Weed-Soybean Competition in a Long-Term Cropping Systems Experiment

Margaret Ball and Matthew Ryan

Cornell University, Field of Soil and Crop Sciences

7 January 2015

Northeast Weed Science Society of America

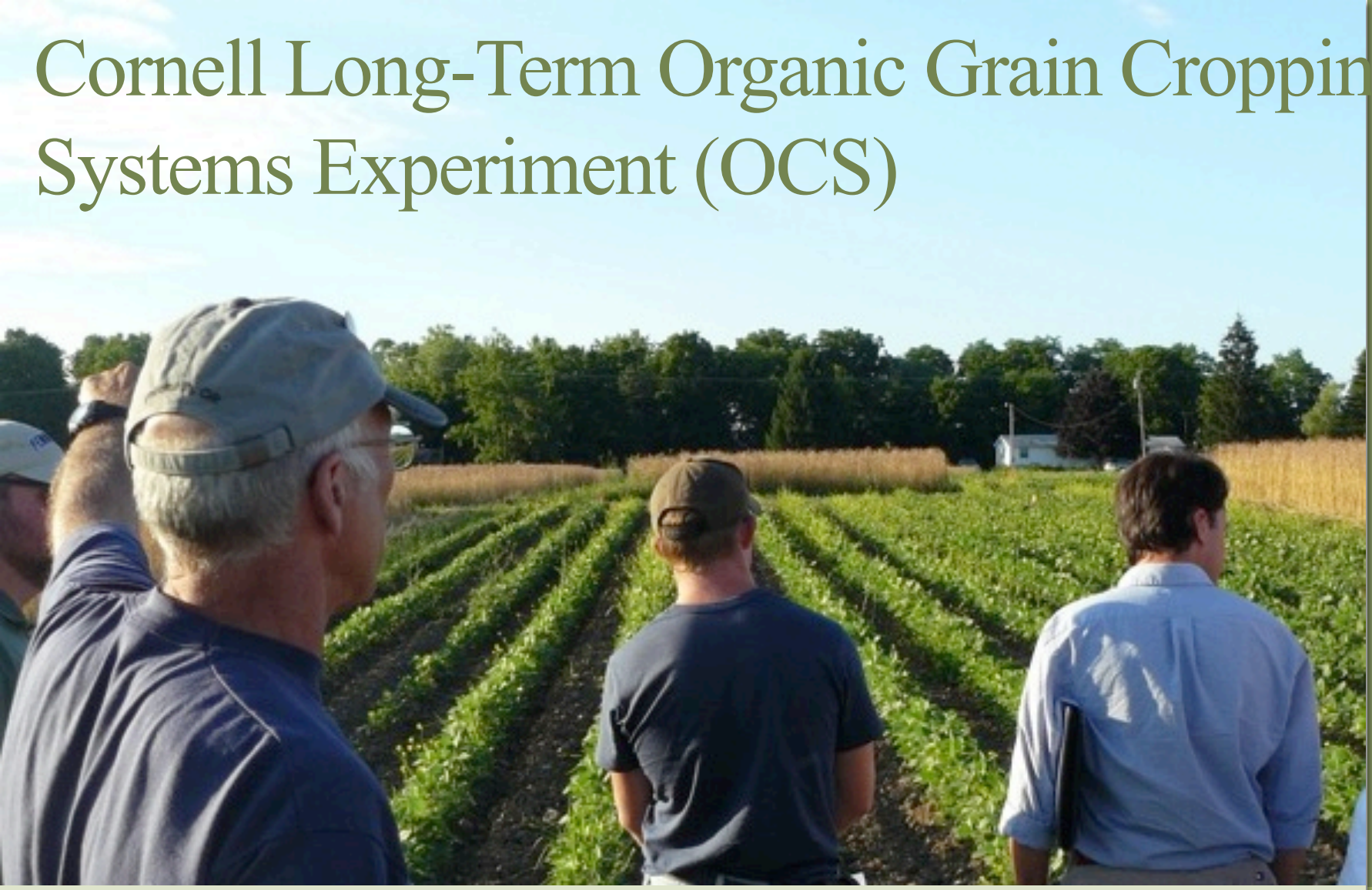
Background

- Weeds are a major problem for organic growers (DeDecker et al. 2014)
- Ecological weed management challenge: Reduce weeds' competitive impact?
- Few long-term studies comparing multiple organic cropping systems

Objectives

- Compare four organic management systems in terms of
  - Weed suppression
  - Weed community composition
  - Weed-crop competition in soybean.

Cornell Long-Term Organic Grain Cropping Systems Experiment (OCS)

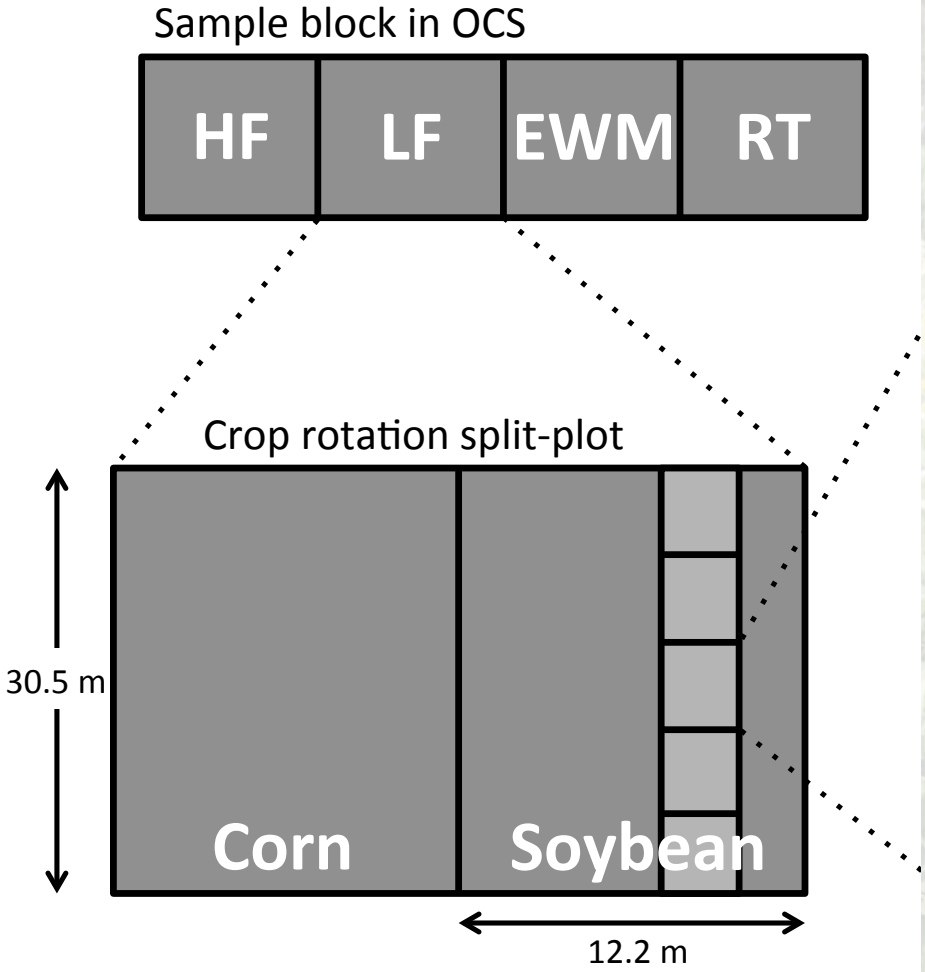


Caldwell B, Mohler CL, Ketterings QM, DiTommaso A (2014). Yields and Profitability during and after Transition in Organic Grain Cropping Systems. Agron. J. 106:871–880

Cropping Systems in the OCS

	HF High Fertility	LF Low Fertility	EWM Enhanced Weed Mgmt.	RT Reduced Tillage
Approach	Maximize **yield** with more inputs	Maximize **profit** with fewer inputs	Better long-term results with **fewer weeds**	Better long-term results with **improved soil**
Fertility	Red clover, Poultry compost	Red clover	Red clover	Winter pea, Poultry compost
Tillage	Moldboard plow	Same as HF	Same as HF	Chisel plow, zone tillage
Cultivation	Tine weeding, inter-row cultivations	Same as HF	Extra tine weedings and cultivations	Same as HF
Rotation	Corn – soybean– spelt – barley/ buckwheat – soybean – spelt	Corn – soybean– spelt	Corn – soybean– spelt	Corn –soybean – spelt – barley/ buckwheat – soybean – spelt

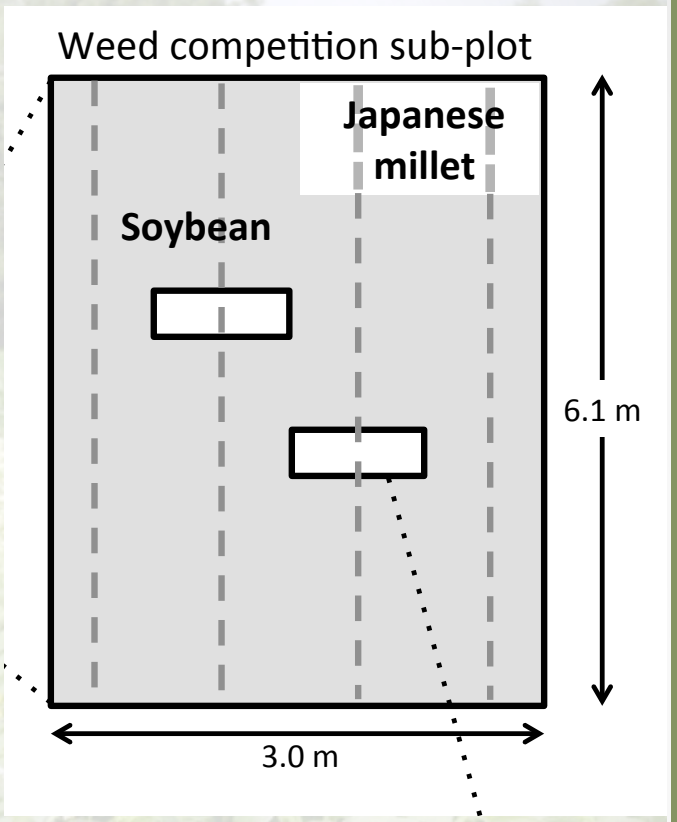
Nested Competition Experiment



Treatments	
SM	Standard Management
WF	Weed Free
SS	Supplemented Seedbank
N	Nitrogen Added
P	Phosphorous Added

Methods - Field

- Planting, 30 May
- Biomass sampling, 18 August
- Harvest, 6 October



Methods - Statistics

- ANOVA and Tukey-Kramer means comparison (SAS)
  - Weed biomass log(x+1) transformed for equal variance
- Curve fitting with rectangular hyperbola (R 3.1.0)

$$Y_c = \frac{\frac{1}{a_0} N_c}{1 + i_w N_w}$$

Y_c	Soybean yield or biomass
$\frac{1}{a_0}$	Weed-free individual crop plant weight
N_c	Crop density
i_w	Yield loss per unit weed biomass as $N_w \rightarrow$ zero
N_w	Weed biomass

Results

- Weed suppression
- Weed community composition
- Weed-crop competition

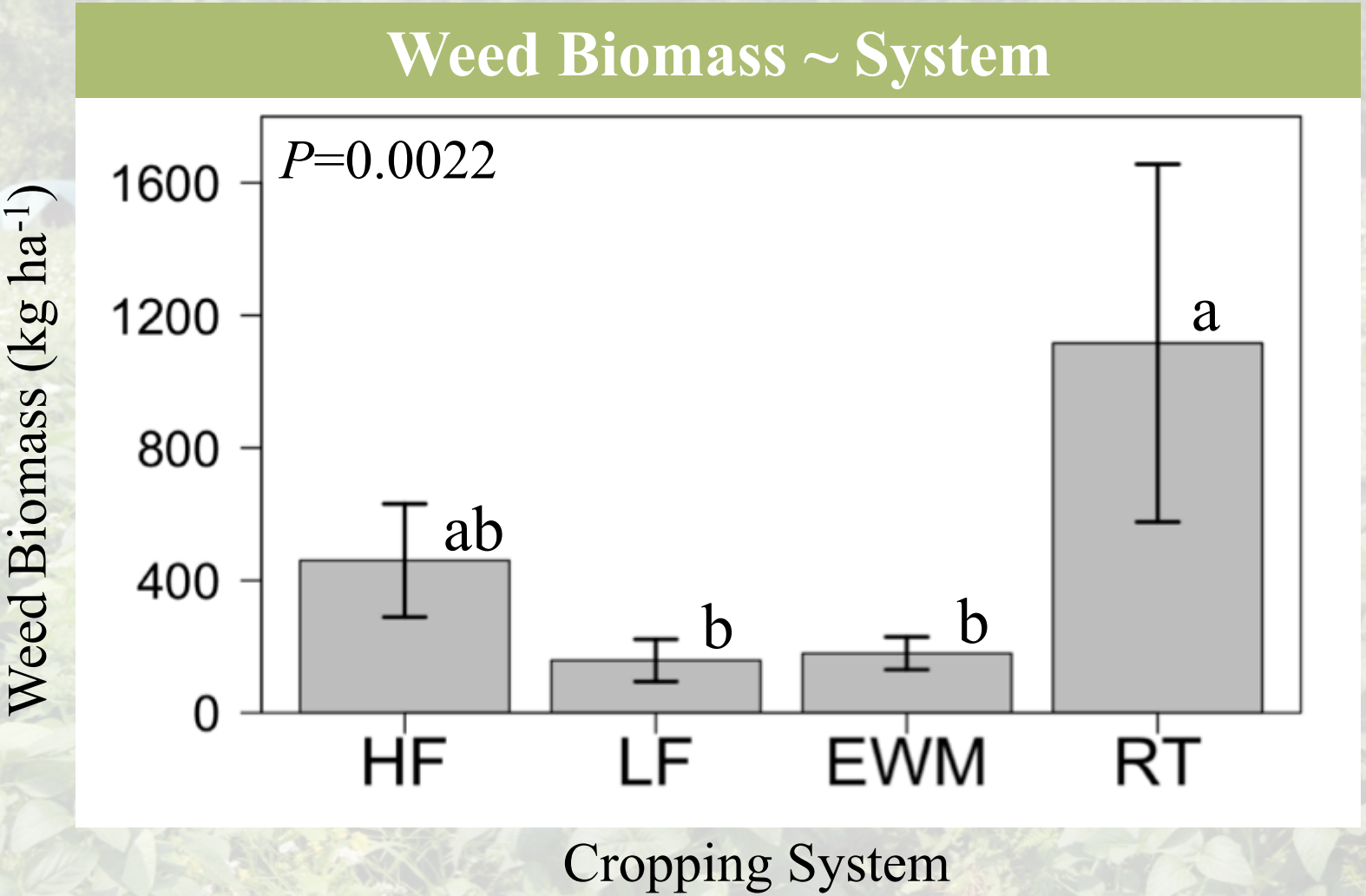
HF

LF

EWM

RT

Weed Suppression



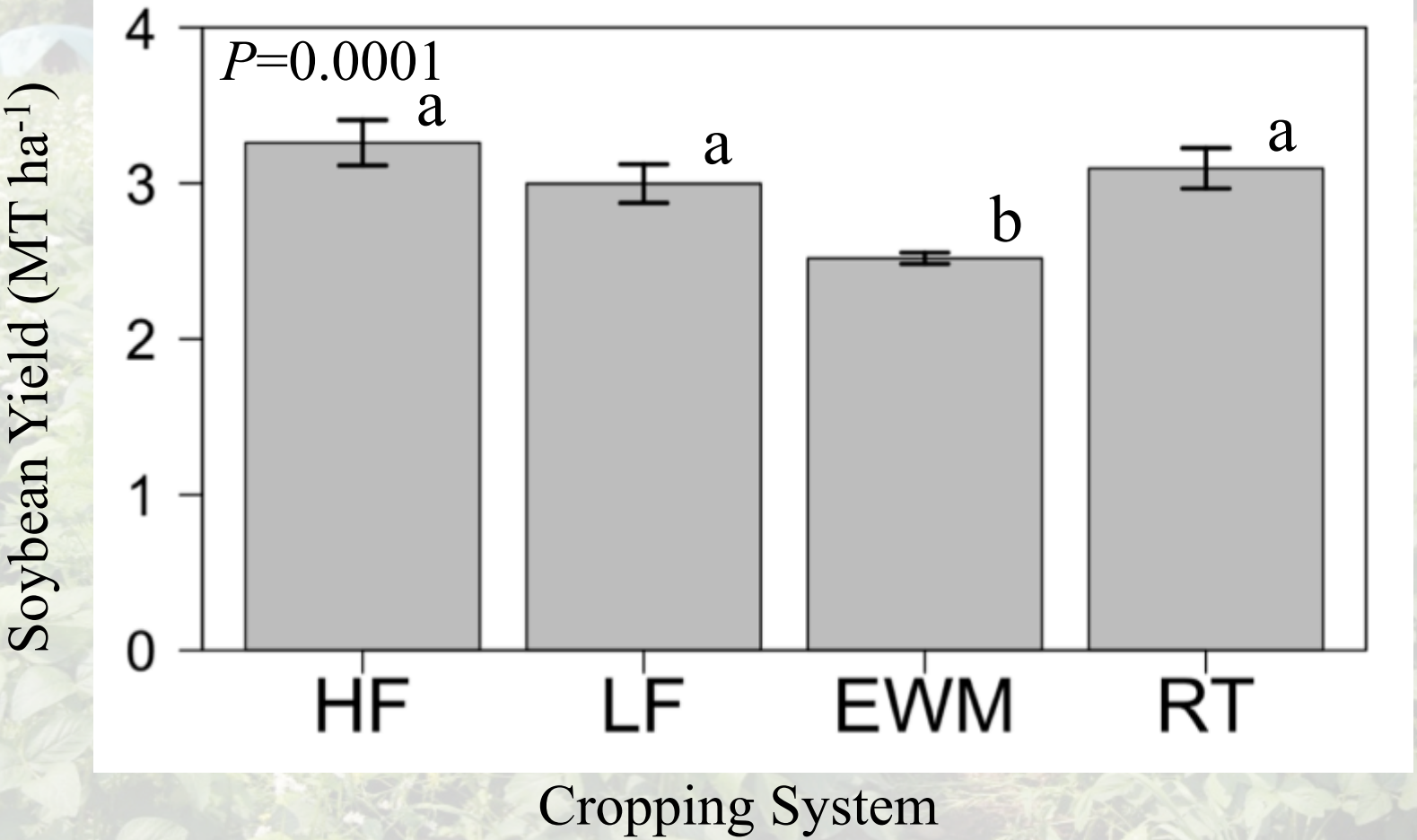
Similar letters indicate no significant difference. Bars represent standard error

Weed Community Composition

Dominant Weed Species by % Total Biomass					
Species	**All**	**HF**	**LF**	**EWM**	**RT**
Fagopyrum esculentum Moench	**33**	**41**	-	-	**42**
Setaria faberi	**21**	4	**26**	**39**	**23**
Cirsium arvense	**10**	-	0.3	-	**15**
Sonchus arvensis L.	**9**	**19**	**56**	1	0.5
Ambrosia artemisiifolia L.	**6**	**11**	**5**	**26**	1
Sinapis arvensis	6	**8**	1	**21**	3
Chenopodium album	5	1	-	-	**8**
Amaranthus spp.	4	-	-	-	**6**
Taraxacum officinale	2	**10**	-	-	-
Calystegia sepium	2	0.3	**6**	**11**	0.22

Weed-Crop Competition

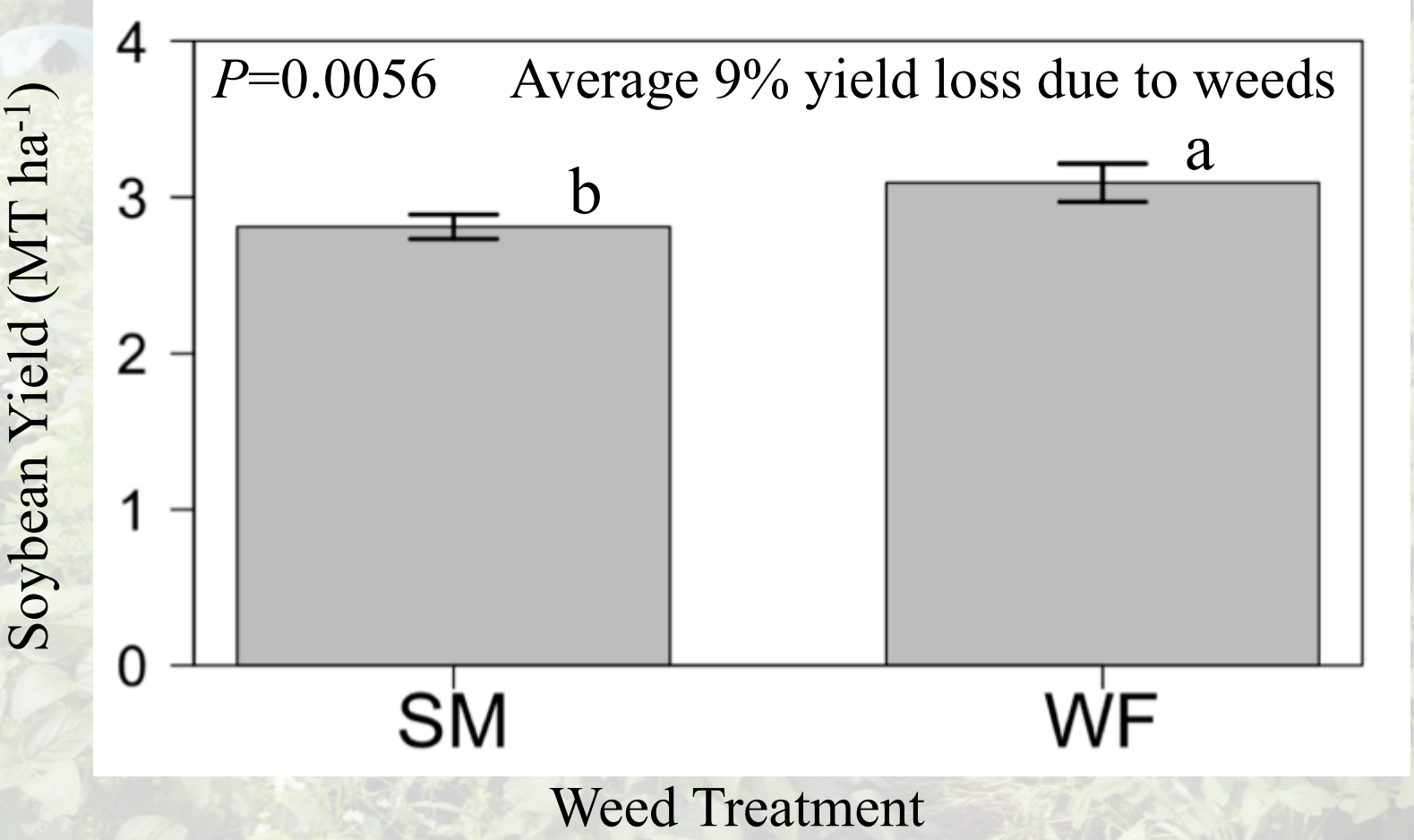
Yield ~ System * Treatment



Similar letters indicate no significant difference. Bars represent standard error

Weed-Crop Competition

Yield ~ System * Treatment



Similar letters indicate no significant difference. Bars represent standard error

Weed-Crop Competition

Soybean Biomass ~ Weed Biomass

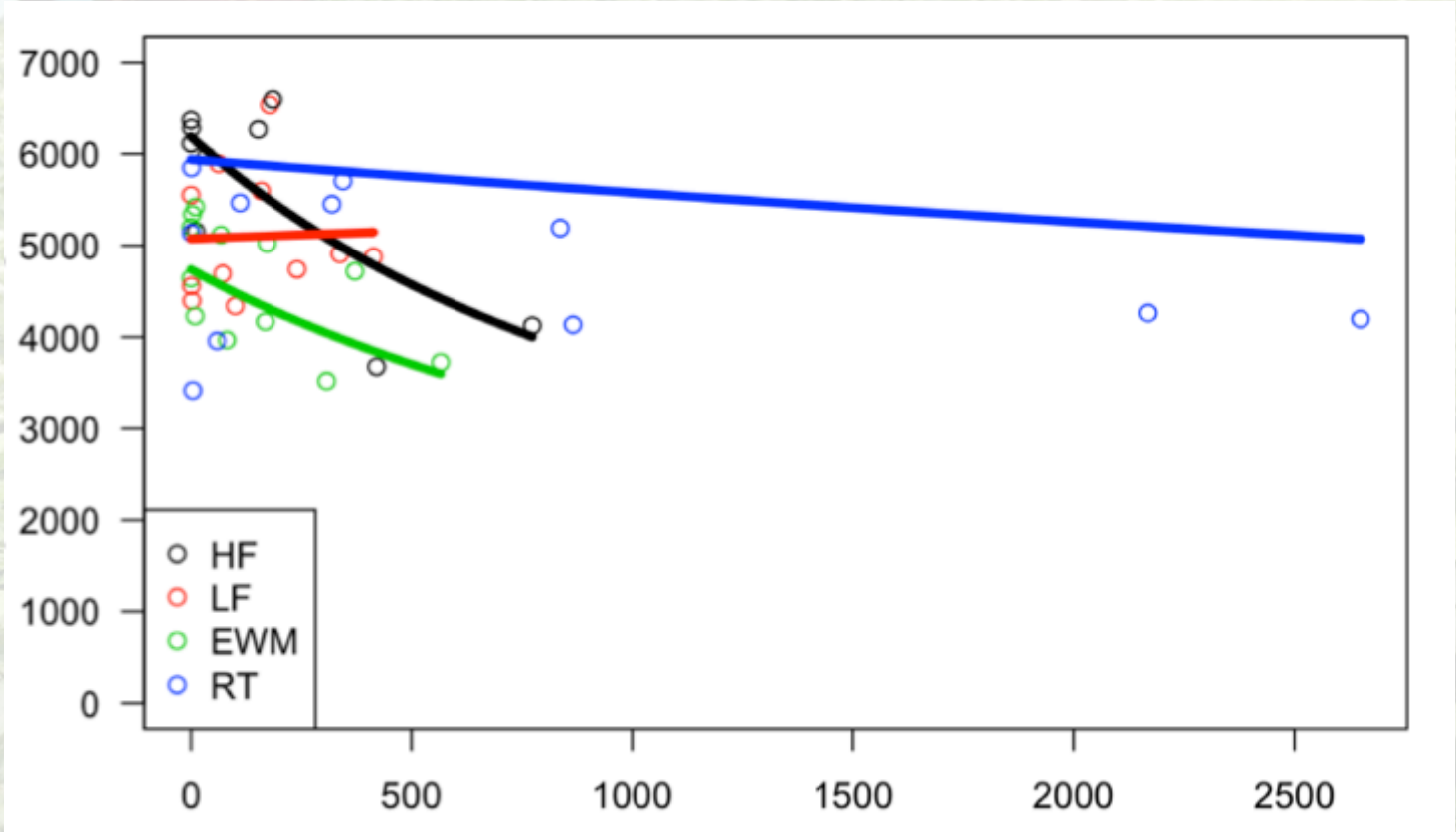
$$Y_c = \frac{\frac{1}{a_0} N_c}{1 + i_w N_w}$$

System	*P*		a_0	i_w
All	0.076	*	0.00969	0.000136
HF	0.064	*	0.00808	0.000705
LF	0.92		0.00985	-0.000033
EWM	0.07	*	0.01055	0.000559
RT	0.40		0.00842	0.000064

* = $P < 0.1$

Weed-Crop Competition

Soybean Biomass ~ Weed Biomass



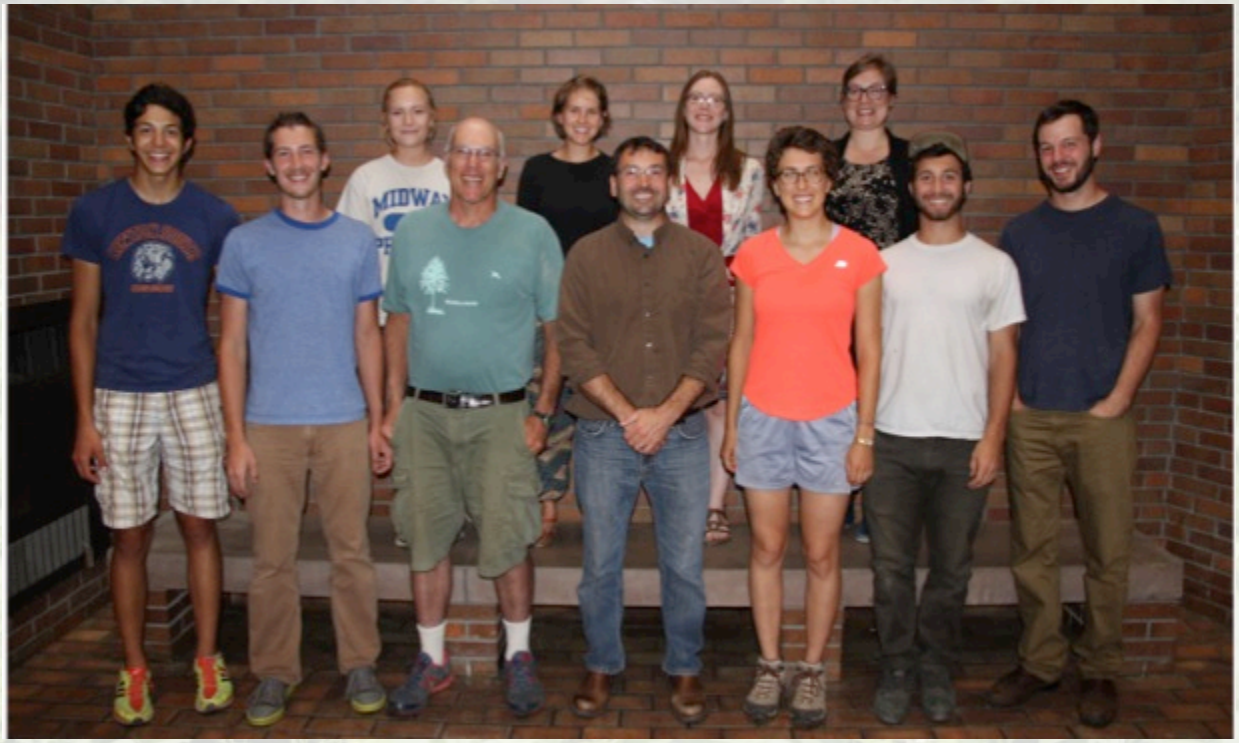
Conclusions

- RT system - highest weed biomass
- EWM system - lowest yield (root damage?)
- Average 9% yield loss to weeds, over all systems
- LF system most favorable for soybean
  - Competitive yield
  - Good weed suppression
  - Low input costs

Further Research

- Repeat experiment (2015)
- Added nutrient treatments
- Soil tests to compare systems
  - NO3 & NH4
  - N mineralization potential
  - Particulate Organic Matter
  - Total soil C & N
  - Bulk density
- Soybean N fixation

Thank you! Questions?



- Matthew Ryan, Antonio DiTommaso, Laurie Drinkwater
- Brian Caldwell, Chris Pelzer, Ann Bybee-Finley, Jeff Liebert, Carri Marschner, Heather Scott, Emily Reiss, Bryan Emmett
- Ashley, Jason, Lauren, Alex, Andrew, Sarah