



United States Department of Agriculture

# Rationale and feasibility of breeding alfalfa for improved establishment under corn silage



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## Overview of alfalfa interseeding system

- Alfalfa interseeded soon after corn planting
- Corn silage harvested, alfalfa remains as a cover crop
- Following years alfalfa harvested as a forage crop

## Successful interseeding of alfalfa

- Increases 1<sup>st</sup> year alfalfa forage production by 60 to 130%
- Reduces corn yield by ~5% (range 0-20%)
- Expected to increase net return of corn-alfalfa rotations by up to 15%
- Improves water infiltration and reduces losses of soil, P, and N by up to 80% during and after corn production



**Forage yield  
potential of the  
alfalfa interseeding  
system**

# Alfalfa establishment in Wisconsin by interseeding vs. conventional methods

Ongoing studies funded by the US Alfalfa Farmer Research Initiative (“Alfalfa checkoff program”)

## Establishment in corn silage

Alfalfa interseeded at corn planting

Alfalfa interseeded at corn V1

## Conventional establishment

Spring seeded alfalfa

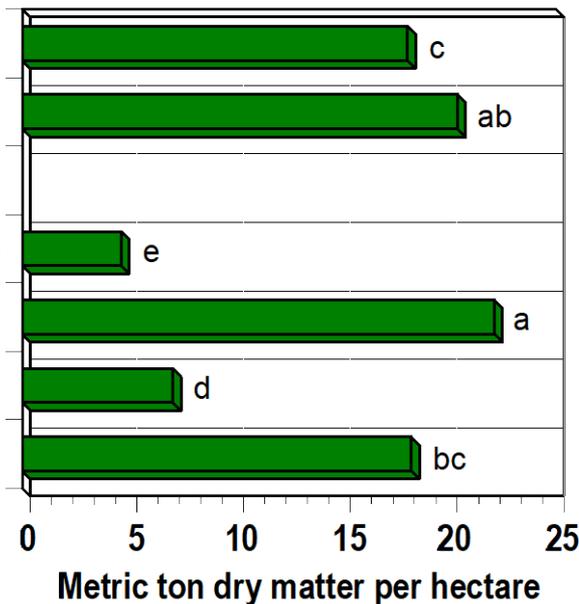
Corn silage then spring-seeded alfalfa in year 2

Barley then summer-seeded alfalfa

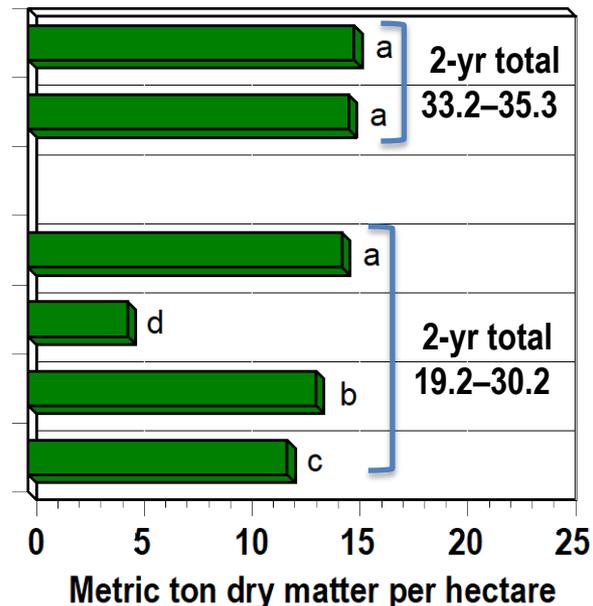
Corn silage then late summer-seeded alfalfa

Treatments with unlike letters differ at  $P = 0.05$

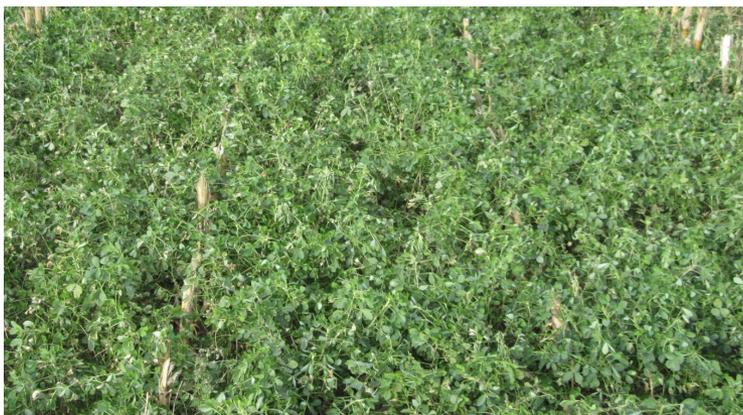
Corn silage, alfalfa, or barley yield 2020



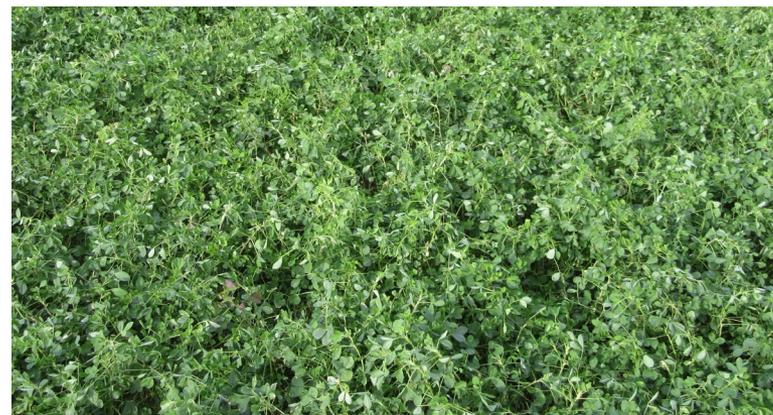
Alfalfa yield 2021



Interseeded at corn V1



Conventional spring-seeded



# **Factors influencing success of alfalfa interseeding in corn silage**

- **Field selection**
- **Weather**
- **Alfalfa variety and corn hybrid**
- **Fertilizer management**
- **Seedbed preparation and seeding method**
- **Seeding rates of alfalfa and corn**
- **Timing of corn silage and alfalfa seeding**
- **Weed control**
- **Application of plant protective chemicals on alfalfa**
- **Corn harvest management**

**Role of “protective” agrichemical  
treatments, alfalfa variety, and  
weather on establishment of  
interseeded alfalfa**

# Foliar agrichemical treatments enhance alfalfa health and survival under corn

Mid July

Early August

Non-treated control



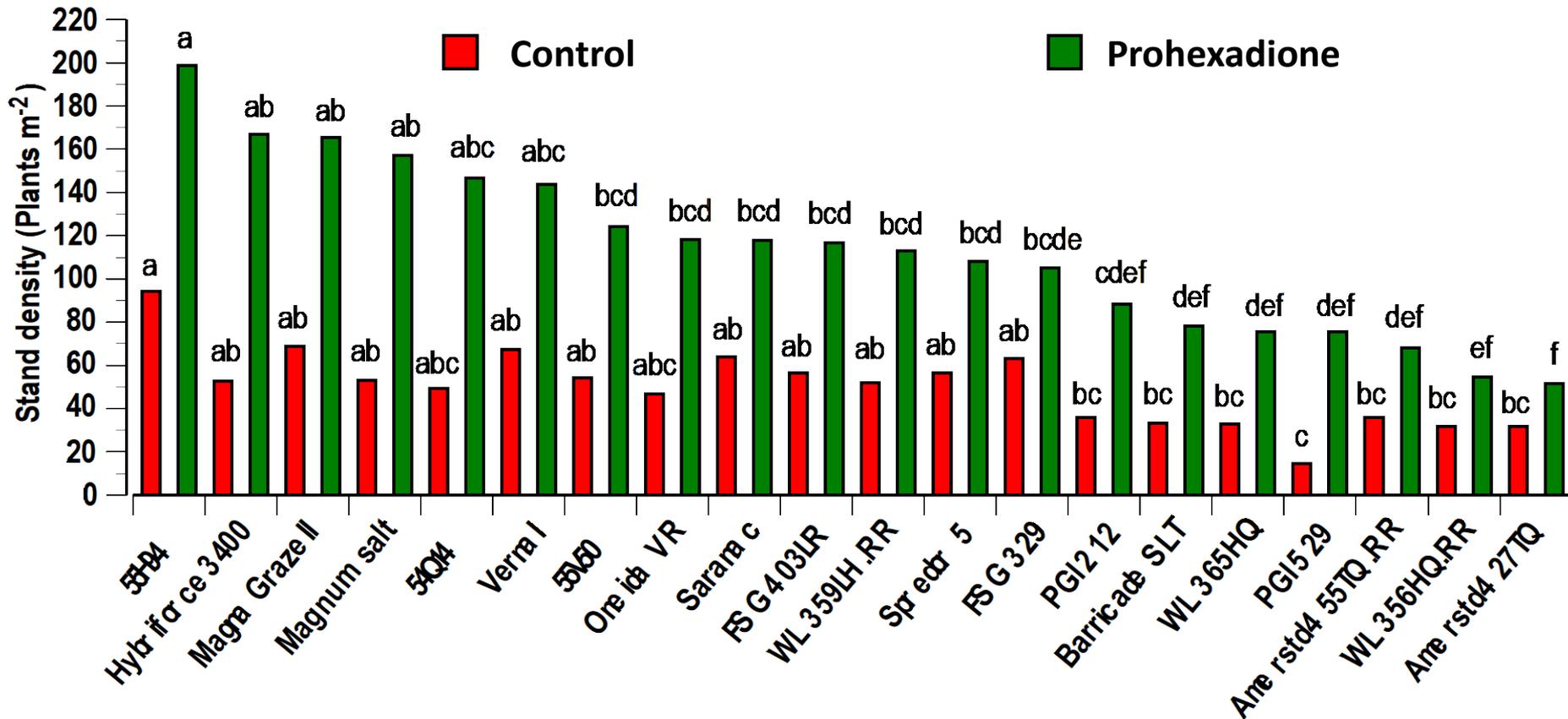
Prohexadione +  
Fungicide/Insecticide



*Published in  
Agronomy, 2021*

# Some alfalfa varieties are better adapted for establishment under corn

Stand density after corn in 2015, averaged across two sites in Wisconsin



# But using current better adapted varieties and agrichemicals will not ensure good stands of alfalfa after corn

Near normal conditions

Wet conditions

Non-treated control



Prohexadione +  
Fungicide/Insecticide



Published in  
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# **Can alfalfa be bred for improved establishment under corn silage?**

**Investigators: John Grabber and Heathcliffe Riday, USDA-ARS**

**Nicolas Enjalbert, SeedLinked**

**Steve Wagner, Corteva Agriscience**

**David Mickelson, S&W Seed**

# Methods

## ■ Breeding phase

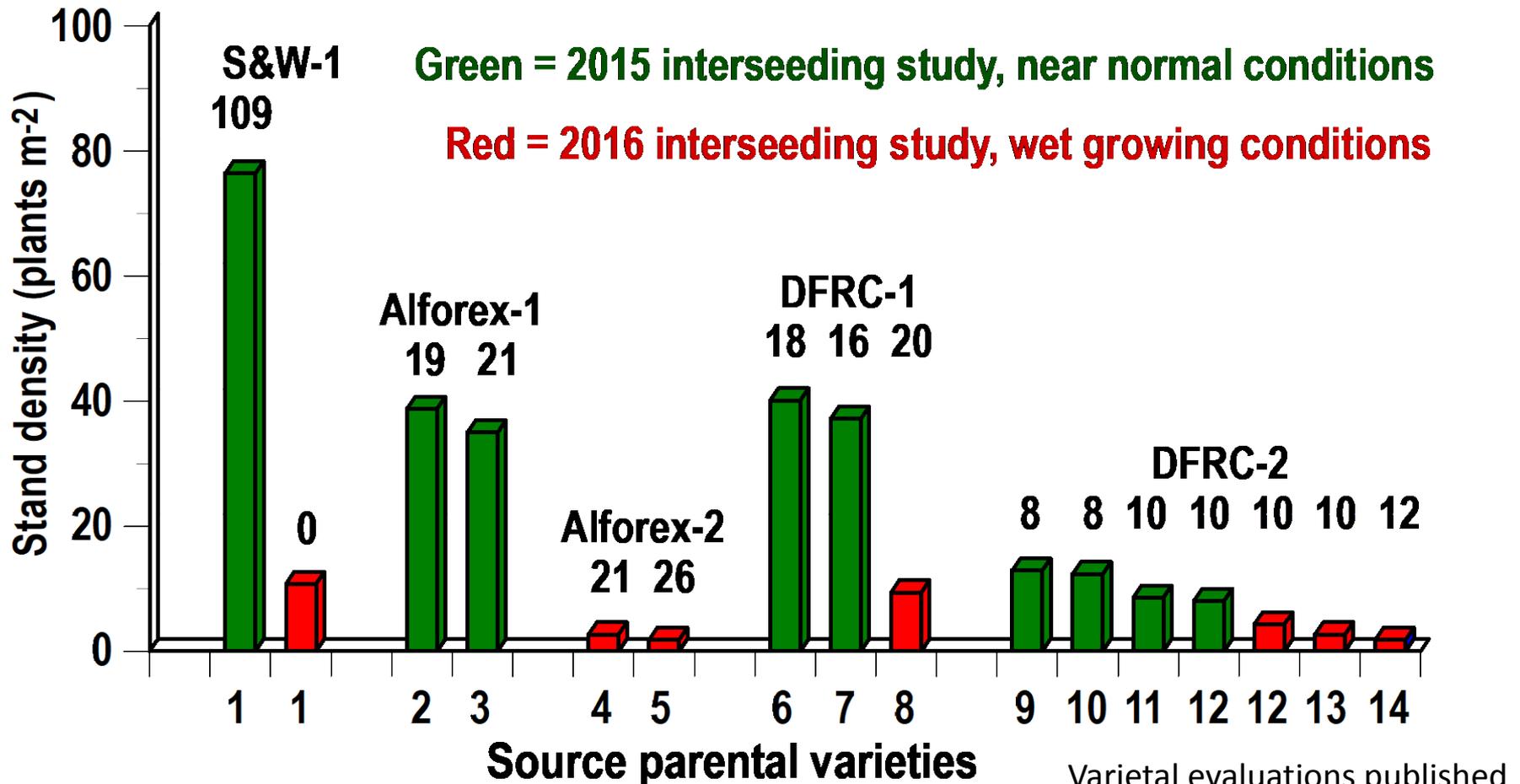
- Surviving alfalfa plants from previous varietal evaluations under corn were selected and collected in late summer 2017.
- Plants assigned to five crossing groups for production of cycle-1 polycross seed and hybrid F1 seed via crossing with a male-sterile line.
- Seed production from each group done in cages or in a greenhouse during late 2017 and 2018.

## ■ Evaluation phase

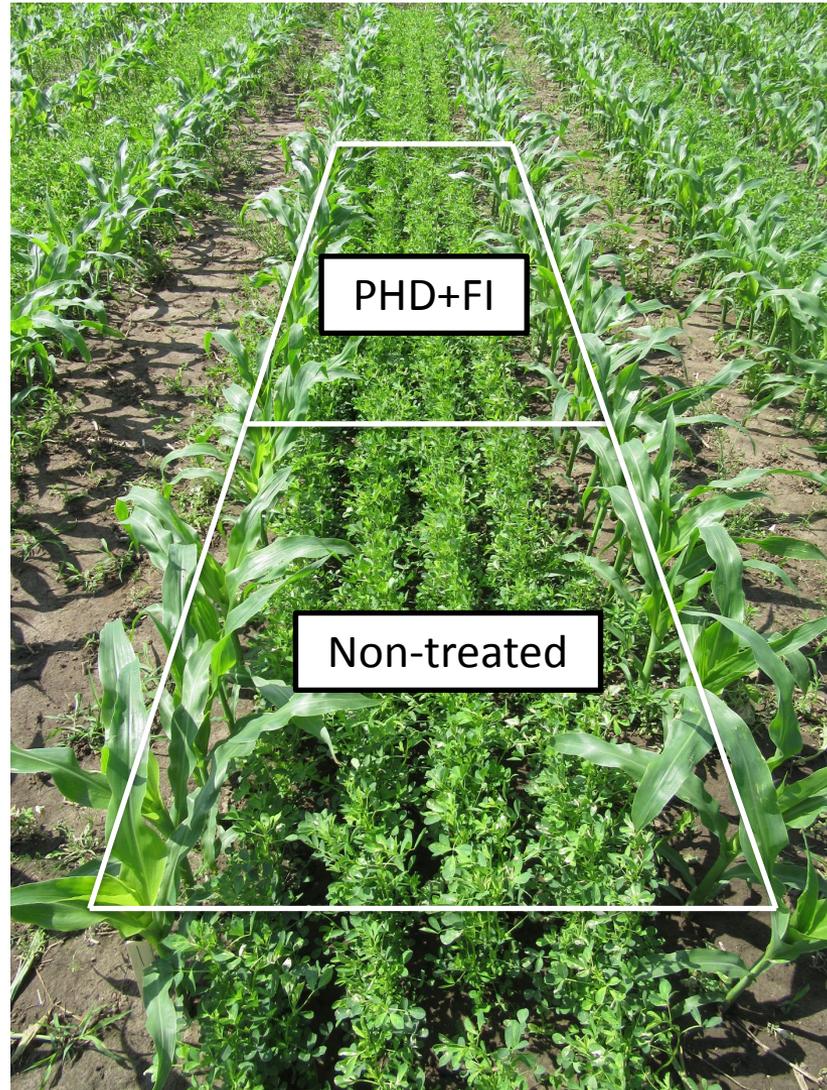
- Corn planted in mid-May 2019, intensively managed, and harvested for silage in mid-September at two locations in southern Wisconsin.
- Parental, cycle-1 polycross, and cycle-1 hybrid seed drilled at 18 kg ha<sup>-1</sup> within 3 days of corn planting in whole plots according to a randomized complete block design.
- Split plots were non-treated controls or treated with prohexadione, fungicide, and insecticide.
- Evaluated alfalfa foliar health, herbage mass, and root mass in July during establishment under corn.
- Alfalfa plant density determined four weeks after corn harvest.
- Data subjected to an analysis of variance with preplanned and post-hoc comparisons.

# Post corn harvest stand density of parental varieties used for crossing groups

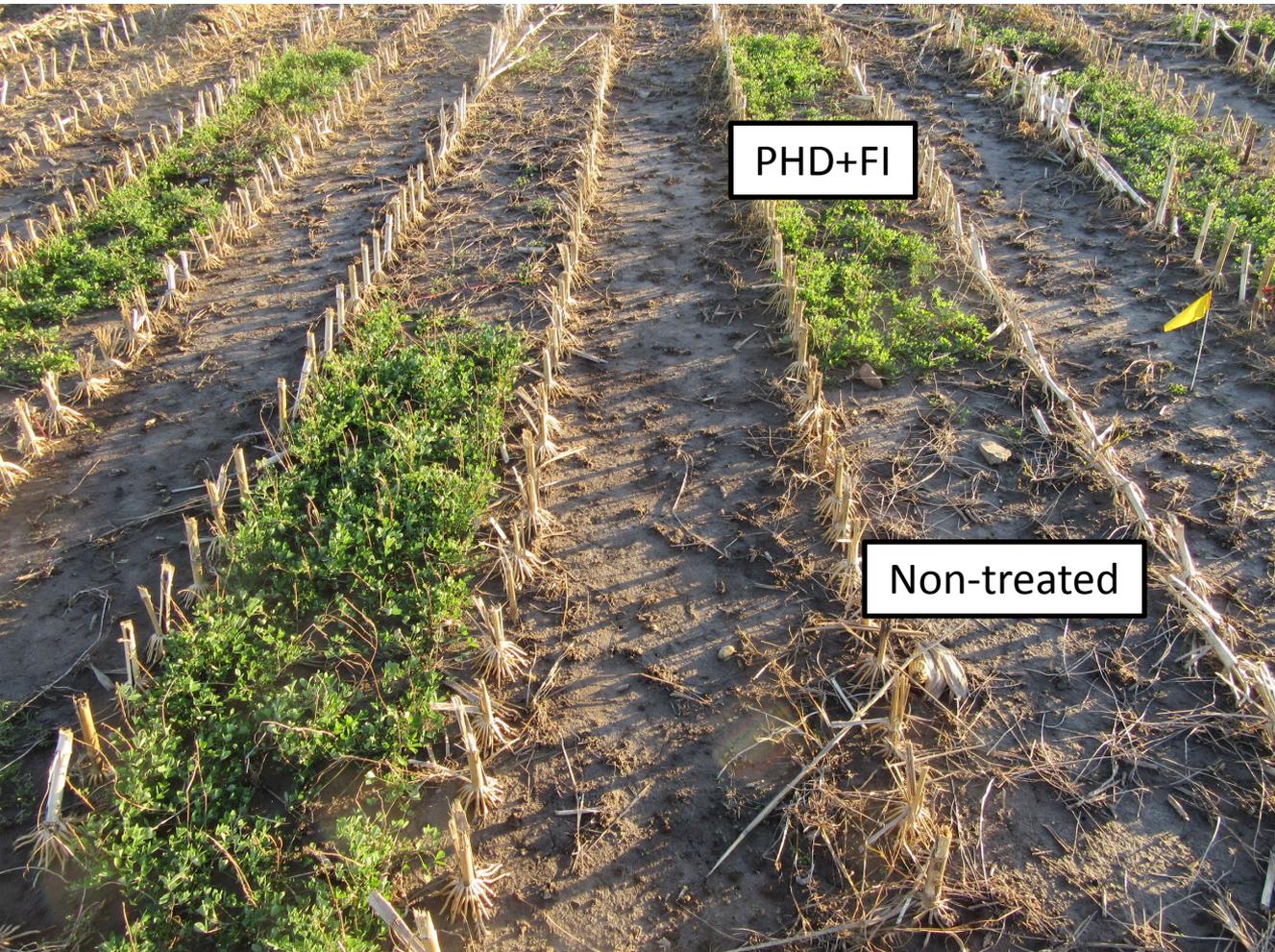
Relative survival of varieties in crossing groups:  
 S&W-1 > Alforex-1, DFRC-1 > Alforex-2, DFRC-2



# Alfalfa entry whole plot and non-treated vs. prohexadione + fungicide/insecticide (PHD+FI) treated subplots in mid June 2019



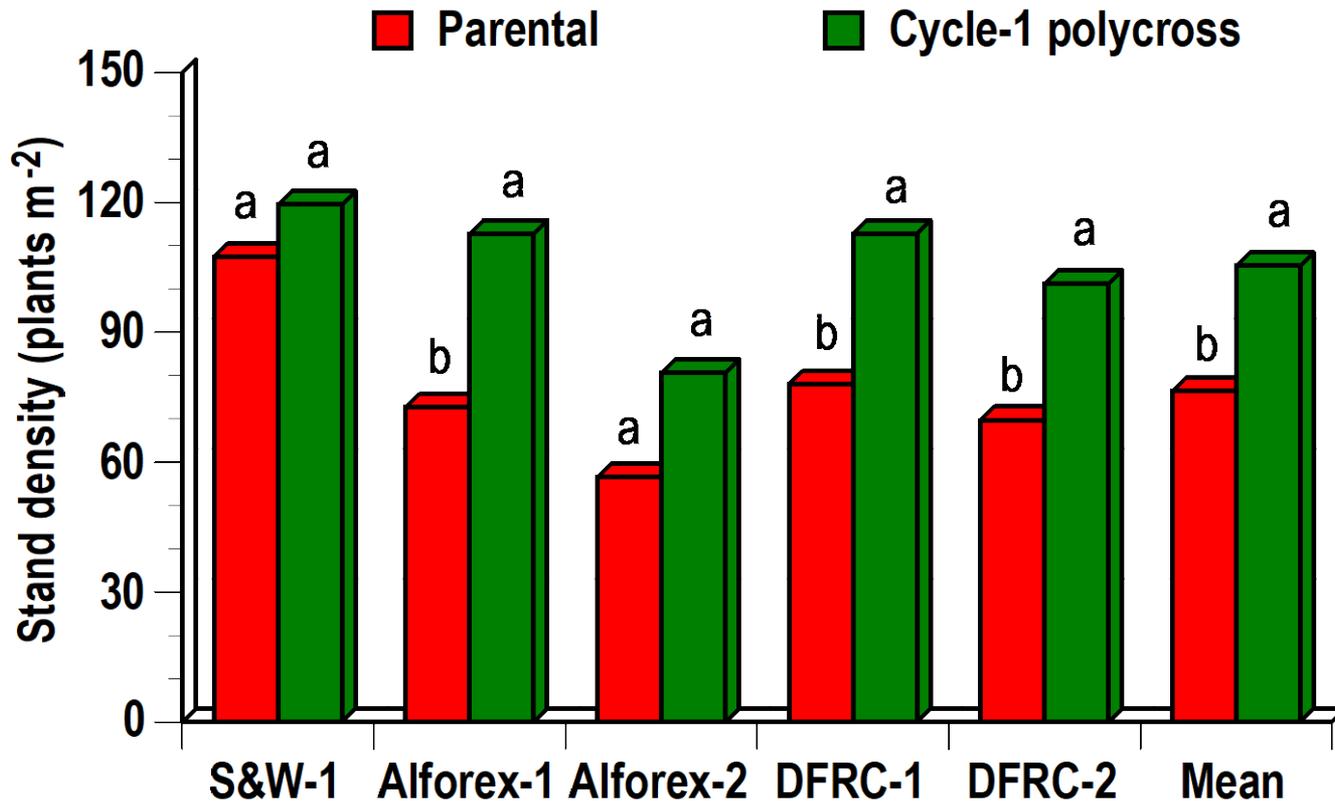
# Alfalfa entry whole plots and non-treated vs. prohexadione + fungicide/insecticide (PHD+FI) treated subplots in October 2019



- Growing season precipitation was 42% above normal
- Corn silage yield averaged 23.8 metric tons per hectare
- PHD+FI treatment
  - Decreased defoliation and leaf necrosis by 54%
  - Decreased herbage mass by 8%
  - Increased crown and root mass by 26%

# October stand density of PHD+FI treated parental vs. cycle-1 polycross entries after corn harvest averaged across locations

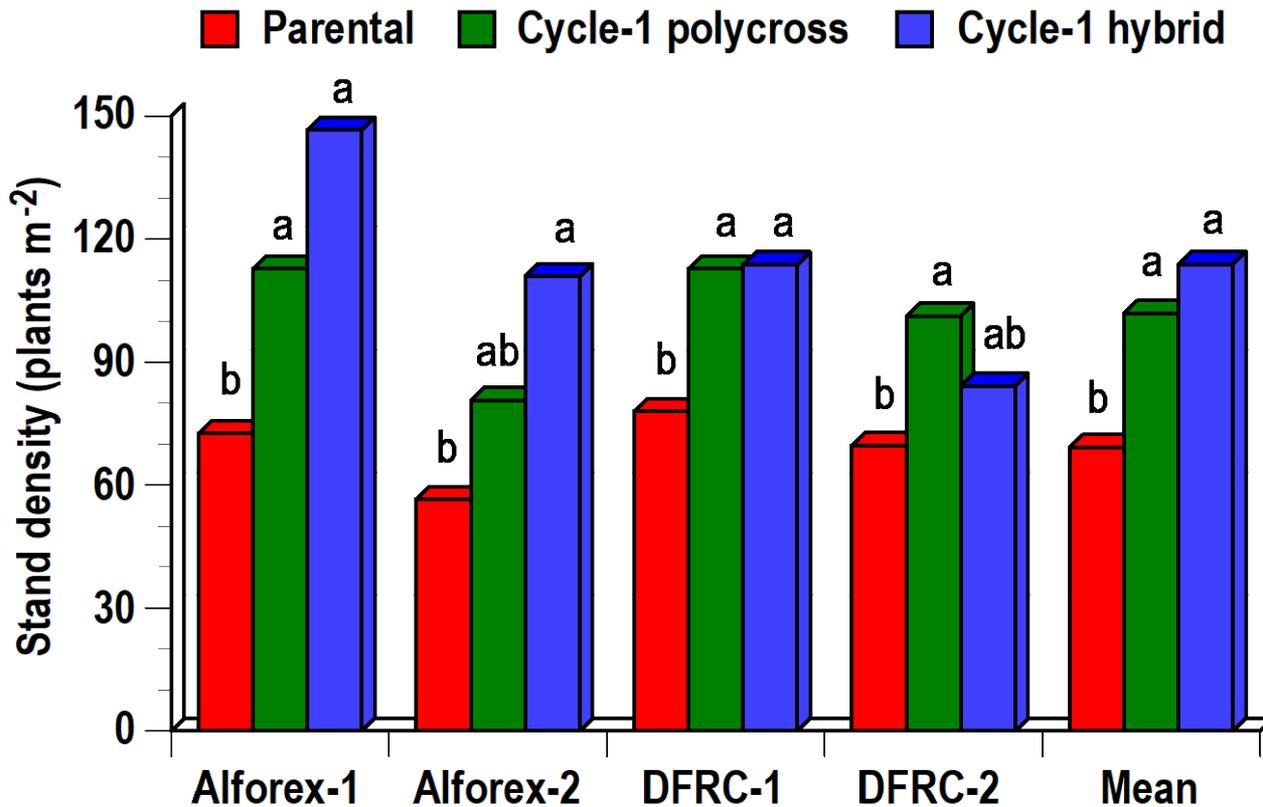
Crossing group survival: S&W-1  $\geq$  Alforex-1, DFRC-1  $\geq$  DFRC-2  $\geq$  Alforex 2



Factorial analysis: Crossing groups, selection response, and location main effects significant at  $P = 0.05$ , all interactions not significant

Within crossing groups, entries with unlike letters differ at  $P = 0.05$

# October stand density of PHD+FI treated parental, cycle-1 polycross and cycle -1 hybrid entries averaged across locations



Factorial analysis: Crossing groups, selection/hybridization response, and location main effects significant at  $P = 0.05$ , all interactions not significant

Within crossing groups, entries with unlike letters differ at  $P = 0.05$

Post hoc contrast: Hybrid > polycross for Alforex crossing groups at  $P = 0.05$

Post hoc contrast: Hybrid = polycross for DFRC crossing groups at  $P = 0.05$

# Conclusions

- **Plant selection and hybridization can increase plant survival of alfalfa established under corn during wet growing conditions, but the response may differ among alfalfa breeding populations.**
- **Agrichemical treatments (prohexadione, insecticide, and especially fungicide) will likely be needed to ensure good establishment of improved alfalfa varieties under corn during wet growing conditions.**
- **Several cycles of selection may be needed to routinely approach optimal stand densities of about 200 plants m<sup>-2</sup> for interseeded alfalfa following corn harvest.**

# Objectives of follow-up breeding studies

- **Assess gains in alfalfa seedling survival of USDA and seed industry germplasm subjected to two cycles of recurrent selection under corn silage**
- **Characterize phenotypic traits of parental and selected alfalfa germplasm**
- **Release USDA alfalfa germplasm for further varietal development**

**Thank you!**  
**John.Grabber@usda.gov**



Alfalfa established under corn silage at the UW-Arlington  
Research Station, October 2020