

**Should spring wheat breeding for organically managed systems be conducted on organically managed land?**

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# Outline

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- Background
- What we did.
- What happened.
- What we thought about what happened.
- What did we learn.



# Background

- Research limited
- Interest in crop breeding
- Weeds are a problem
- Competitive ability
- Semi-dwarf wheat cultivars
- Competitive traits



# Background

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- Organic breeding not a priority
  - Increased environmental variability
  - Similar Rankings (quality and disease)
  - Similar Heritability estimates (Maize)
- Trait differences
  - Complexity
  - GxE issues
  - Rank Differences
- Suggested to select for Organic on Organic

# What we did.

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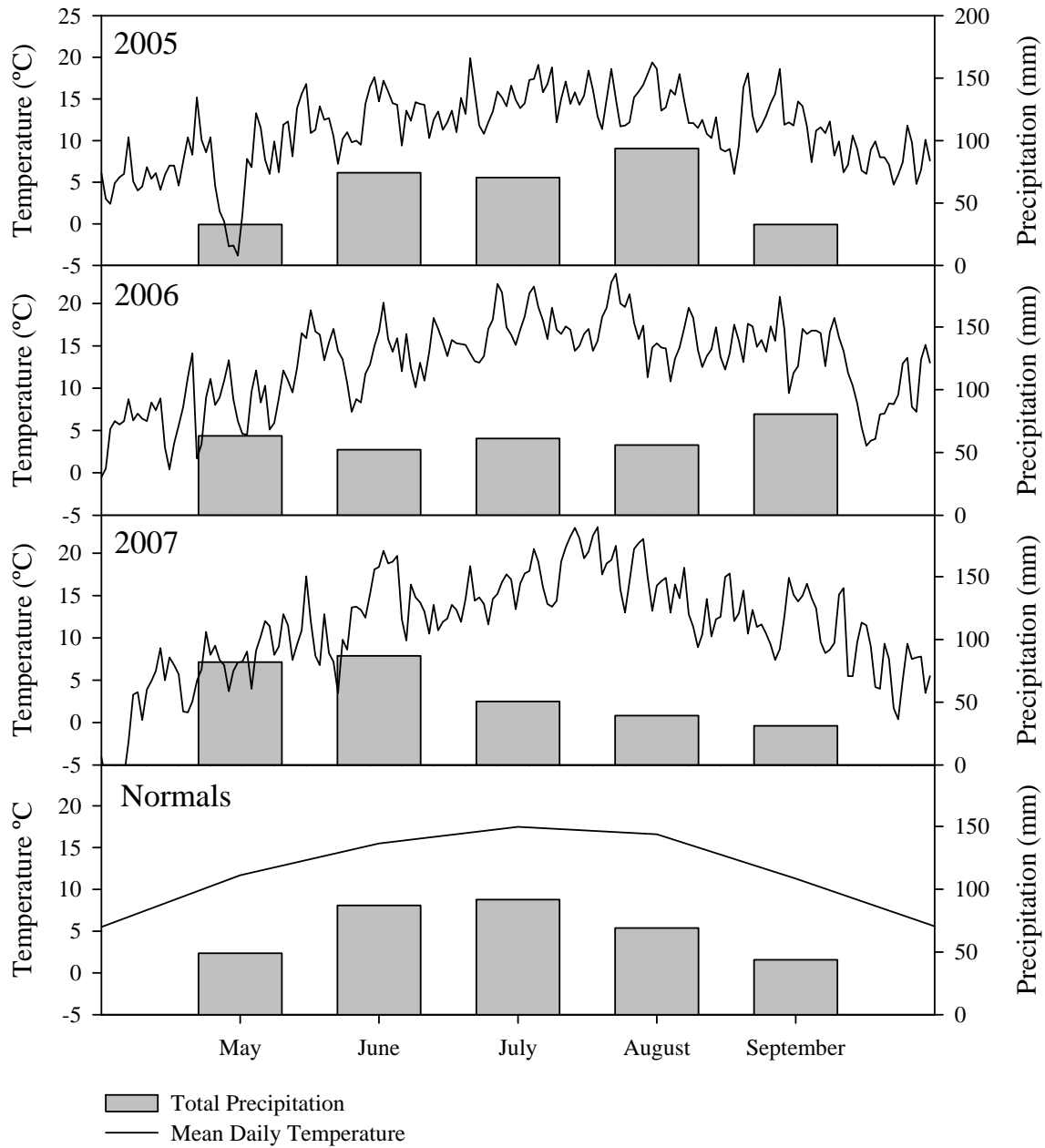
- AC Barrie x Attila population
- Two Sites, one conventional one organic
- Three years
- Data recorded:
  - early season vigour, plant height, number of spikes  $\text{m}^{-2}$ , grain yield, 1000 kernel weight, kernels spike<sup>-1</sup>, test weight, harvest index, grain protein, flag leaf area, weed biomass, and days from seeding to anthesis, and physiological maturity.

# What we did.

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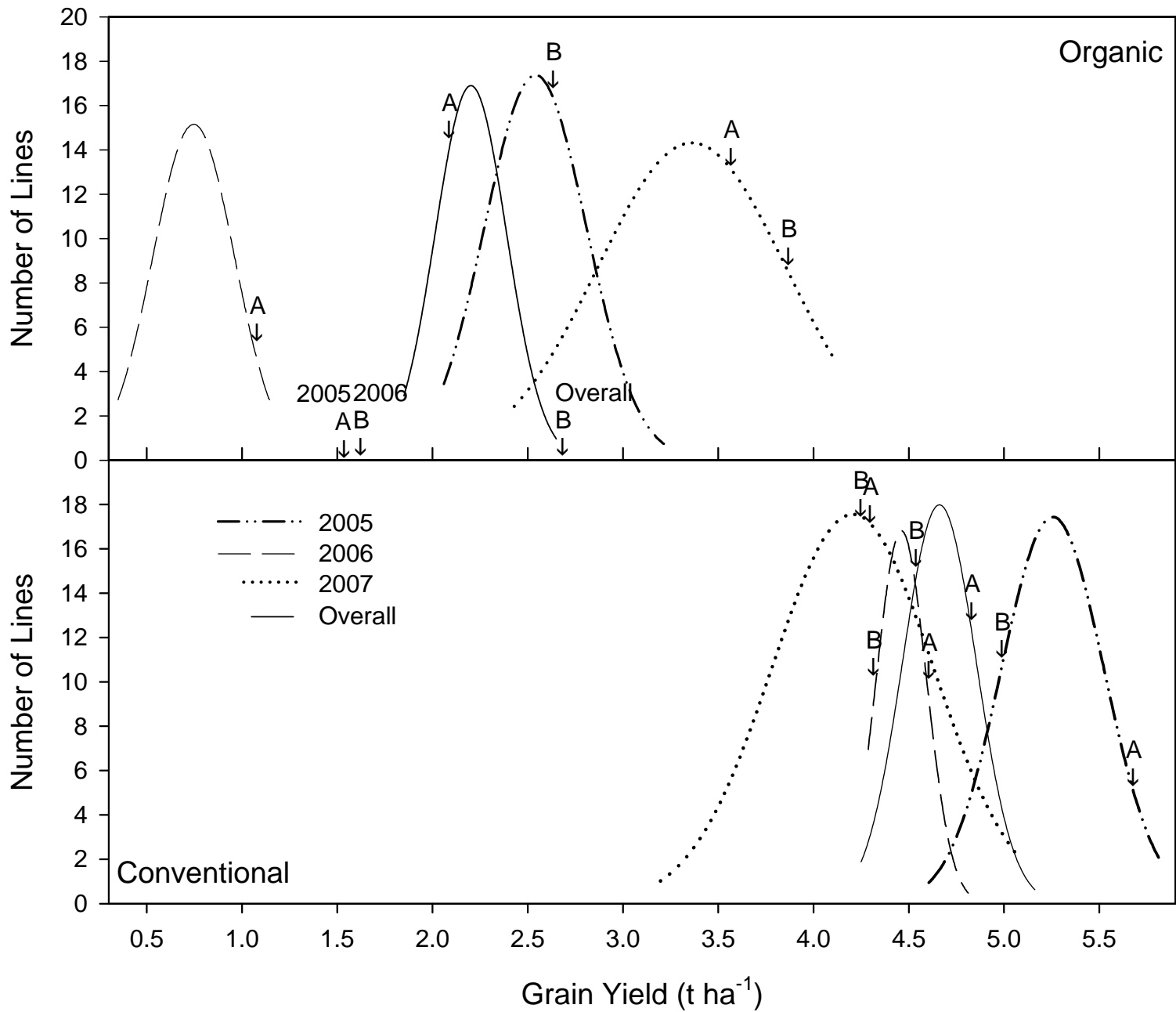
- Genetic parameters
  - Heritability, Response to Selection, Genetic Correlations
- Compared population distributions each year
- Compared selected lines within each system





# What Happened

Variable	AC Barrie		Attila		Diff Between Parents		Population Mean		SE Of Diff
	Con	Org	Con	Org	Con	Org	Con	Org	
<b>Grain Yield (t ha<sup>-1</sup>)</b>	<b>4.54*</b>	<b>2.68*</b>	<b>4.83**</b>	<b>2.09**</b>	<b>-0.29</b>	<b>0.59*</b>	<b>3.88*</b>	<b>1.85*</b>	<b>0.67</b>
Spikes m <sup>-2</sup>	536	322	414	336	122*	-14	454	343	83
Plant Height (cm)	86	84	71	67	15*	17**	76	74	7.2
Harvest Index (%)	45	45	49	42	-4	3	47	42	2.3
<b>Grain Protein (%)</b>	<b>14.1**</b>	<b>15.2**</b>	<b>12.8**</b>	<b>14.4**</b>	<b>1.3**</b>	<b>0.8**</b>	<b>13.0</b>	<b>14.8</b>	<b>0.58</b>
Weed Biomass (g m <sup>-2</sup> )	0	10	1**	20**	-1	-10	1*	13*	3.5
Days to Anthesis	59	53	58	53	1	0	59	53	3.3
Days to Maturity	90	90	95	90	-5	0	94	92	3.5
Grain Fill Duration (Days)	32*	37*	37	37	-5*	0	35	39	3.9



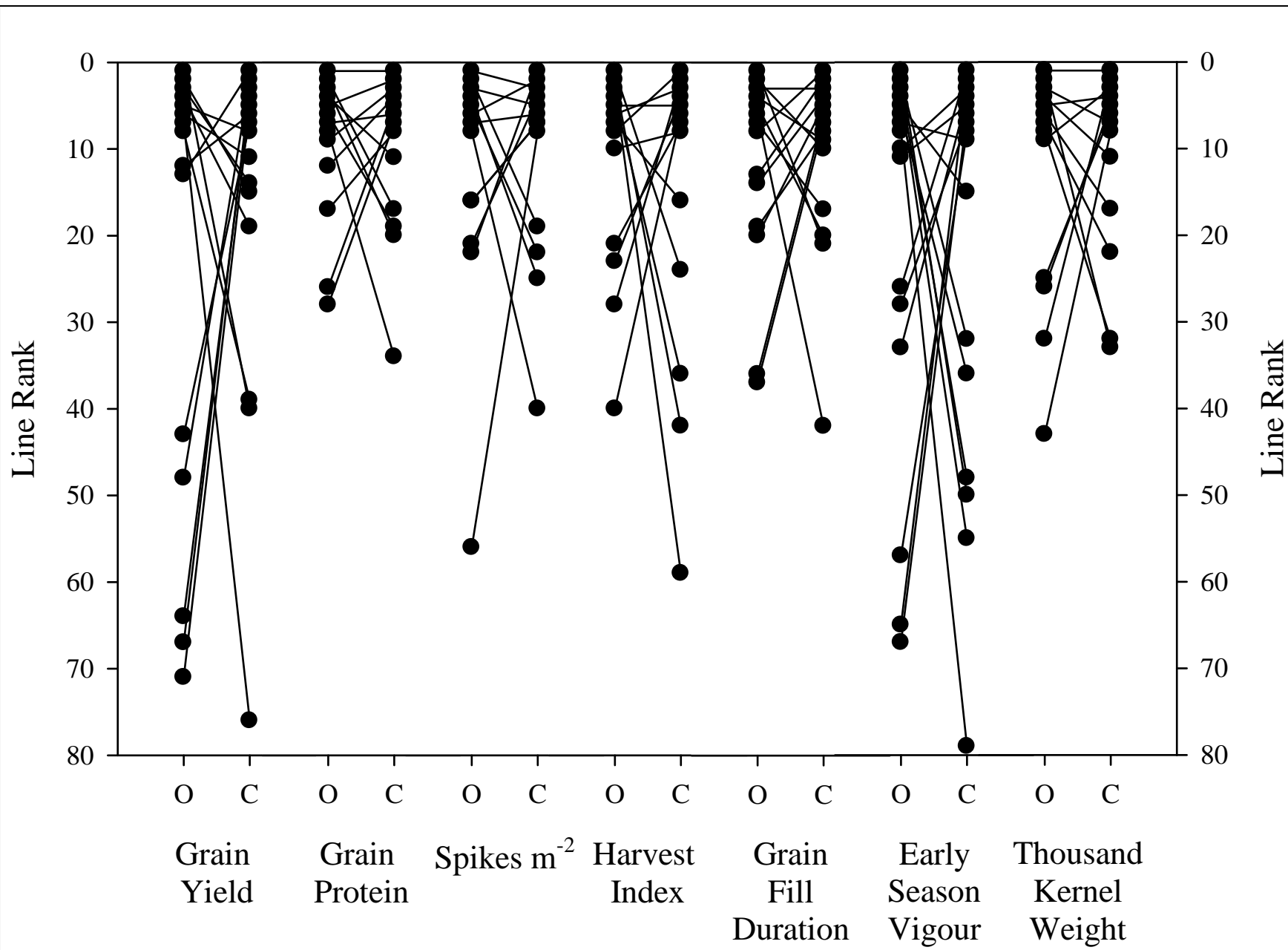


# What Happened

Variable	Heritability Estimate (%)				SR <sub>e</sub> <sup>a</sup>		SR <sub>0</sub> <sup>a</sup>	
	Conv <sup>b</sup>	SE <sup>c</sup>	Org <sup>b</sup>	SE	Conv	Org	Conv	Org
Grain Yield (t ha <sup>-1</sup> )	22	5	14	5	0.25	0.13	0.54	0.47
Spikes m <sup>-2</sup>	22**	5	4**	4	30	6	54**	35**
Plant Height (cm)	67**	4	43**	5	9	7	12	11
Test Weight (kg hl <sup>-1</sup> )	51**	5	26**	6	1.4	1.0	1.8	1.8
Kernels spike <sup>-1</sup>	47	5	37	6	5	4	7*	5*
1000 Kernel Weight (g)	59**	5	39**	5	3	3	4	4
Harvest Index (%)	31	5	37	6	2	5	3**	6**
Flag Leaf Area (cm <sup>2</sup> )	36	5	32	6	11	9	3	3
Grain Protein (%)	62**	6	31**	8	0.83	0.45	1.1	0.8
Weed Biomass (g m <sup>-2</sup> )	7	4	2	2	-0.13	-0.45	-0.3**	-0.9**
Early Season Vigour	6	3	4	3	0.1	0.1	0.3	0.2
Days to Anthesis	37*	6	53*	5	-1	-3	-2**	-4**
Days to Maturity	35	5	44	5	-2	-4	-4*	-6*
Grain Fill Duration (Days)	21	6	27	5	1	2	3*	4*

# What Happened

Trait	Rank ( $r_s$ )	Lines selected in common		
		10%(8)	15%(12)	20%(16)
Grain Yield	0.33	1	4	8
Spikes m <sup>-2</sup>	0.63	4	7	8
Plant Height	0.86	7	9	10
Test Weight	0.70	3	6	9
Kernel spike <sup>-1</sup>	0.75	3	5	11
1000 Kernel Weight	0.80	4	7	8
Harvest Index	0.63	3	5	7
Flag Leaf Area	0.40	4	7	8
Grain Protein	0.77	4	6	6
Weed Biomass	0.22	2	3	4
Early Season Vigour	0.26	0	3	5
Grain Fill Duration	0.57	2	4	6



# What we thought about it.

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- Heritability similar between systems or lower in organic
- So breeding on organic could produce genetics gains similar to conventional.
- This is not true for all traits.

# What we thought about it

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- Nine traits with 50% or fewer lines selected in common between systems.
- Suggests that selecting in the two systems will result in large differences in lines retained
- Loschenberger and associates (2008) recommend growing parallel trials

# What we thought about it

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- Observed Response to selection did not differ despite different heritability estimates.
- Suggests that genetic gain may not differ between systems
- More difficult to predict under organic

# What we thought about it

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- AC Barrie known to perform well on organic land
- Semi-dwarf trait known to increase yields
- Attila popular cultivar
- Semi-dwarf may not be beneficial for organic

# What we thought about it

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- Weeds were higher in organic
- Weed suppression not a heritable trait (not different from zero)
- Maybe too much random variation in the organic plots
- Weeds controlled with herbicide in conventional

# What we learned

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- Organic management may make reduce the precision of genetic parameters
- Makes prediction difficult, but direct selection should result in observable gains
- Selection on conventional for organic does not result in the same lines as direct selection
- Organic Breeding should be done on organically managed land.



Thank you for your  
attention.

Questions?