Impact of PRE + POST vs. POST-only Weed Management on N_2O Emissions

Rebecca R. Bailey, Vince M. Davis

Nitrous oxide (N_2O) is a potent greenhouse gas with implication for contributing to global warming effects. Emissions increase as available soil nitrate, soil moisture, carbon availability, and soil temperature increase. In the absence of preemergence (PRE) herbicides, weeds compete with crops and reduce soil nitrate and moisture levels, which may reduce N_2O emissions relative to a weed-free environment. However, once weeds are terminated with postemergence (POST) herbicides, emissions may increase as the weeds supply carbon to microbial denitrifiers. To determine this relationship, three non-crop greenhouse studies, two non-crop field studies, four corn studies, and two soybean studies were conducted in 2013 and 2014 to compare the effects of PRE + POST and POST-only weed management strategies on N_2O emissions before and after weed termination. All studies included this main effect of weed management, which was combined in a factorial treatment structure with nitrogen (N) rates of 0 or 200 kg N ha^{-1} (non-crop greenhouse), 0 or 225 kg N ha^{-1} (non-crop field), and 0, 90, or 180 kg N ha^{-1} (corn), or row widths of 38- or 76-cm (soybean). PRE herbicides and N were applied at the time of planting, and POST applications were made when weeds were 10-15 cm tall. N_2O emissions were measured from gas samples collected weekly from static chambers placed within each plot from the time of planting until four weeks after POST application in the non-crop studies and until mid-September in the corn and soybean studies. Data were compared separately for each set of studies in SAS 9.3 using mixed a model with main factors and their interaction as fixed effects and environments as random effects. Means were separated using Fisher's protected LSD at $\alpha = 0.05$. N_2O emissions were not influenced by *weed*N* in the non-crop greenhouse, non-crop field, or corn studies (p=0.0927, p=0.4359, and p=0.8800, respectively), but higher N rates led to increased N_2O emissions (p=<0.0001) in all studies. In the soybean study, neither *width* (p=0.8592) nor *weed*width* (p=0.5955) had a significant impact on N_2O fluxes. In the greenhouse studies, emissions after termination were higher in treatments with weeds than those without (2.6 vs. 1.3 mg N_2O-N m^{-2}, p=0.0003), and overall emissions were higher for the POST-only treatments (p=0.0003). At the field-scale, POST-only treatments had lower emissions than PRE + POST treatments before termination in the soybean study, but weed management did not influence N_2O emissions from the non-crop field, corn, or soybean studies for any other measurement period. Corn yield was 13.2 vs. 12.1 Mg ha^{-1} (p=<0.0001) when a PRE was used vs. when it was not, and soybean yield was also significantly higher in the PRE + POST vs. POST-only management system (4270 vs. 3620 kg ha^{-1}, respectively, p=0.0007). In summary, an impact of weeds on N_2O emissions was detectable in the greenhouse and soybean studies. Although season-long N_2O emissions were comparable for both PRE + POST and POST-only weed management strategies in the corn and soybean systems, use of a PRE herbicide was still important for increased yield.

Impact of PRE + POST vs. POST-only Weed Management Strategy on N_2O Emissions

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WCWS
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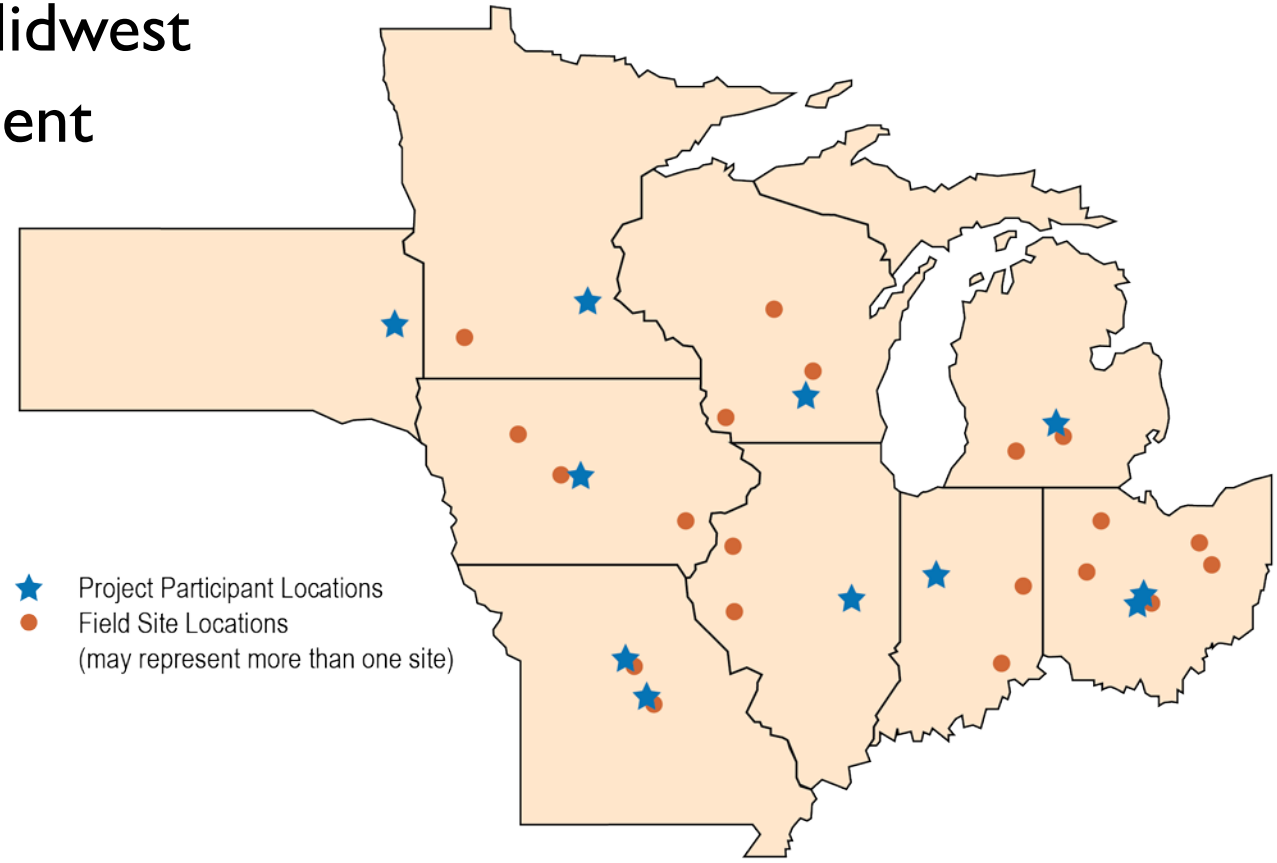
Crop Weed Science

Why this research?

- USDA-NIFA Corn-Climate CAP
- Investigates C, N, water footprints in corn-based cropping systems in Midwest
- IPM component

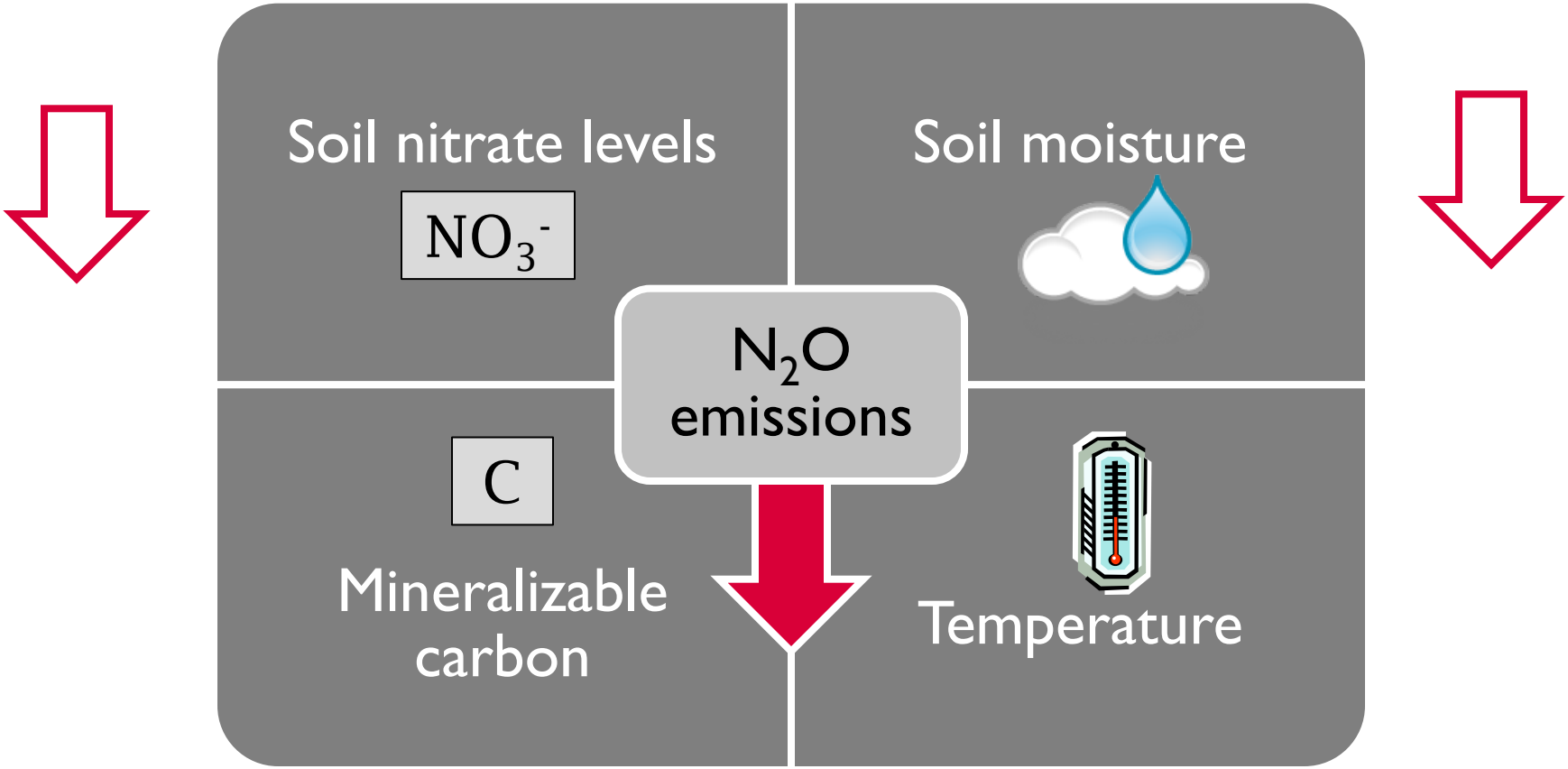


SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

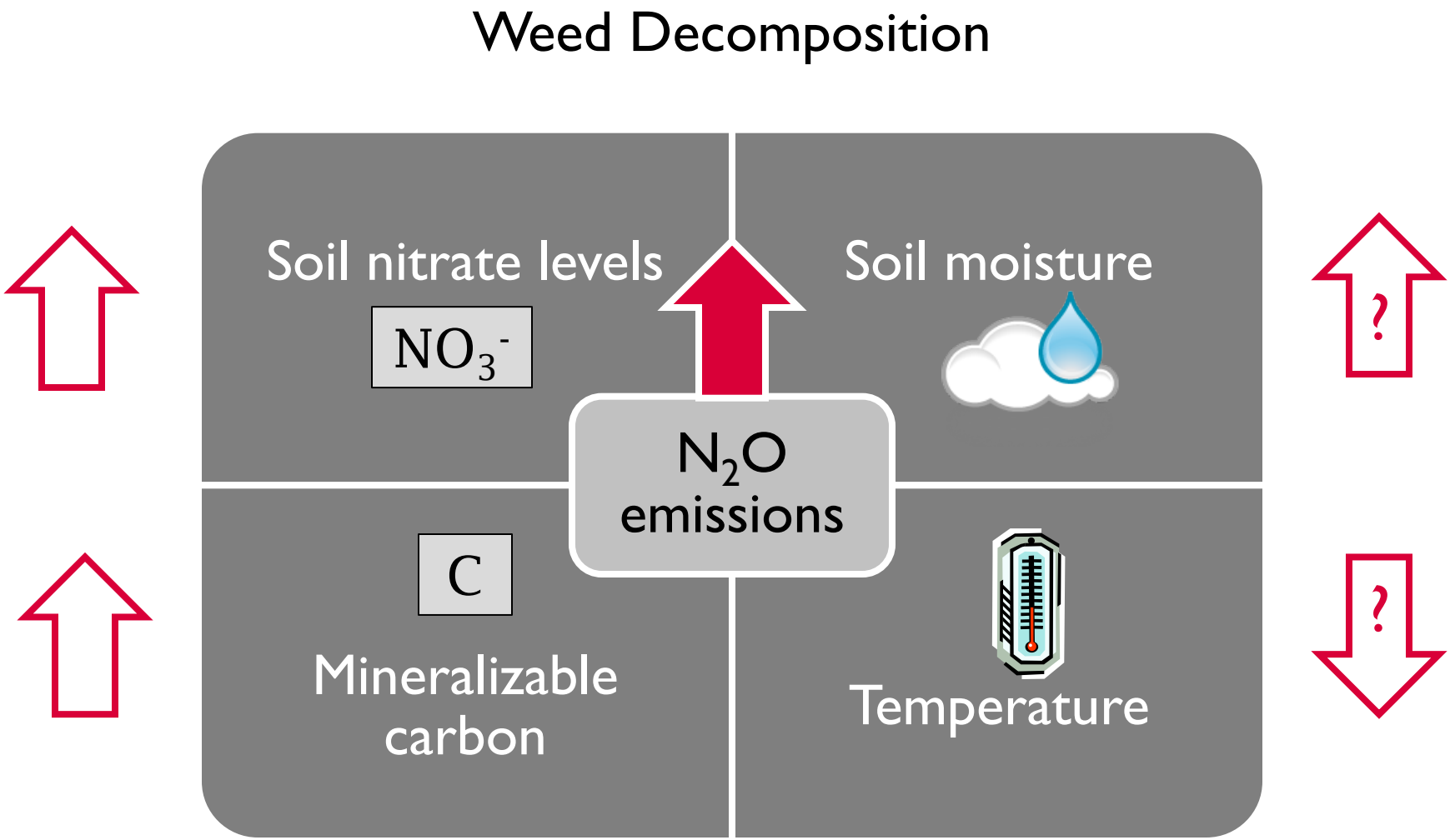
Background

- 300x more potent than CO_2
- 75% from agricultural land management // 5% US

Weed Growth



Background


Weed Decomposition
Soil nitrate levels
NO_3^-
Soil moisture
?
N_2O emissions
C
Mineralizable carbon
Temperature
?

Objectives

1. To determine if weeds reduce N_2O emissions while growing and/or increase emissions after termination

2. To compare how a PRE + POST ('weed-free') vs. a POST-only ('weedy') herbicide management strategy impacts N_2O emissions

3. To determine if N rate (or row width) affects how weeds influence N_2O emissions

11 Studies

PRE + POST (-W) vs. POST-only (+W)

Non-crop: 3 greenhouse trials, 2 field trials

- 2 x 2 of weed management and N rate

Corn: 2 locations, 2 years

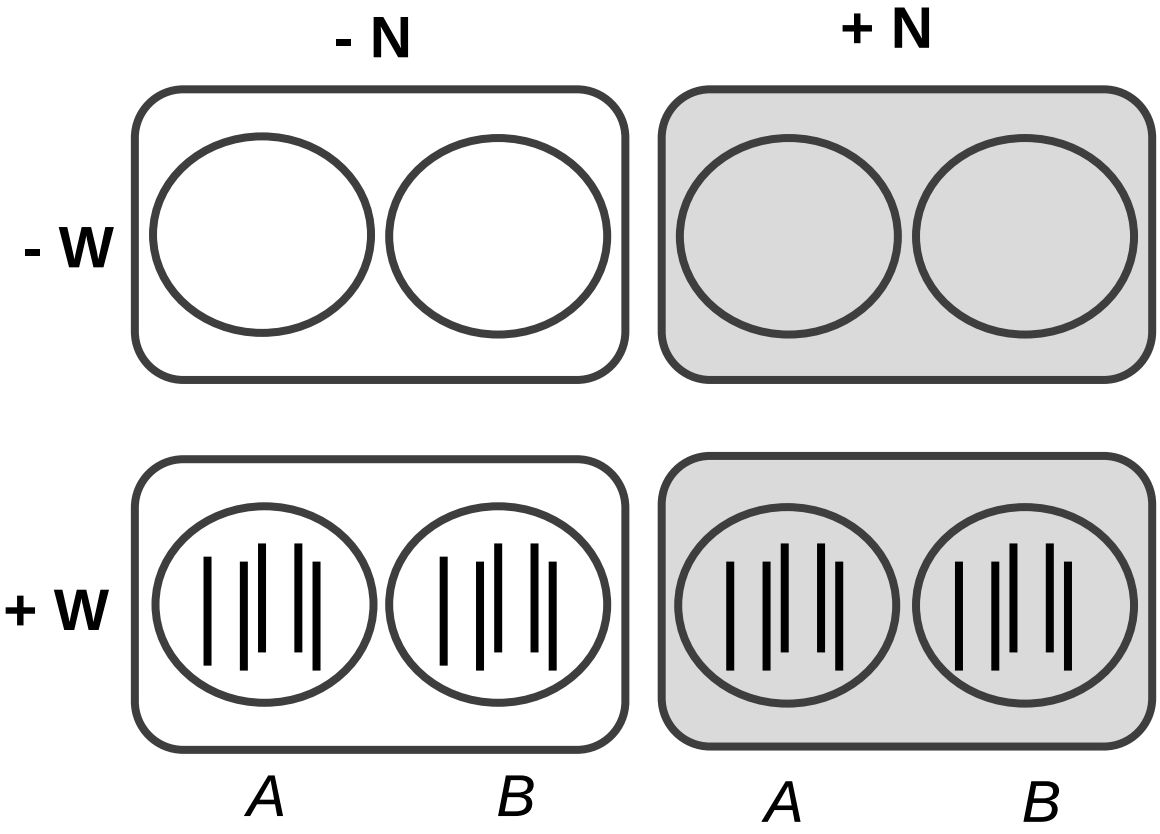
- 2 x 3 of weed management and N rate

Soybean: 2 years

- 2 x 2 of weed management and row width

Greenhouse study

Greenhouse study



At POST: weeds killed in sampling chamber A
biomass collected from chamber B

Field study

Corn study

0 kg N ha^{-1} | **90** kg N ha^{-1} | **180** kg N ha^{-1}

PRE + POST



POST-only



2013 and 2014
Janesville and Arlington, WI

Soybean study

2013 and 2014
Arlington, WI

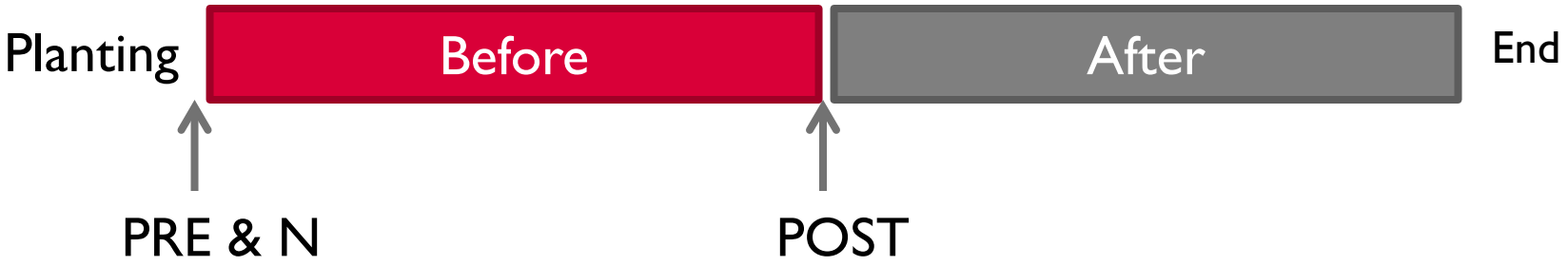
38 cm

76 cm

PRE + POST

POST-only

General methods



- Mixed model procedure
  - Fixed: *weed N weed*N* OR *weed width weed*width*
  - Random: *year, loc(year), rep(loc)*

Results: N_2O

- No effect of *weed*N* or *weed*width*

- Effect of *N* or *width*:

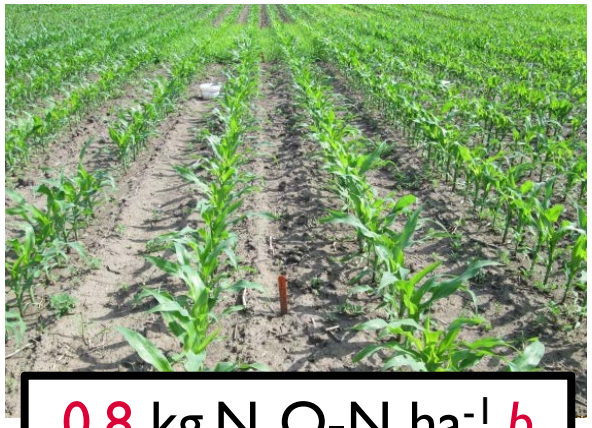
Study	Effect	P-value for N_2O Emissions		
		Before termination	After termination	Total
Non-crop GH	*N*	<0.0001	<0.0001	<0.0001
Non-crop field	*N*	<0.0001	0.0363	<0.0001
Corn	*N*	<0.0001	<0.0001	<0.0001
Soybean	*width*	0.4828	0.5102	0.3615

Results: N_2O

0 kg N ha^{-1} | **90** kg N ha^{-1} | **180** kg N ha^{-1}

PRE + POST

0.4 kg N_2O-N ha^{-1} *c**



0.8 kg N_2O-N ha^{-1} *b*

1.2 kg N_2O-N ha^{-1} *a*

POST-only

Total emissions

*statistical differences at $\alpha = 0.05$

Results: N_2O

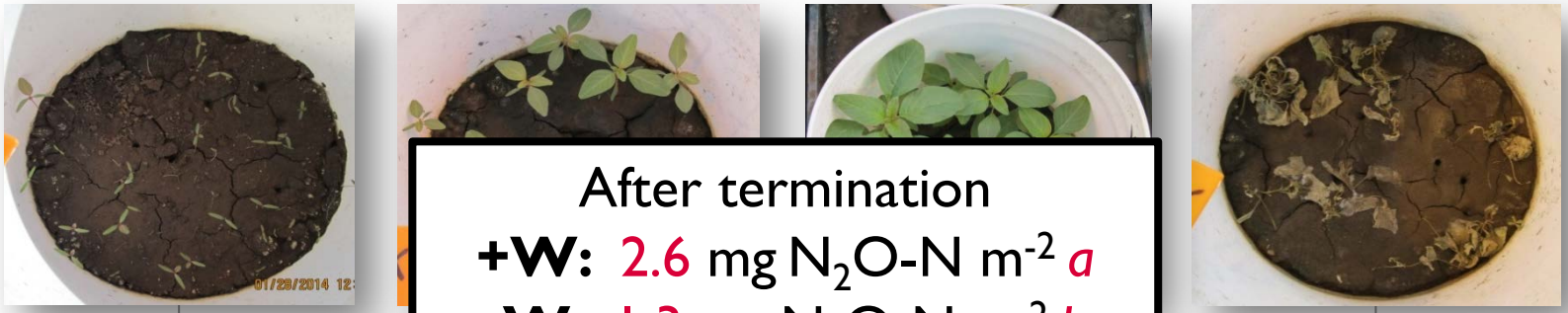
- Effect of *weed*:

Study	Effect	P-value for N_2O Emissions		
		Before termination	After termination	Total
Non-crop GH	*weed*	0.1626	0.0003	0.0004
Non-crop field	*weed*	0.3972	0.8004	0.4028
Corn	*weed*	0.5636	0.5151	0.5038
Soybean	*weed*	0.1537	0.7189	0.2409

Poster 75

Results: N_2O

15 DAP | 25 DAP | 32 DAP | 39 DAP 7 DAA



After termination

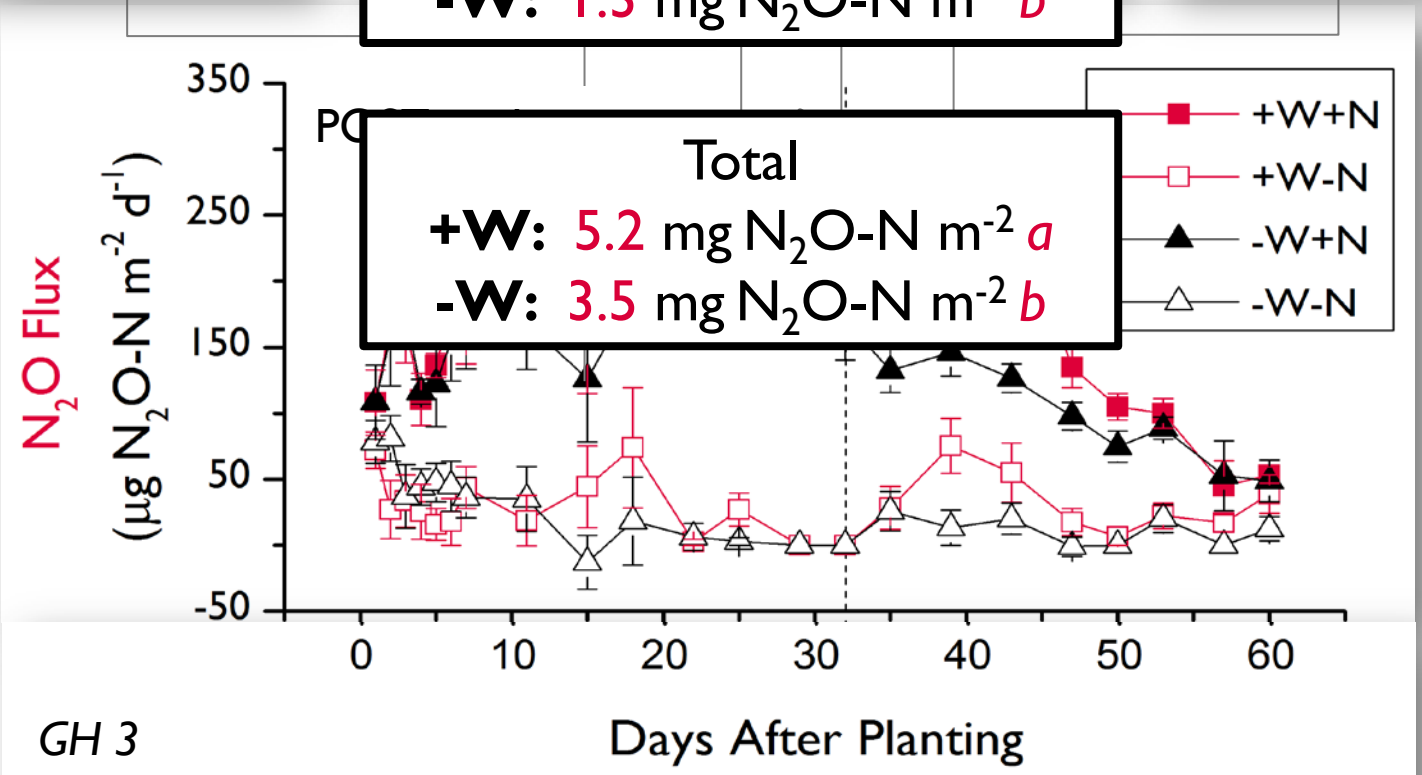
+W: 2.6 mg N_2O-N m^{-2} *a*

-W: 1.3 mg N_2O-N m^{-2} *b*

Total

+W: 5.2 mg N_2O-N m^{-2} *a*

-W: 3.5 mg N_2O-N m^{-2} *b*

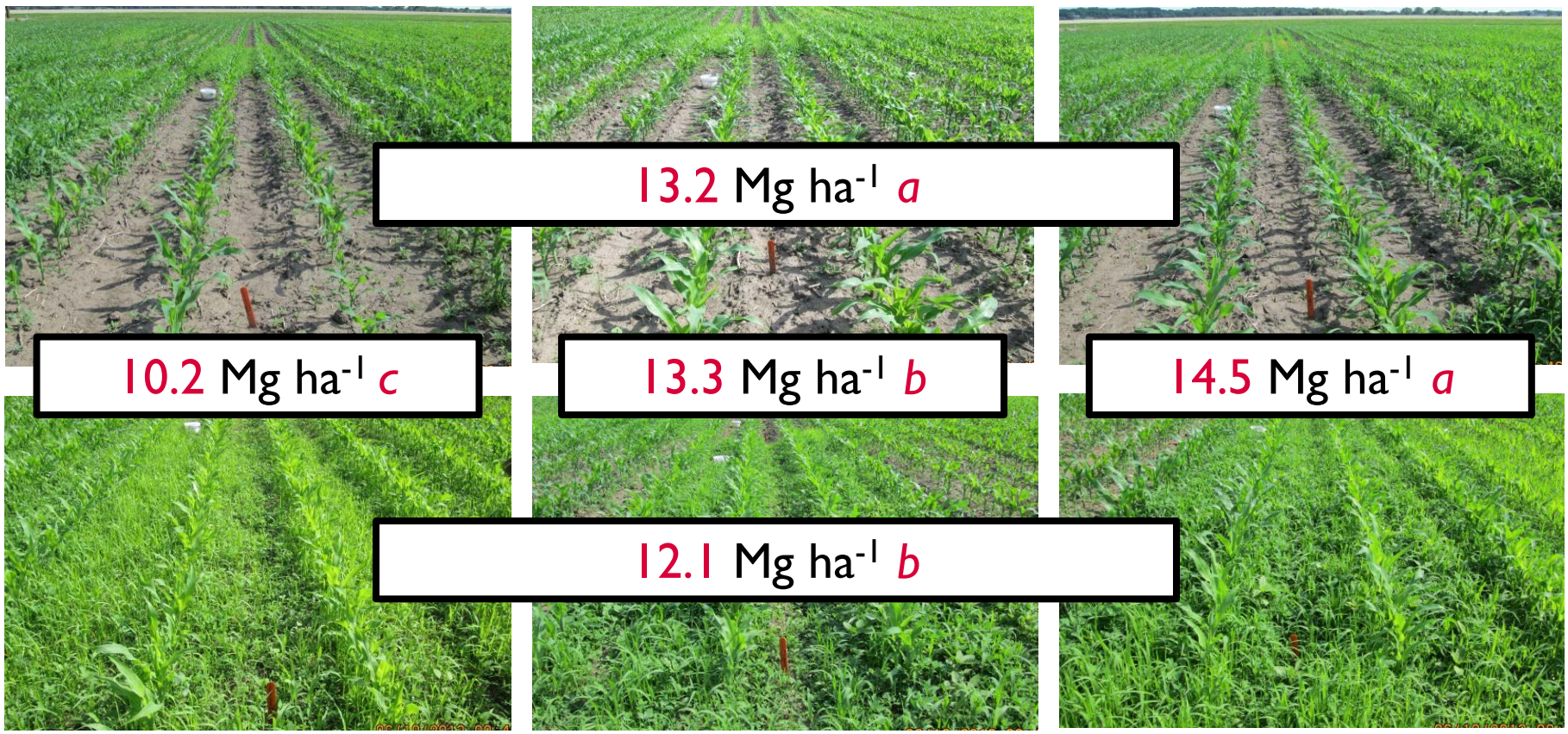


GH 3

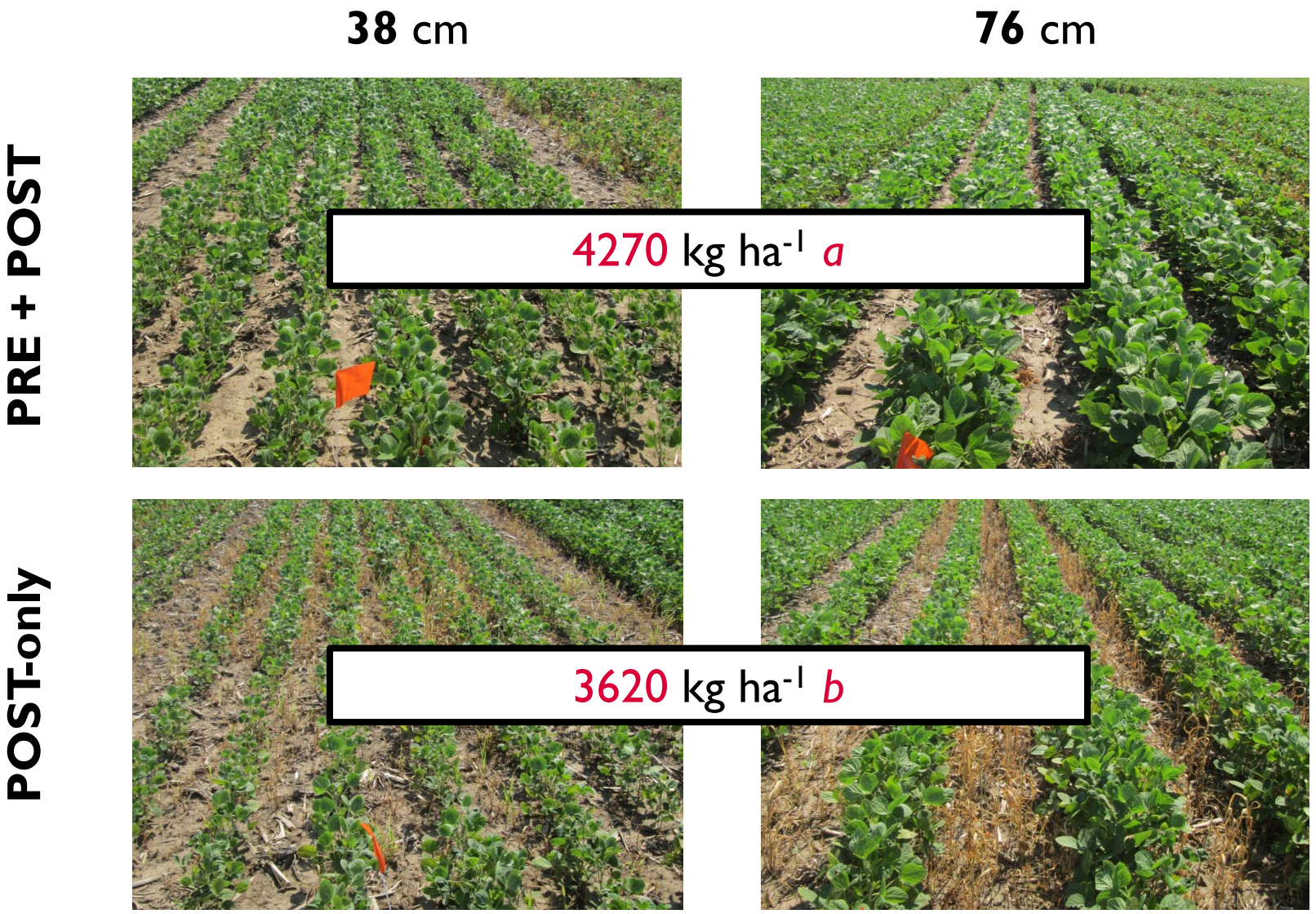
Results: Yield

Study	P-value for Yield		
Corn	*weed*	*N*	*weed*N*
	<0.0001	<0.0001	0.8997
Soybean	*weed*	*width*	*weed*width*
	0.0007	0.6018	0.5825

Results: Yield



Results: Yield



Summary

- More N = more N_2O emissions
- In GH, weeds increased emissions after termination and total emissions
- Weeds didn't significantly influence emissions in field studies

- Corn yield increased with more N
- Corn and soybean yield increased with use of a PRE

Conclusions

- Able to detect differences in how weeds impact N_2O emissions
- At the field-scale, season-long emissions were comparable for PRE + POST and POST-only
  - Magnitude of emissions (10-100x)
  - Biotic and abiotic variability

- N management more important in regulating N_2O
- Use of a PRE still important to prevent yield loss

Questions?

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