

What Controls Alfalfa Establishment & Silage Corn Yield When Both Crops Are Planted Together?



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Interseed alfalfa into corn silage

- Alfalfa planted in corn inter-rows within one week of corn planting
- Spray agrichemicals to improve alfalfa survival
- Corn silage harvested
- Alfalfa re-grows as a cover crop

Become a crop in subsequent year(s)



Benefits of interseeding alfalfa into corn silage

- Increases forage production
 - **Doubles** alfalfa yield compared to spring seeding
 - **>10% increase** in forage production over 2 years
- Increases profitability
 - **7-15% increase** under typical production practices
- Increases environmental benefits
 - Soil and nutrient losses **decreased by 37-87%**



Challenges of interseeding alfalfa into corn silage

- Corn silage yield can be reduced due to alfalfa competition
 - **0-15% reductions** observed over last 10 years
- Alfalfa establishment can fail
 - Low ROI
- Wet soil during harvest can damage alfalfa stands
- Extra \$\$\$ and time
 - **1-3 EXTRA agrochemical applications**
 - Higher amounts of fertilizer needed



Some challenges can be improved, but importance of specific factors is unknown

- How important is environment in establishment year?
 - H1: Wet years favor corn, poor alfalfa establishment
- How important is agronomic practices?
 - H2: Planting date (corn, alfalfa) and harvest time will influence alfalfa establishment
- How important is soil nutrients/pH?
 - H3 Nitrogen is important (corn);
 - H4 pH is important (alfalfa)
- How important is pest management?
 - H5: Alfalfa foliar, PLH insects; annual grasses reduce alfalfa establishment



NIFA Funded multi-state effort to optimize alfalfa establishment and minimize corn silage yield loss 2018-2019

- Wisconsin , Michigan, Idaho
- research station and on farm
- 19 site-years = 568 experimental units
- Random forest analysis
- Experimental factors
 - RR vs conventional
 - Corn population
 - +/-Fungicide and Insecticide (FI)
 - +/- Plant growth regulator (prohexadione) (PHD)
 - FI+PHD

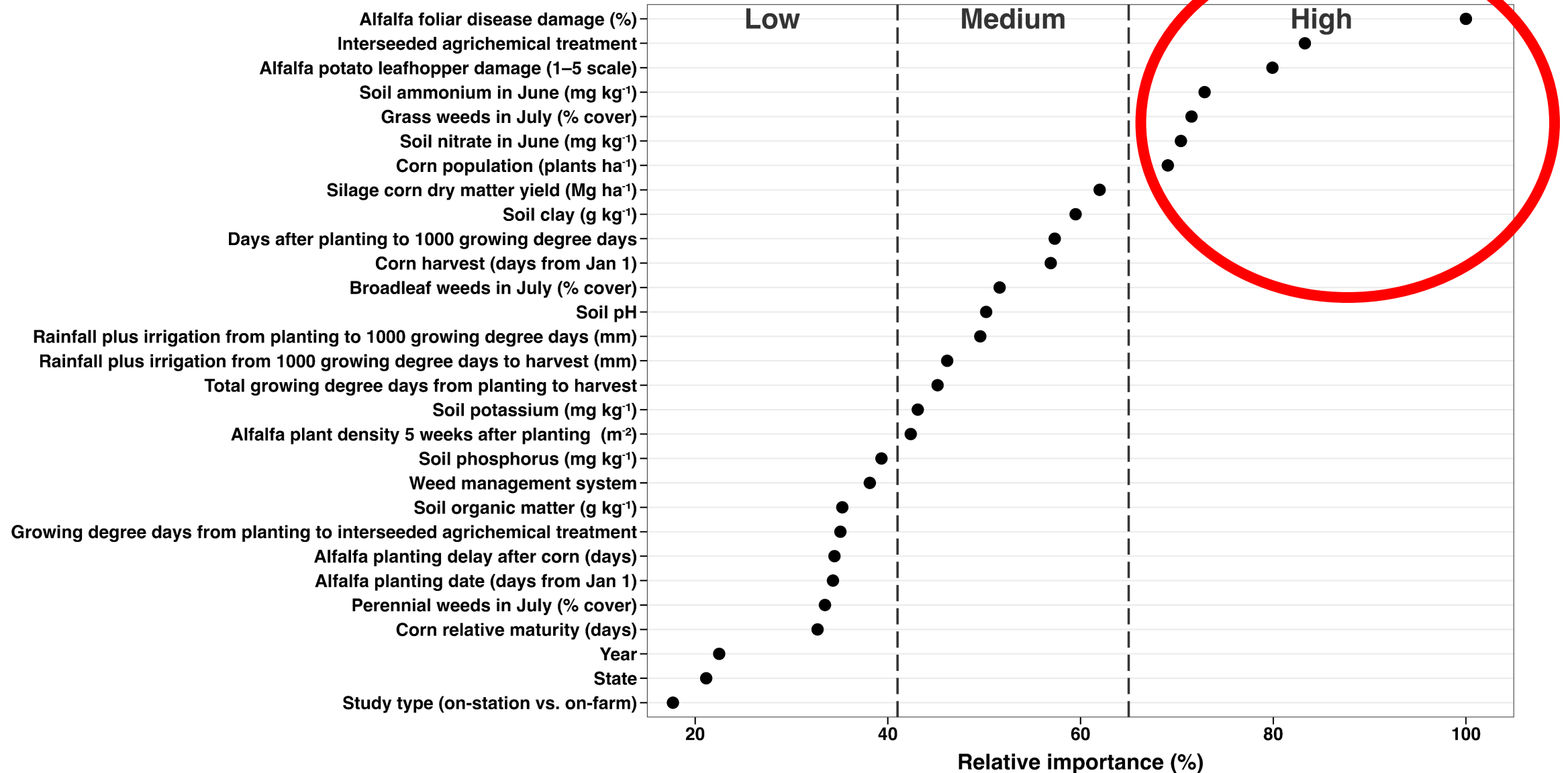


29 predictor variables evaluated

- Experimental factors:
 - Year, state, on farm vs station
- GDD and Precip/irr.
 - planting – 1000 GDD
 - 1000 GDD – harvest
- Soil:
 - NO₃, NH₄, pH, K, P, OM, % Clay
- Planting dates:
 - Corn, alfalfa, alfalfa plant delay after corn
- Crop planting factors:
 - Corn pop, corn relative maturity,
 - alfalfa variety (rr vs conventional)
- Pest prevalence:
 - weed cover, plant leaf hopper injury, foliar disease level
- Agrichemical use:
 - PHD, FI, P+ FI

Factors that impact alfalfa establishment (fall)

Model explained 72% of variability

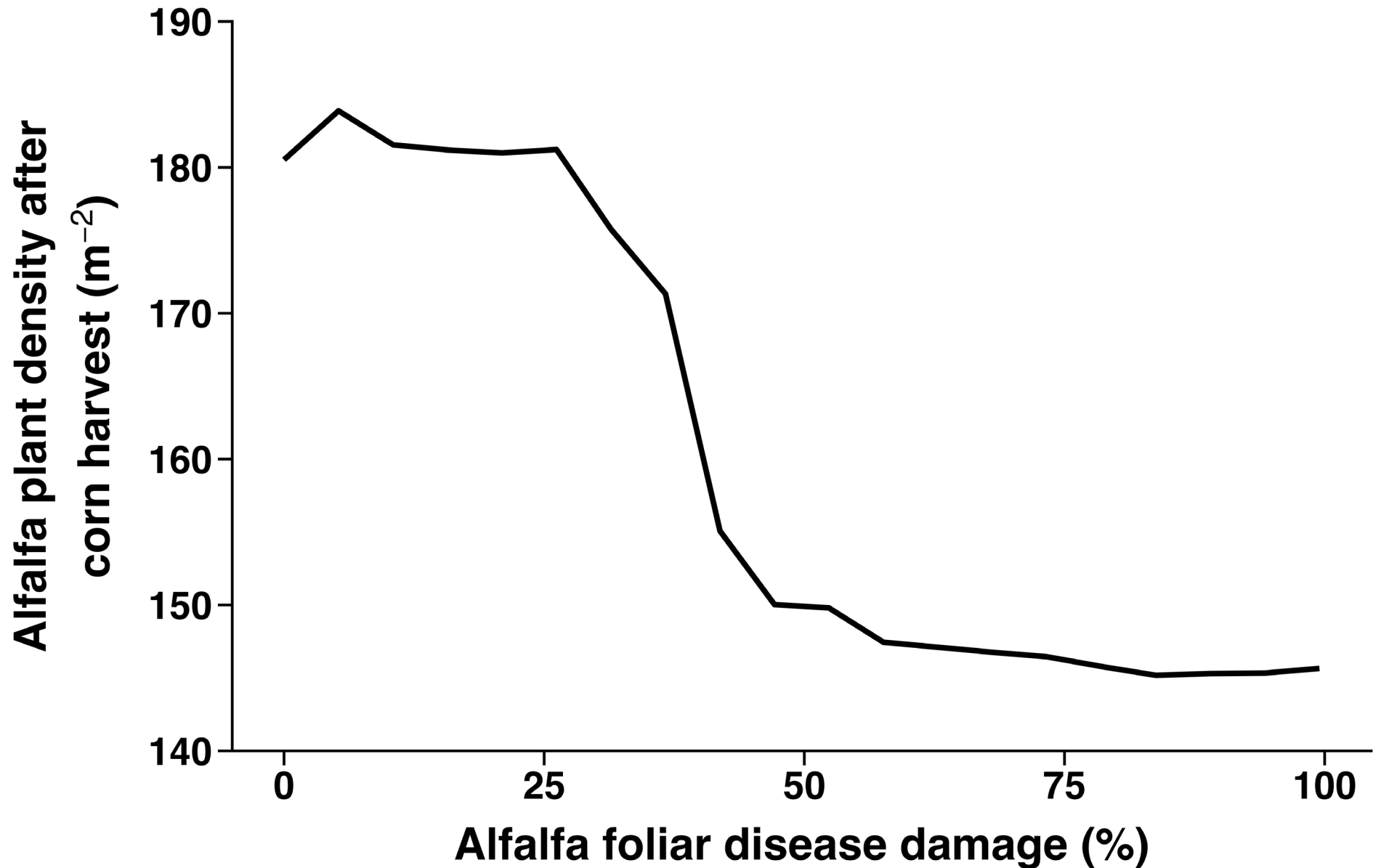


Variables of high importance (alfalfa)

Predictor variable	Rank	Measurement	When measured/applied
Foliar disease on alfalfa	1	% alfalfa leaves affected	Measured in August
Use of agrochemicals (PHD, FI)	2	Yes/No	Applied at corn canopy closure
Plant leaf hopper injury	3	Scale of 0-5	Measured in August
Soil NH4	4	mg /kg	Measured June
Grass weed cover	5	%	Measured in August
Soil NO3	6	mg /kg	Measured June
Corn population	7	Plants/A	Measured at end of season

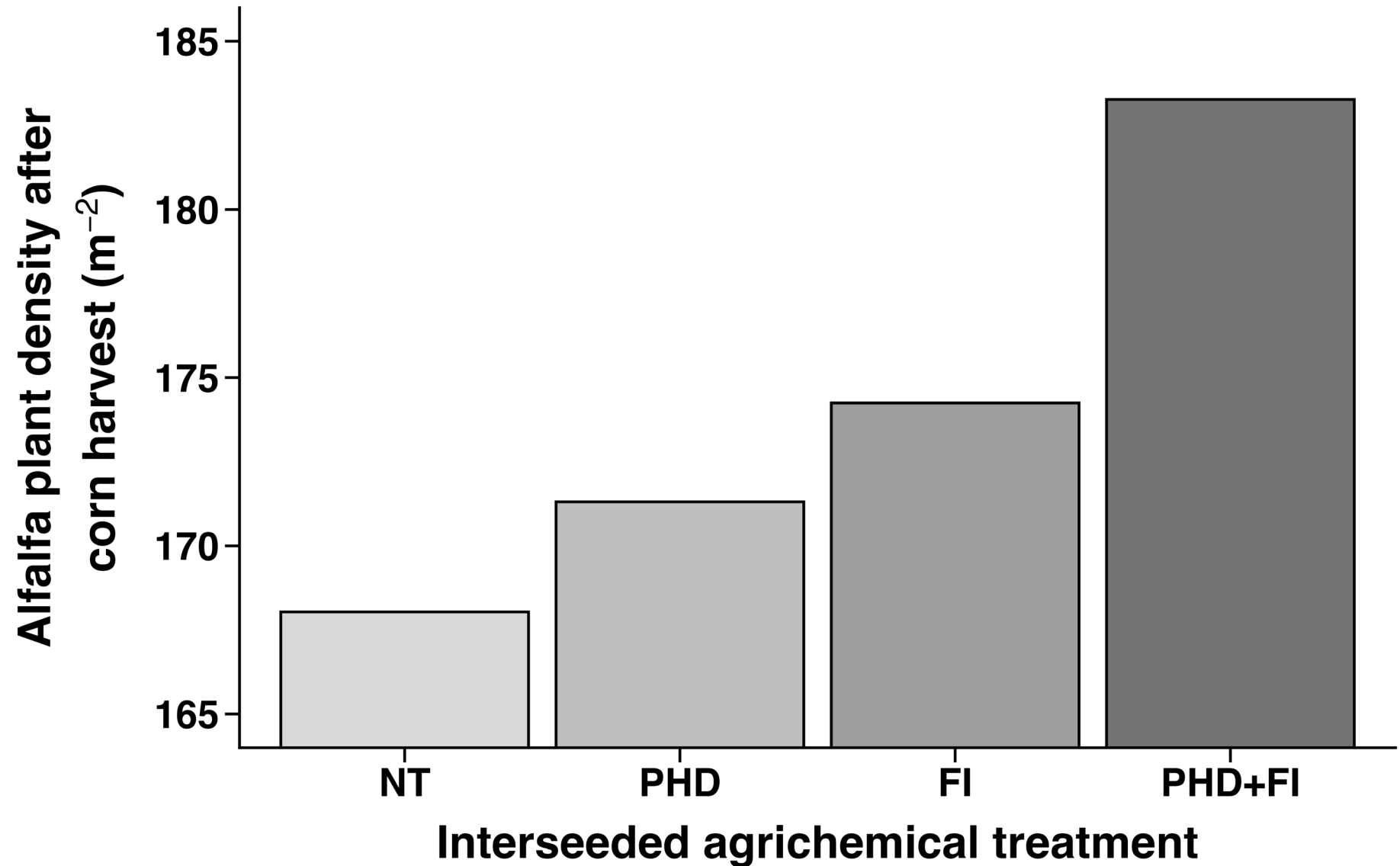
Alfalfa foliar diseases reduces establishment

>50% injury
reduced
alfalfa by 30
plants m^2



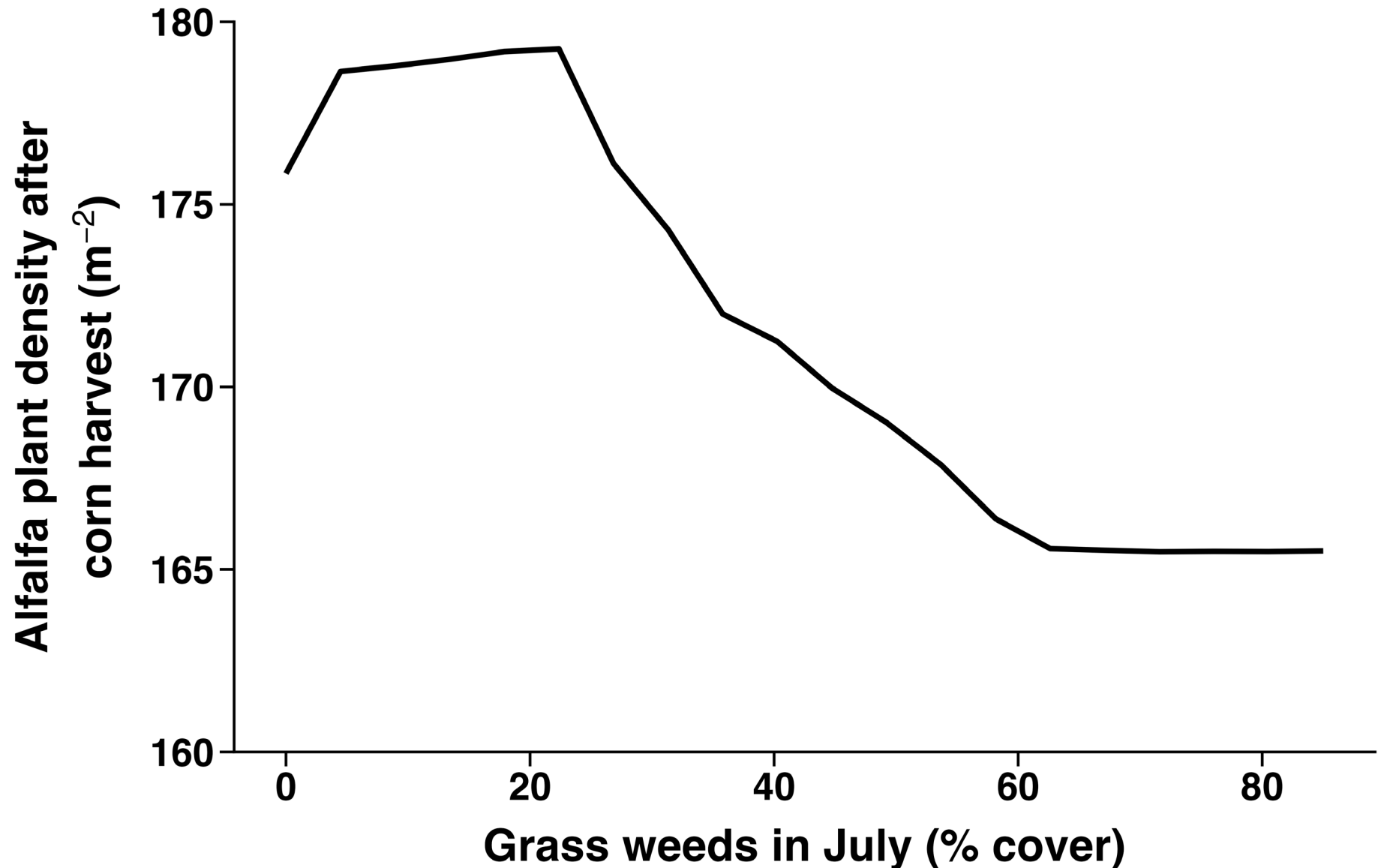
Fungicides, Insecticides + PHD reduced impact

PHD + FI
increased
alfalfa plant
density by
16 plants
 m^2



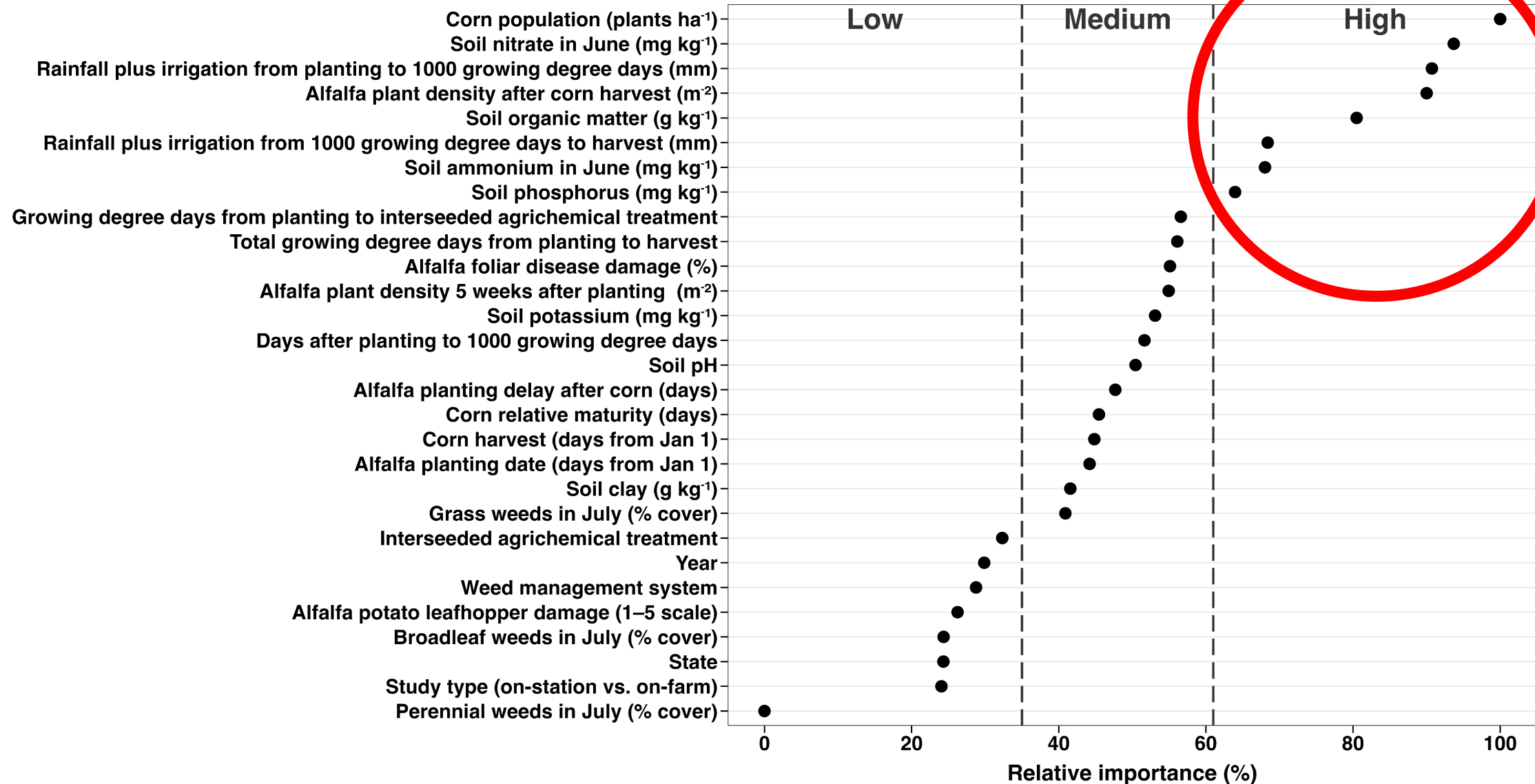
Grass weeds reduce alfalfa establishment

>25%
annual
grass cover
reduced
alfalfa plant
density by
up to 13
plants m^2



Factors that impact corn silage yield

Model explained 76% of variability

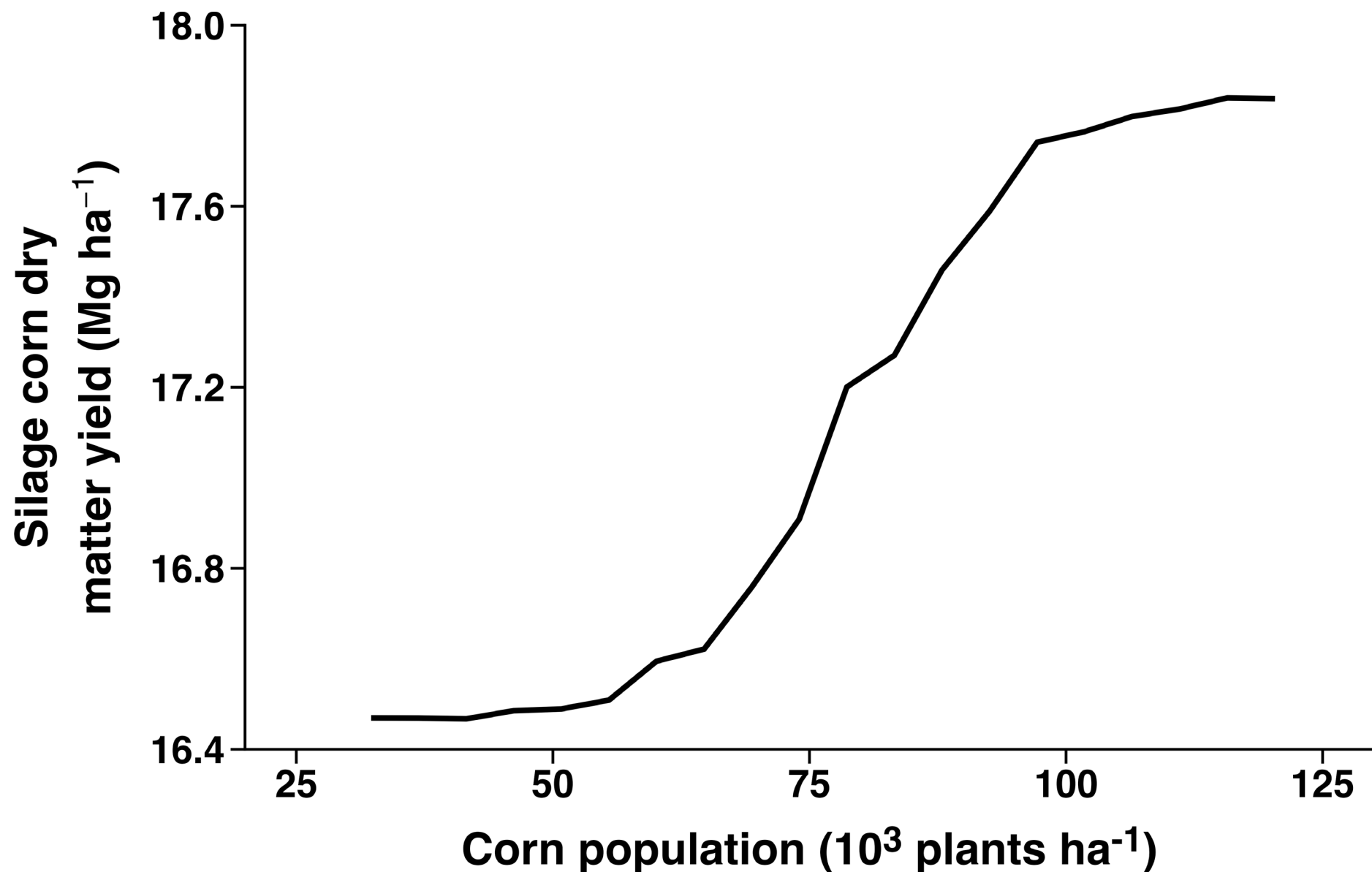


Variables of high importance (corn)

Predictor variable	Rank	Measurement	When measured/applied
Corn population	1	Plants/ha	Measured at end of season
Soil NO3	2	mg /kg	Measured June
Early season H2O	3	mm	from planting to 1000 GDD
Alfalfa plant density	4	Plants/ha	Measured in fall
Soil organic matter	5	%	Measured June
Late season H2O	6	mm	1000 GDD to harvest
Soil NH4	7	mg /kg	Measured June
Soil P	8	mg /kg	Measured June

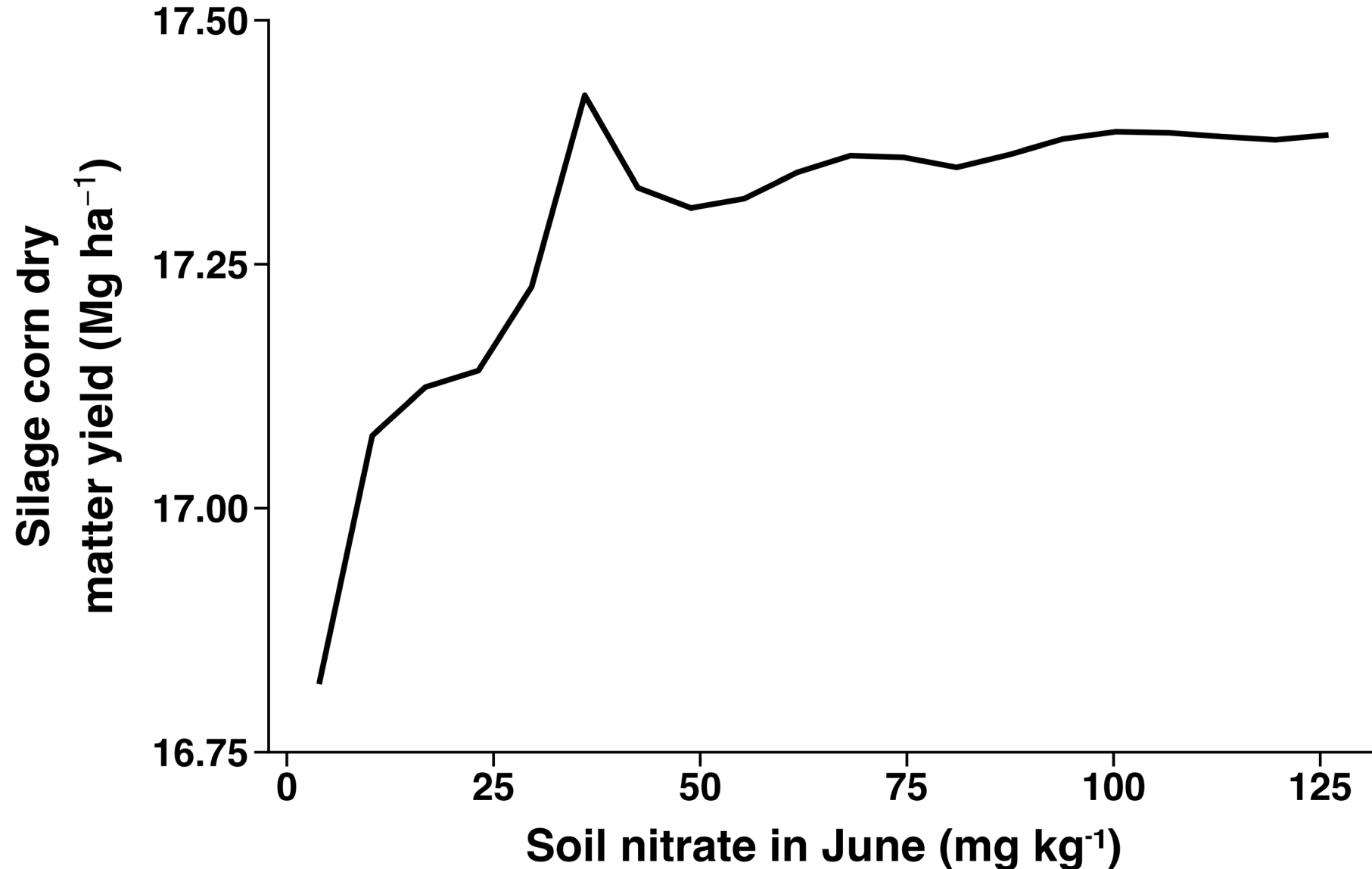
Corn population is related to corn silage yield

Low corn populations can reduce yield > 1 Mg ha⁻¹



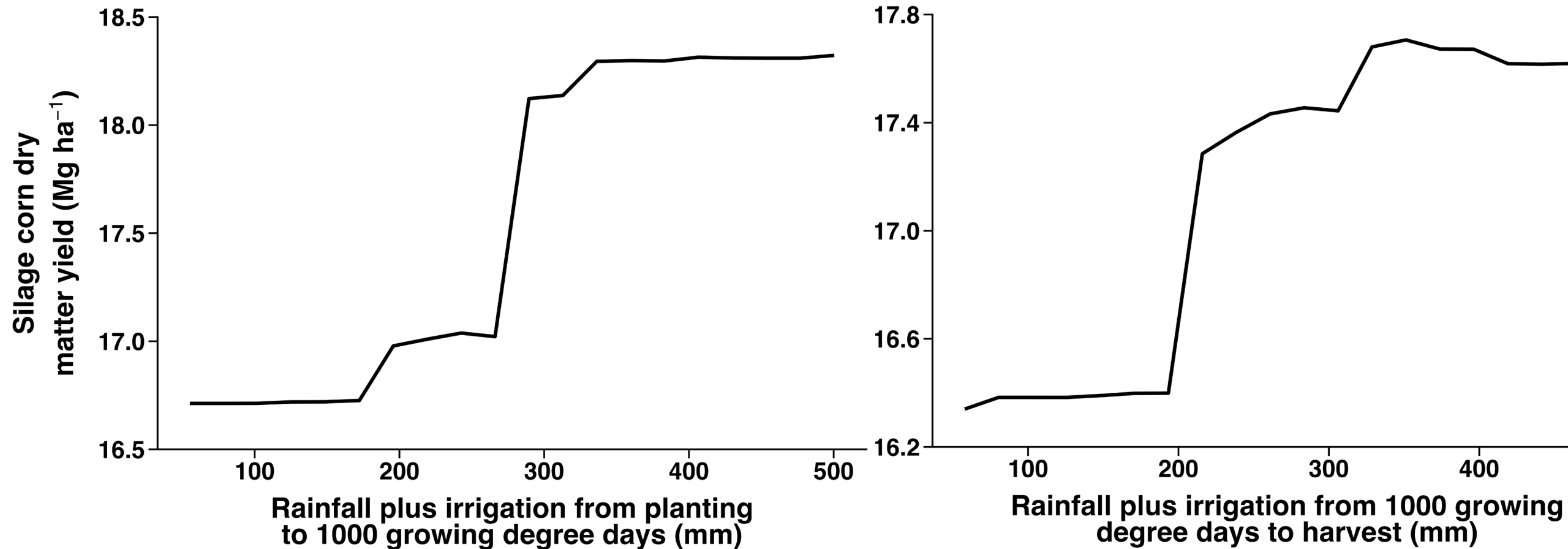
Soil NO₃ is related to corn silage yield

Soil NO₃ <
35 mg/kg
can reduce
yield up to
0.6 Mg ha⁻¹



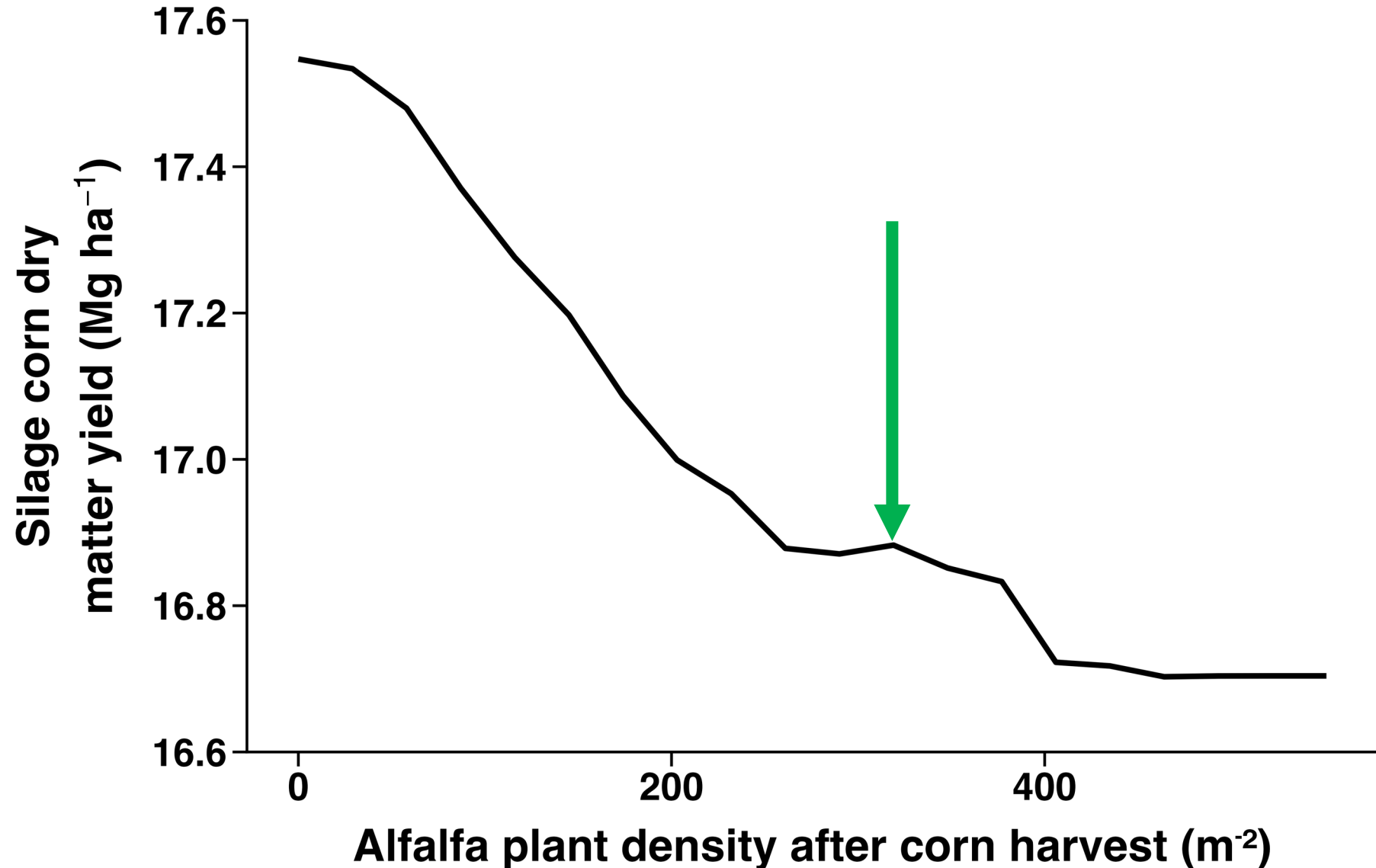
H2O is related to corn silage yield

> 200 mm precip/irrigation benefits silage corn yield



Alfalfa plant density is related to corn silage yield

High alfalfa
plant
density can
reduce yield
 0.8 Mg ha^{-1}



Key predictors influencing corn and alfalfa

Predictor	Corn	Alfalfa	Interpretation
Corn population	Positive	Negative	Corn yield increases with high corn pops. ($> \sim 90,000$ plants ha^{-1}) but higher populations increase competition and reduce alfalfa establishment
Nitrogen	Positive	Positive (NO_3) Negative (NH_4)	Corn yield increases with soil N ($\text{NO}_3 \sim 30$ mg kg^{-1} ; $\text{NH}_4 \sim 45$ mg kg^{-1}) Alfalfa plant density increases if $\text{NO}_3 > 25$ mg kg^{-1} ; NH_4 decreases if > 45 mg kg^{-1})
Alfalfa plant density	Negative	-	Alfalfa reduces corn yield with well established stands reducing yield by $> \sim 0.5$ Mg DM ha^{-1}
Early season water	Positive	Negative	Corn yield increase with precip/irrigation, alfalfa establishment decreased (slightly)
Late season water	Positive	Positive	Corn yield increased with precip/irrigation, alfalfa plant density decreased when > 300 mm
Alfalfa foliar disease	Positive	Negative	Alfalfa establishment declines when foliar disease exceeds $\sim 25\%$ damage
Potato leafhopper	Positive	Negative	Alfalfa establishment declines when leafhopper visible damage exceeds 10% of leaflets
PHD+FI	Negative	Positive	Treatments reduce improve alfalfa establishment, reduced corn yield
Annual grass weeds	Positive	Negative	Alfalfa establishment declines when cover exceeds $\sim 25\%$
Organic matter	Positive	Negative	Corn yield increased, alfalfa plant density decreases with OM > 25 g kg^{-1}

Conclusions

- Corn/alfalfa interseed is a viable options for dairy production
 - Economic and environmental benefits
- To optimize alfalfa establishment
 - Apply fungicide to prevent foliar diseases
 - Scout and apply insecticide if PLH present
- To minimize corn silage yield loss
 - High corn population, ample soil NO₃, ample precipitation



Information utilized to inform future research

- Fungicide trials
- Annual grass weeds impact
- N fertilization
- Effectiveness in short statured corn
- Breeding alfalfa for improved performance
 - Evaluating germplasm

