Stimulating Germination and Emergence of Wild Oat, Volunteer Oat, Barley and Wheat

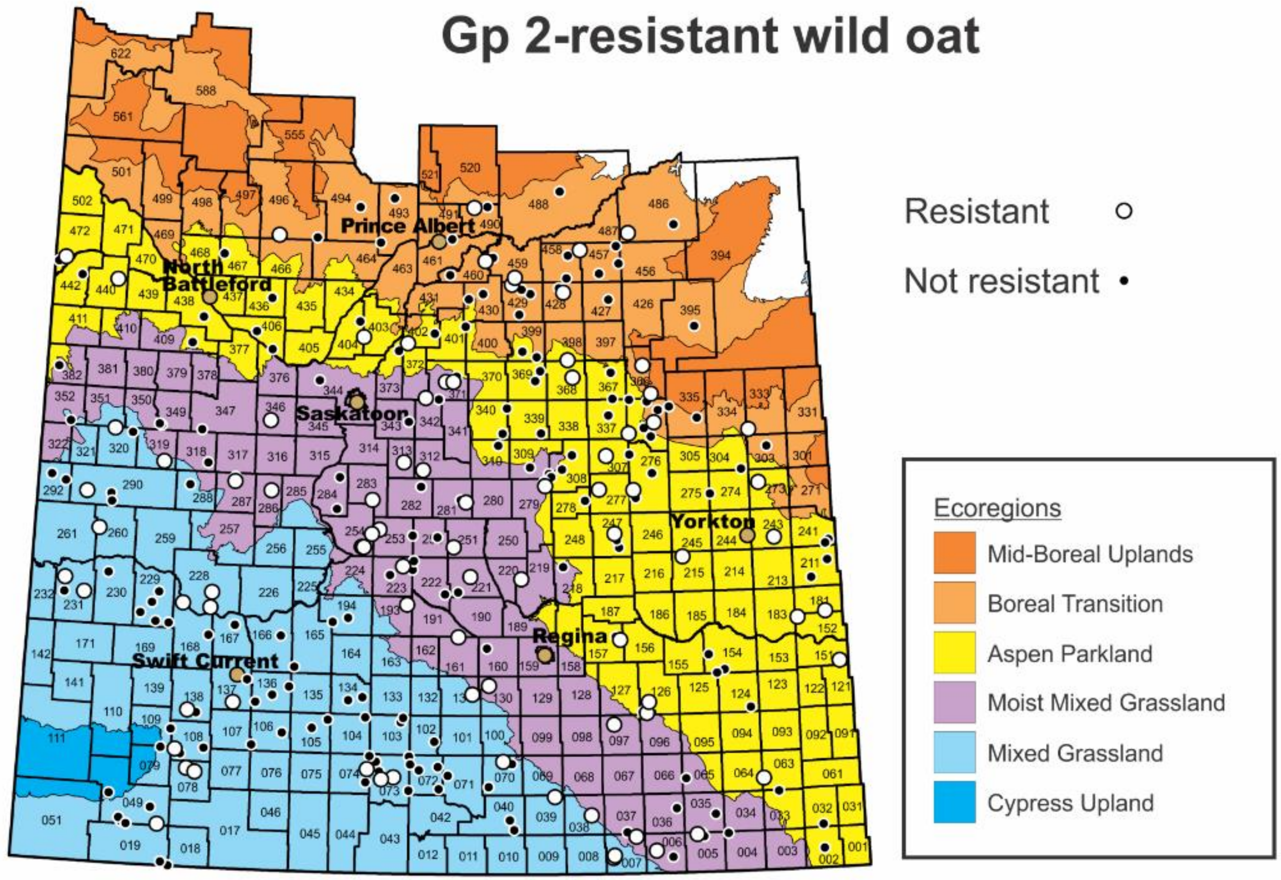
Shaun M. Sharpe[1], Taylor Kaye[1], and Breanne D. Tidemann[2]

[1]Saskatoon RDC, Agriculture and Agri-Food Canada
[2]Lacombe RDC, Agriculture and Agri-Food Canada

Wild Oat (*Avena fatua*) – Herbicide Resistance

Herbicide resistant populations:

- **69% of wild oat populations in Alberta (Beckie et al. 2019)**
- **80% for Manitoba (Beckie et al. 2018)**
- **65% for Saskatchewan (Beckie et al. 2017)**
- **Herbicide resistance for Groups 1, 2, 14, 8/15, and metabolic**



From Beckie et al. 2017

Wild Oat – Problematic Biology

Widespread threat to annual crop production

- **Complex seed dormancy**
- **Persistent seedbank**
- **Long emergence window**
- **Flushes after in-crop herbicides**
- **Seed shatter during harvest**
- **Herbicide resistance (Groups 1, 2, 14, 8/15, metabolic)**

Seed Dormancy in Wild Oat

- **After-ripening – induced after seed formation.**
- **Controlled by 3 genes (Jana et al. 1979)**
- **Large differences between populations (Naylor and Jana 1976).**
- **Maternal environment impacts seed dormancy, for example, water stress (Sawhney and Naylor 1982).**

Photo credits: Jennifer Neudort, CFIA

Seedbank Stimulation

Seedbanks persist for 4 to 5 years on average, up to 7 to 9 years maximum (Van Acker 2009)

Seedbank was identified as a critical part of the wild oat lifecycle to target (Tidemann et al. 2014).

Previous research looked at germination:

- Liquid smoke (Adkins and Peters 2001)
- Nitrates (Saini et al. 1986)
- Gibberellins (Naylor and Jana 1976)

Seedbank Stimulation – Resistance Management

- **Resistance is affected by how many plants must be killed by any given mode of action.**
- **Reducing seedbanks reduces the number of wild oat plants which any given herbicide will be active against.**
- **Risk reduction strategy – fewer plants to kill, fewer plants left to select for resistance.**

Seeds - Dormancy vs Germination vs Emergence

Dormancy –
temporary inhibition of growth in the seed.

Germination – Overcome dormancy and the seed sprouts, the radical / seed root emerges.

Emergence – When the seedling emerges from the soil.

Objectives

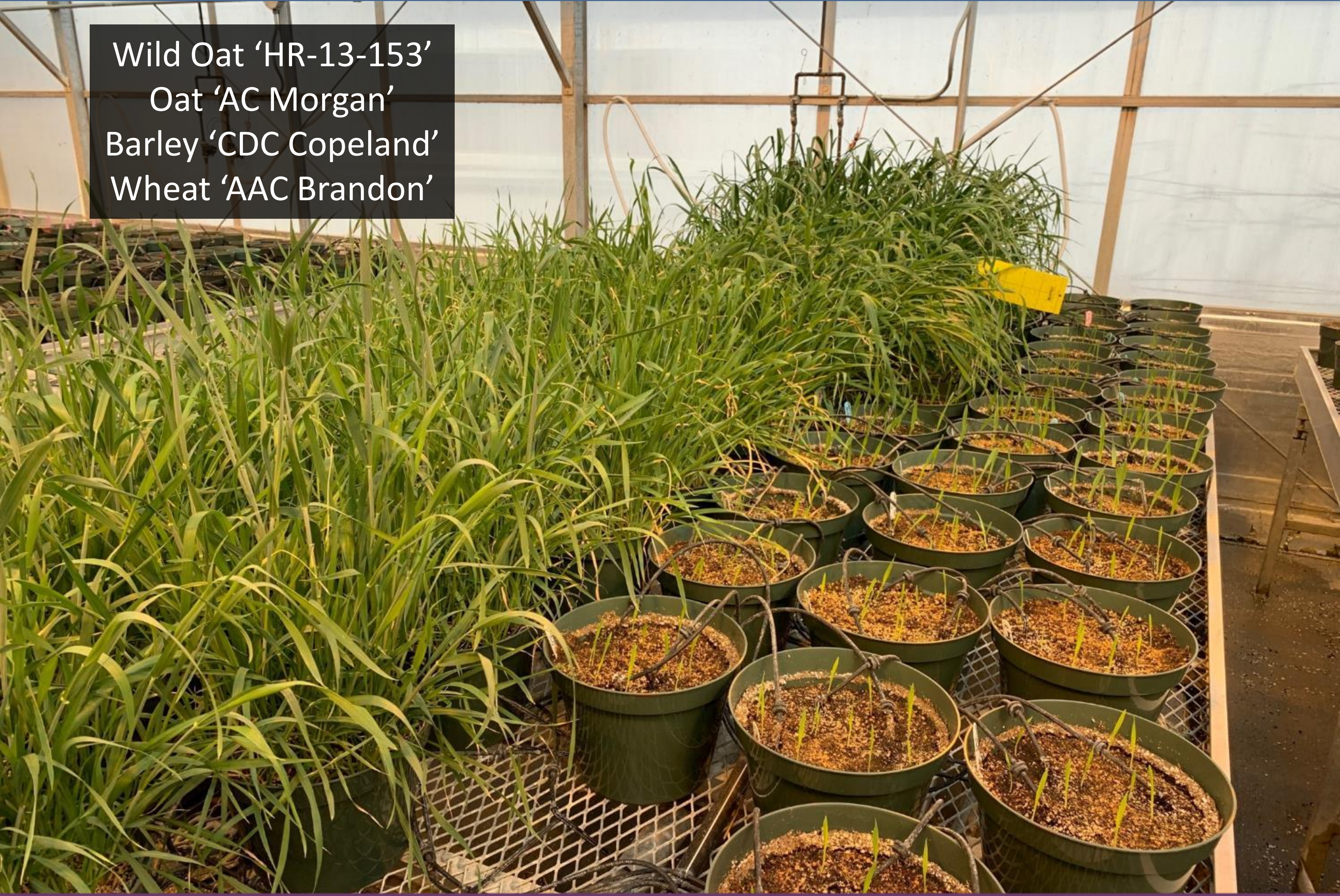
Evaluate pyroligneous acid and potassium nitrate as potential seedbank stimulants for wild oat and volunteer cereals.

Germination in petri dishes

Develop a spray pattern to evaluate emergence in pots

Evaluate freshly-matured oat, barley, wheat, and wild oat
-Ensure endodormancy / after-ripening in wild oat.

Methodology


Wild Oat 'HR-13-153'
Oat 'AC Morgan'
Barley 'CDC Copeland'
Wheat 'AAC Brandon'

Methodology

Petri dish – Germination
25 seed / dish
10 mL of wetting solution
Sealed with parafilm
Monitored daily.

Pots – Emergence
25 seed pot^{-1}
200 L ha^{-1} of spray solution
Monitored daily.

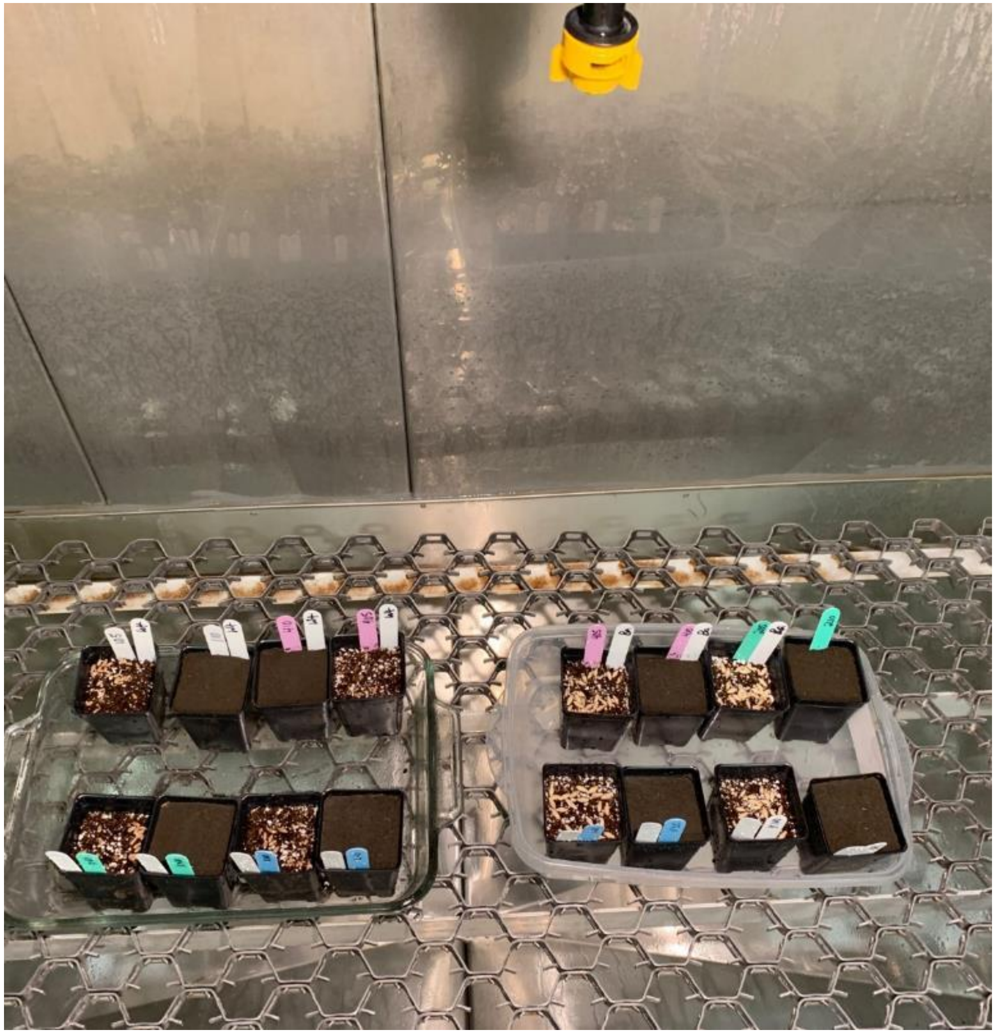
Methodology

Potassium nitrate:
0, 0.1, 1, 10, and 100 mM

Pyroligneous acid:
0, 5, 10, 20, 50, and 100%

$$GRI = \frac{G_1}{T_1} + \frac{G_2}{T_2} + \cdots + \frac{G_n}{T_n}$$

Germination rate index
(Germination speed)



Methodology – Interaction Study

Factor 1: KNO_3 - 0 or 125 kg N ha^{-1}.

Factor 2: PA dose at 0, 0.1, 1, and 10% solutions.

Emergence studies:
Factor 3: Burial Depth 0 or 1 cm (field soil)

Methodology – Analysis

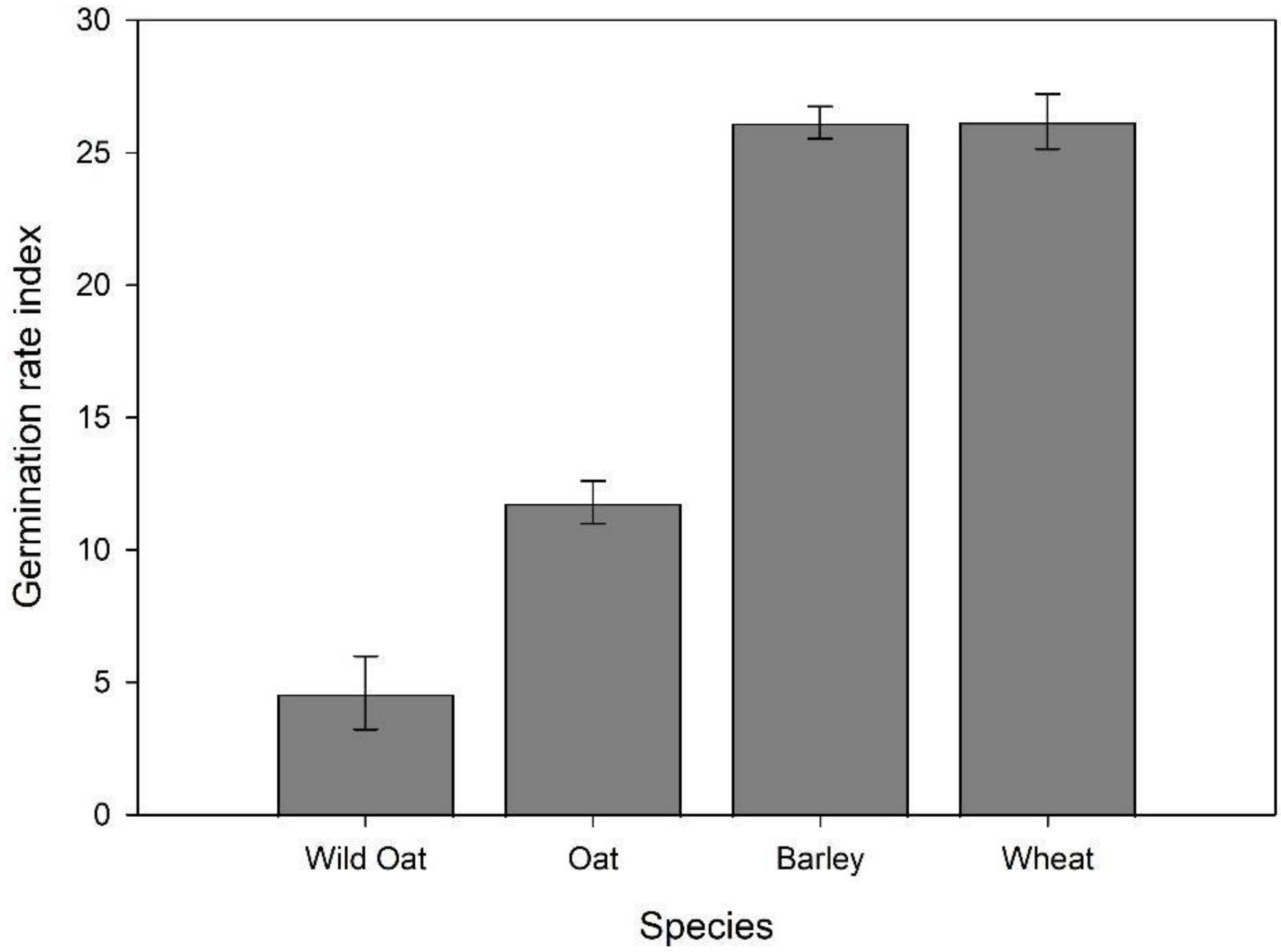
Nonlinear regression in Sigmaplot

ANOVA via PROC GLIMMIX

Tukeys means comparison

Results

Results - Species comparison



Potassium Nitrate Dose Response

No germination or emergence stimulation with any species.

Unexpected with wild oat – previous research has shown stimulation in these ranges in petri dishes.

Some insensitivity in the literature.

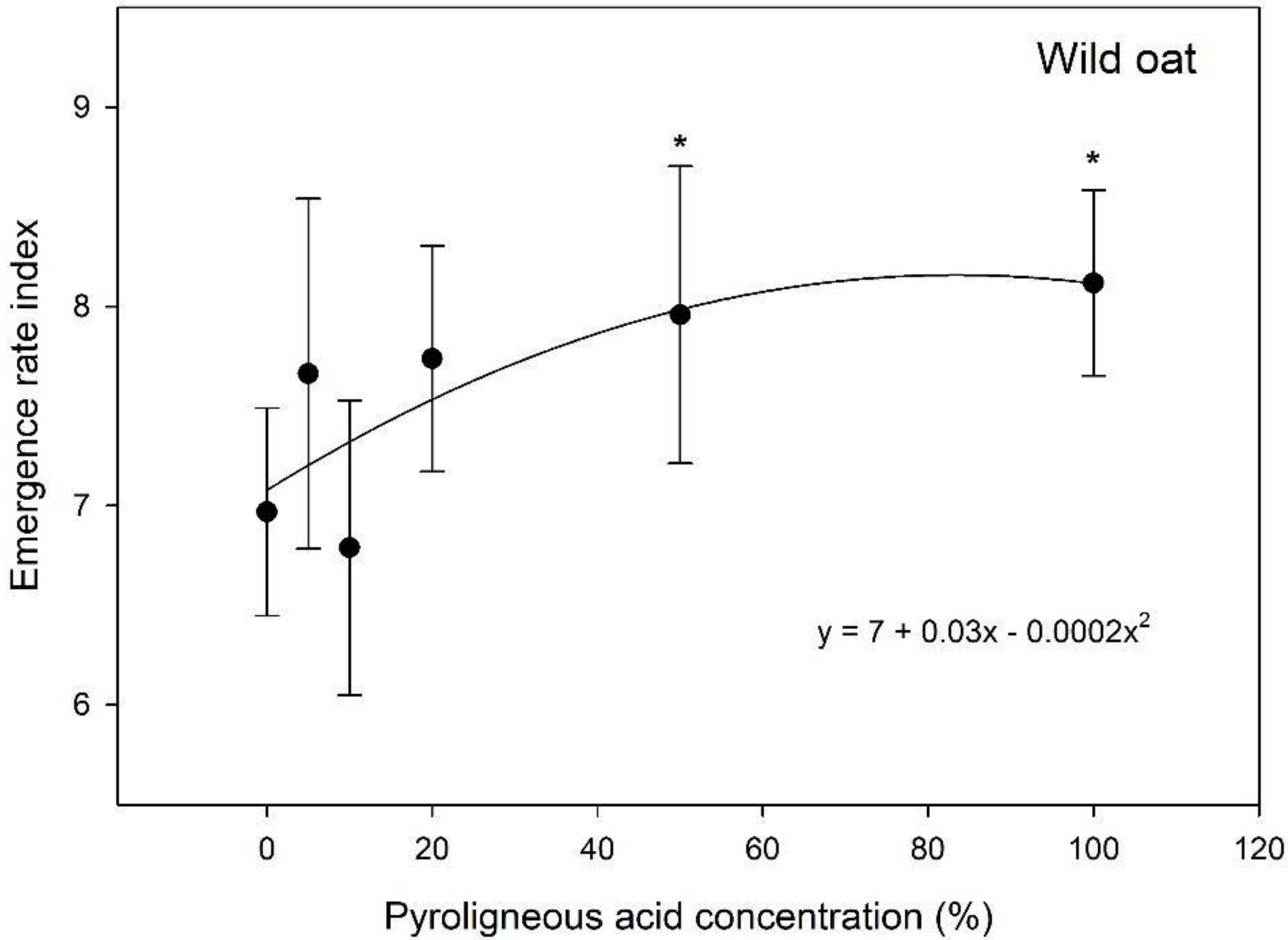
Utilizing fertilizer may not provide consistent results in-field.

Pyroligneous Acid Dose Response - Germination

-Dormancy was induced in all species with all PA solutions evaluated (5% to 100%).

-Seeds were imbibed (swollen) with water but the radicle did not emerge.

Emergence – Pyroligneous acid



Dose	Mean
0%	66%
50%	77%

Emergence – Pyroligneous acid

- Oat – not responsive to PA dose (p=0.27)
- Barley – not responsive to PA dose (p=0.84)
- Wheat – not responsive to PA dose (p=0.19)

Stimulant Interaction - Germination

- Similar results for all four species.
  - KNO3 at 125 kg N ha^{-1} induced dormancy.
  - 10% PA induced dormancy.
- Oat and wild oat were not affected by 0.1 and 1% PA.
- Wheat and barley reduced GRI with 1% PA.

Stimulant Interaction - Emergence

- Wild oat – no stimulation by PA or KNO_3.
- Oat ERI reduced with 1 and 10% PA.
- Barley – 1% PA stimulated emergence
  - 9 vs 10 ERI
- Wheat – No stimulation by KNO_3 or PA

Conclusions

Potassium nitrate did not stimulate germination or emergence.

Pyroligneous acid did stimulate wild oat emergence when 50 to 100% solutions were applied at 200 L ha^{-1}

PA did stimulate emergence of barley at 1% solution applied at 200 L ha^{-1}

Wild oat biotype had higher emergence rate than anticipated. Not as dormant as other studied lines.

- Stored at -24 C, not immediately following seed formation.

Future research

- Field testing for stimulatory effect.
- Herbicidal effect for post-emergence control of vegetation at these concentrations?
  - Acetic acid is a main component in pyroligneous acid

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