Predicting Prairie Weed Community Emergence During Drought: A 1930's Dust Bowl Case Study

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Introduction

- **Drought** is a reoccurring, significant threat to Prairie field crop production.
- Changes in **extreme weather** such as heat and drought are thought to be more frequent and intense with the **changing climate** (Bush and Lemmen 2019).
- The **Dry Belt** within the **Palliser Triangle** is the most arid portion of land within the Triangle, which receives less than 350 mm of precipitation per year (Marchildon et al. 2009).

Methodology

- A literature review was conducted to identify relevant emergence models for the **Saskatchewan weed community** using a recent survey (Leeson et al. 2016).
- Weather data was collected from Environment Canada at Swift Current for 1930 during the **"Dust Bowl" drought**. Swift Current sits on the eastern edge of the Dry Belt within the Palliser Triangle (Marchildon et al. 2009).
- Rainfall data was used to simulate soil moisture using the **Soil Temperature and Moisture Model** developed through the USDA-ARS by Spokas and Forcella (2009).
- A loam soil type was selected, an arid climate, and the snow melt option enabled.
- Growing degree-day and hydrothermal models were compared to evaluate drought on **simulated weed emergence**.

Results

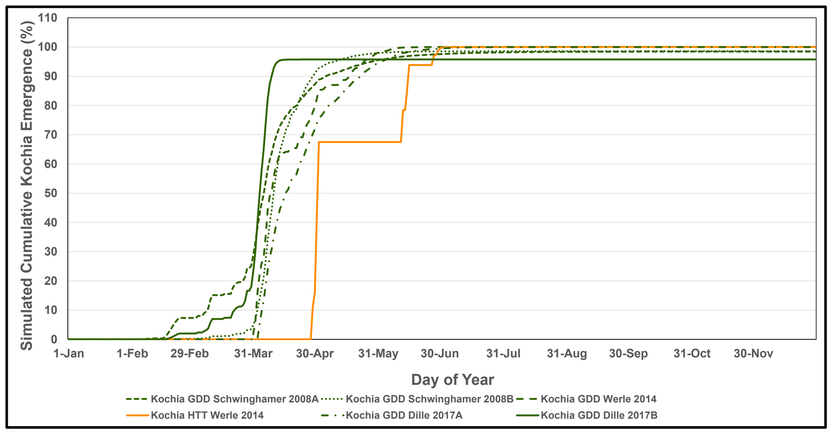

Figure 1. Simulated seedling emergence of kochia (*Bassia scoparia*) during the 1930s "Dust Bowl" in Swift Current, SK. Models derived from previous research.

Results

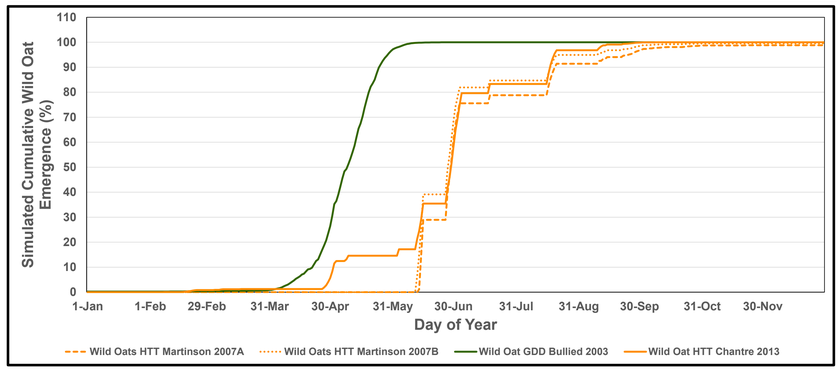

Figure 2. Simulated seedling emergence of wild oat (*Avena fatua*) during the 1930s "Dust Bowl" in Swift Current, SK. Models derived from previous research.

- Species with both growing degree-day and hydro-thermal models available in the literature was limited.
- A total of **82 models** were found in the literature for relevant weed species.
- Only **19 models** using hydro-thermal functions were found for water-limiting considerations.
- **Kochia** is drought tolerant and was the least effected by drought, with a simulated emergence shift of 24 days (Figure 1).
- Simulated **wild oat** 50% emergence shifted 50 days (Figure 2).
- Simulated **false cleavers** emergence was the most effected across available species models, with a shift in 240 days to reach 20% emergence (Figure 3).
  - Drought followed by late-season moisture may lead to increased false cleaver plants to emerge late and potentially *overwinter*, but more study is required.
- Simulated volunteer wheat 50% emergence, which represents a widely used Prairie field crop, was delayed 118 days (Figure 4).

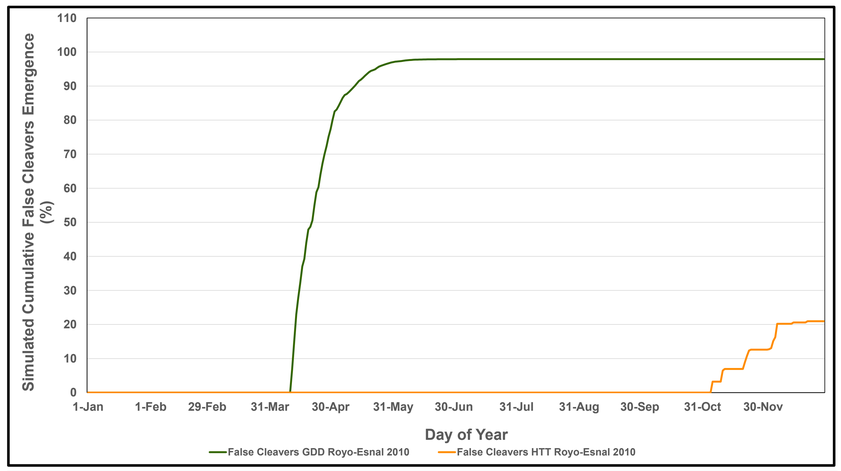

Figure 3. Simulated seedling emergence of false cleavers (*Galium spurium*) during the 1930s "Dust Bowl" in Swift Current, SK. Models derived from previous research.

Results

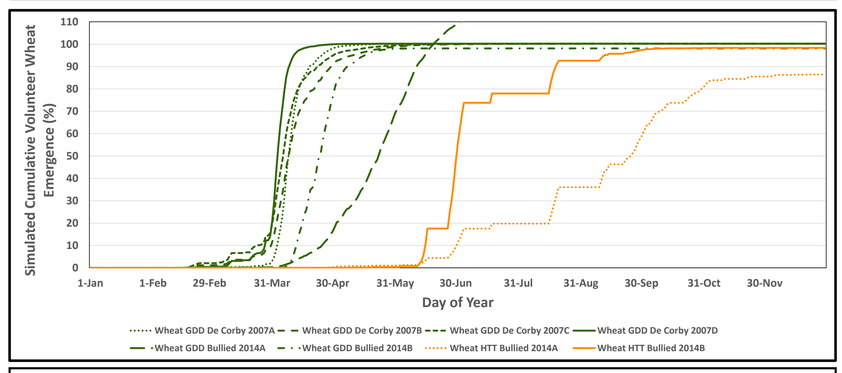

Figure 4. Simulated cumulative emergence of volunteer wheat (*Triticum aestivum*) during the 1930s dust bowl in Swift Current, SK. Models derived from previous research.

Conclusion

- Limited moisture during the 1930 dust bowl event simulated **delayed emergence** for all four weed species considered with both growing degree-day and hydro-thermal time models.
- Delayed emergence was typically "**step-like**", a consequence of moisture limitation followed by rainfall events using hydro-thermal functions.
- Later emerging weeds may affect herbicide spray timings, but this will be species dependent. Uncontrolled weeds may survive and reproduce, replenishing the seedbank and **increasing herbicide resistance risk**.
- There are significant gaps in the literature for agriculturally-relevant weed species models parameterized on the Canadian prairies, particularly for hydro-thermal models for use in moisture-limiting conditions.

References

Bullied, W. J., Bullock, P. R., Flerchinger, G. N., & Van Acker, R. C. (2014). Process-based modeling of temperature and water profiles in the seedling recruitment zone: Part II. Seedling emergence timing. Agric For Meteorol 188:104-120.

Bullied, W. John, Anastasia M. Marginet, Van Acker RC (2003) Conventional-and conservation-tillage systems influence emergence periodicity of annual weed species in canola. Weed Sci 51:886-897.

Bush E and Lemmen DS, editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p

Chantre, GR, Blanco AM, Forcella F, Van Acker RC, Sabbatini MR, González-Andújar JL (2014). A comparative study between non-linear regression and artificial neural network approaches for modelling wild oat (*Avena fatua*) field emergence. J Agri Sci 152:254-262

De Corby K, Van Acker R, Brûlé-Babel A, Friesen L (2007). Emergence timing and recruitment of volunteer spring wheat. Weed Sci 55: 60-69

Dille JA, Stahlman PW, Du J, Geier PW, Riffel JD, Currie RS, Wilson RG, Sbatella GM, Westra P, Kniss AR, Moechnig MJ (2017) Kochia (*Kochia scoparia*) emergence profiles and seed persistence across the central Great Plains. Weed Sci 65:614-25

Leeson JY 2016. Saskatchewan weed survey of cereal, oilseed and pulse crops in 2014 and 2015. Weed survey series. Agriculture and Agri-Food Canada, Saskatoon Research Centre. p. 356.

Marchildon, GP, Pittman J, Sauchyn DJ (2009) "The Dry Belt and changing aridity in the Palliser Triangle, 1895-2000." Prairie Forum. Vol. 34. No. 1.

Martinson K, Durgan, B, Forcella F, Wiersma J, Spokas K, Archer D (2007) An emergence model for wild oat (*Avena fatua*). Weed Sci 55:584-591.

Royo-Esnal A, Torra J, Conesa JA, Forcella F, Recasens J (2010) Modeling the emergence of three arable bedstraw (*Galium*) species. Weed Sci 58:10-15

Schwinghamer TD, Van Acker RC (2008) Emergence timing and persistence of kochia (*Kochia scoparia*). Weed Sci 56:37-41

Spokas K, Forcella F. 2009. Software tools for weed seed germination modeling. Weed Sci. 57:216–227

Werle R, Sandell LE, Buhler DD, Hartzler, RG, Lindquist JL (2014) Predicting emergence of 23 summer annual weed species. Weed Sci 62:267-279

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