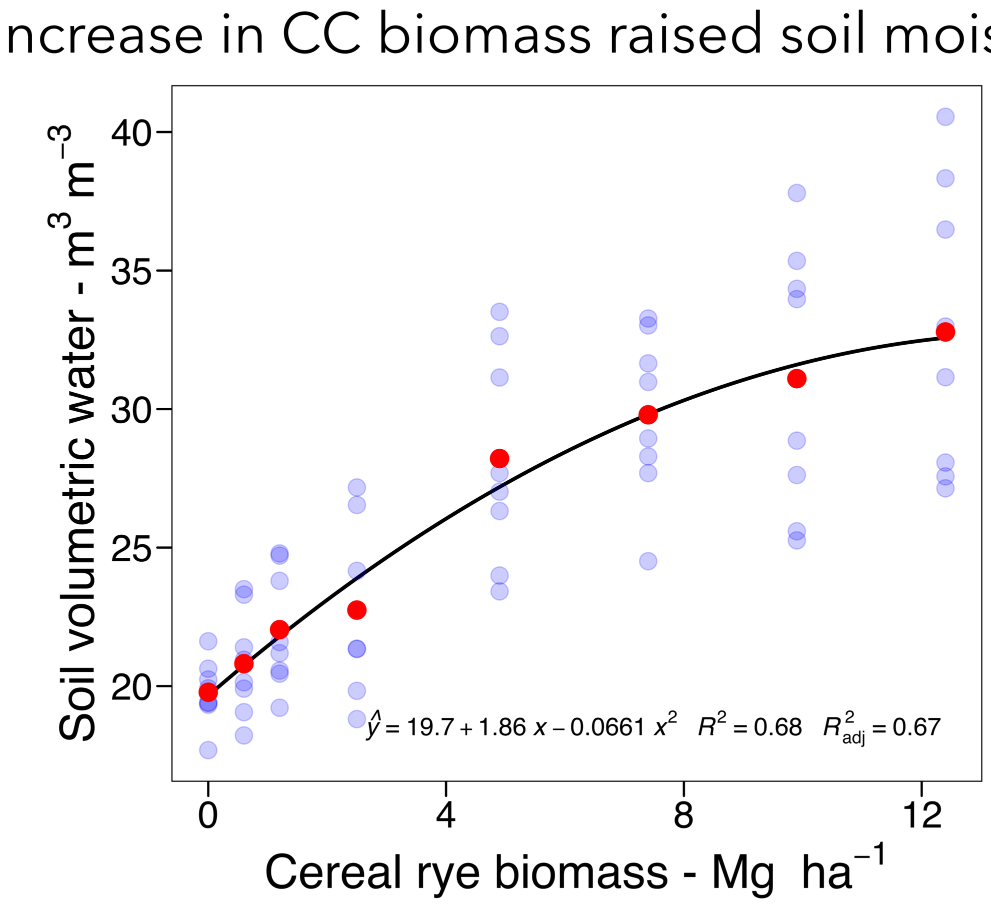

Figure 4: Average (7-70 DAE) soil volumetric water content (0-7.6 cm depth) in response to CC biomass.