Optimizing weed control in grain crops: What works (and what doesn't)

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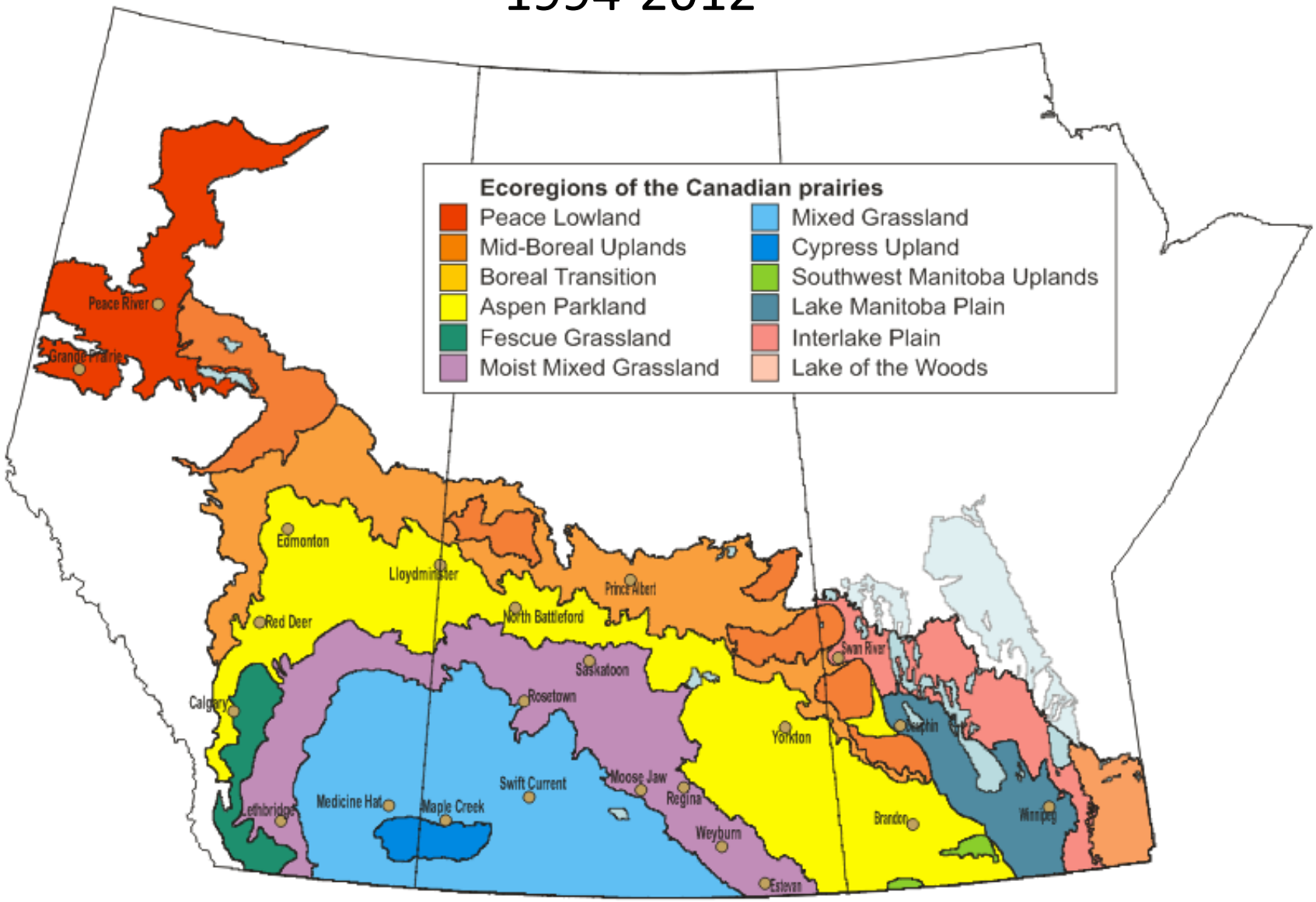
University of Saskatchewan

Long-term Alternative Cropping Systems Study at Scott 1994-2012



Long-term Alternative Cropping Systems Study at Scott 1994-2012

HIGH

RED

Annual grains (DAG)

Low diversity (LOW)

Annuals and perennials (DAP)

ORG

REP 4

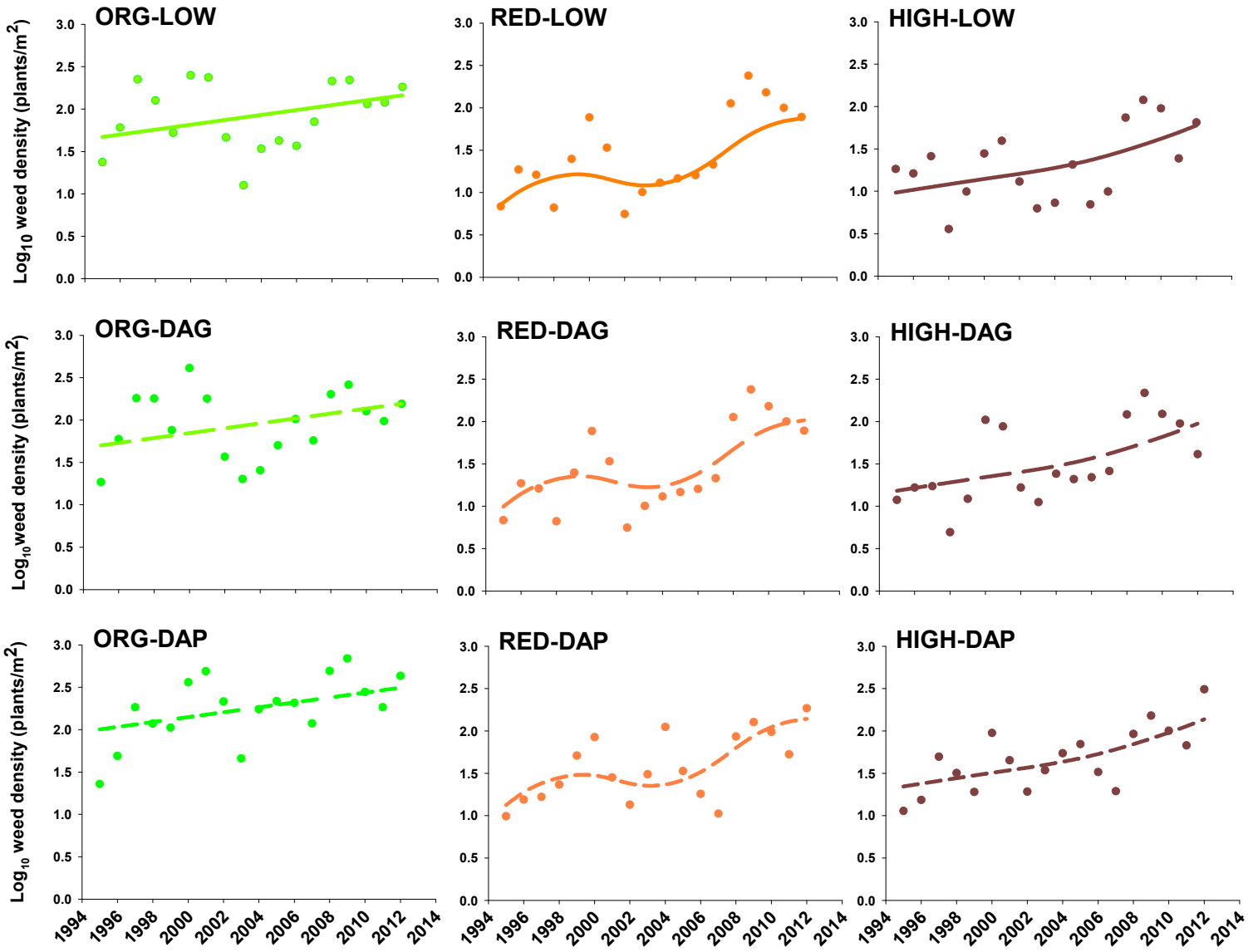
REP 3

REP 2

REP1

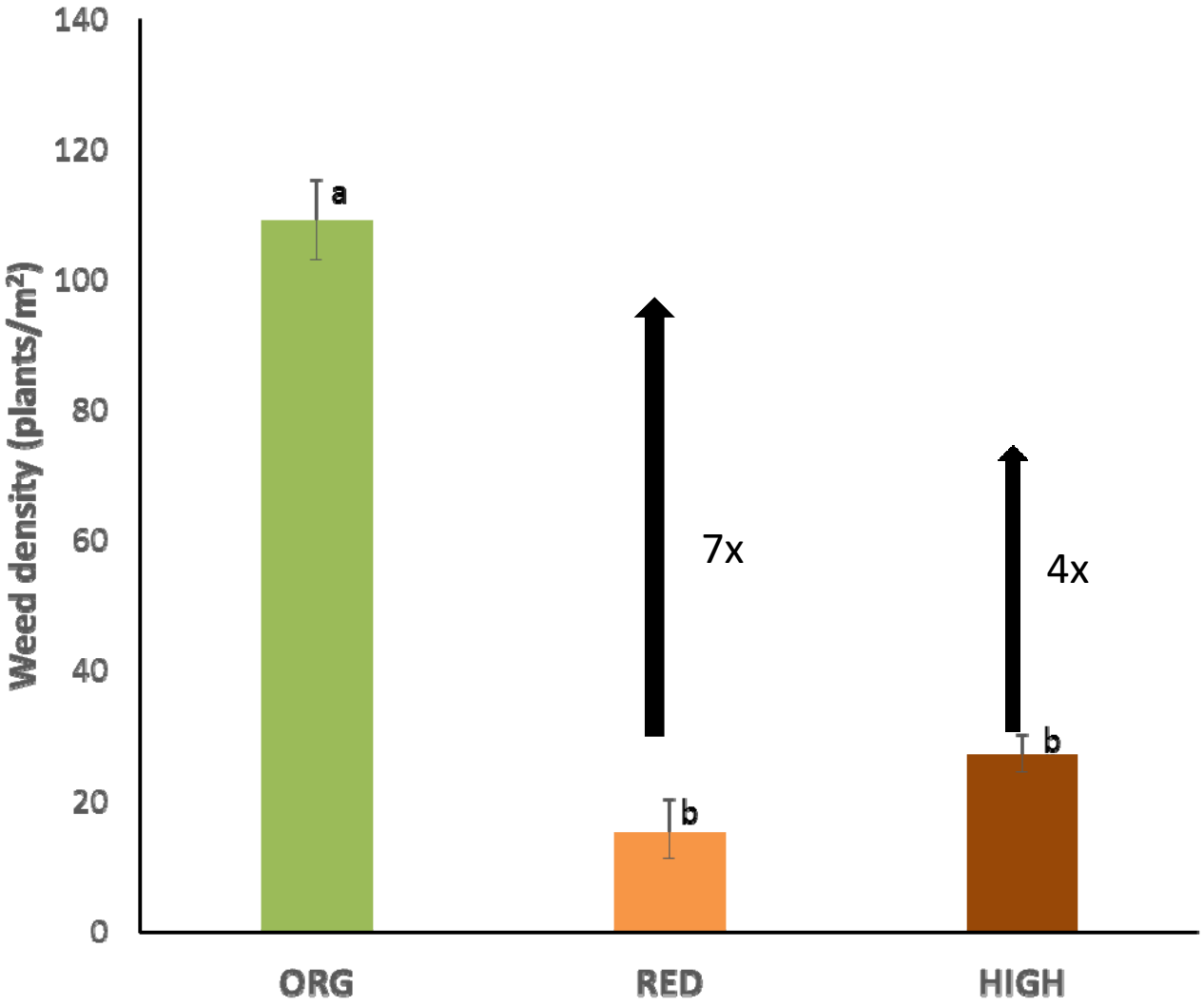
Photograph provided by-Eric Johnson

Long-term trends in residual weed density (average in all crop phases)



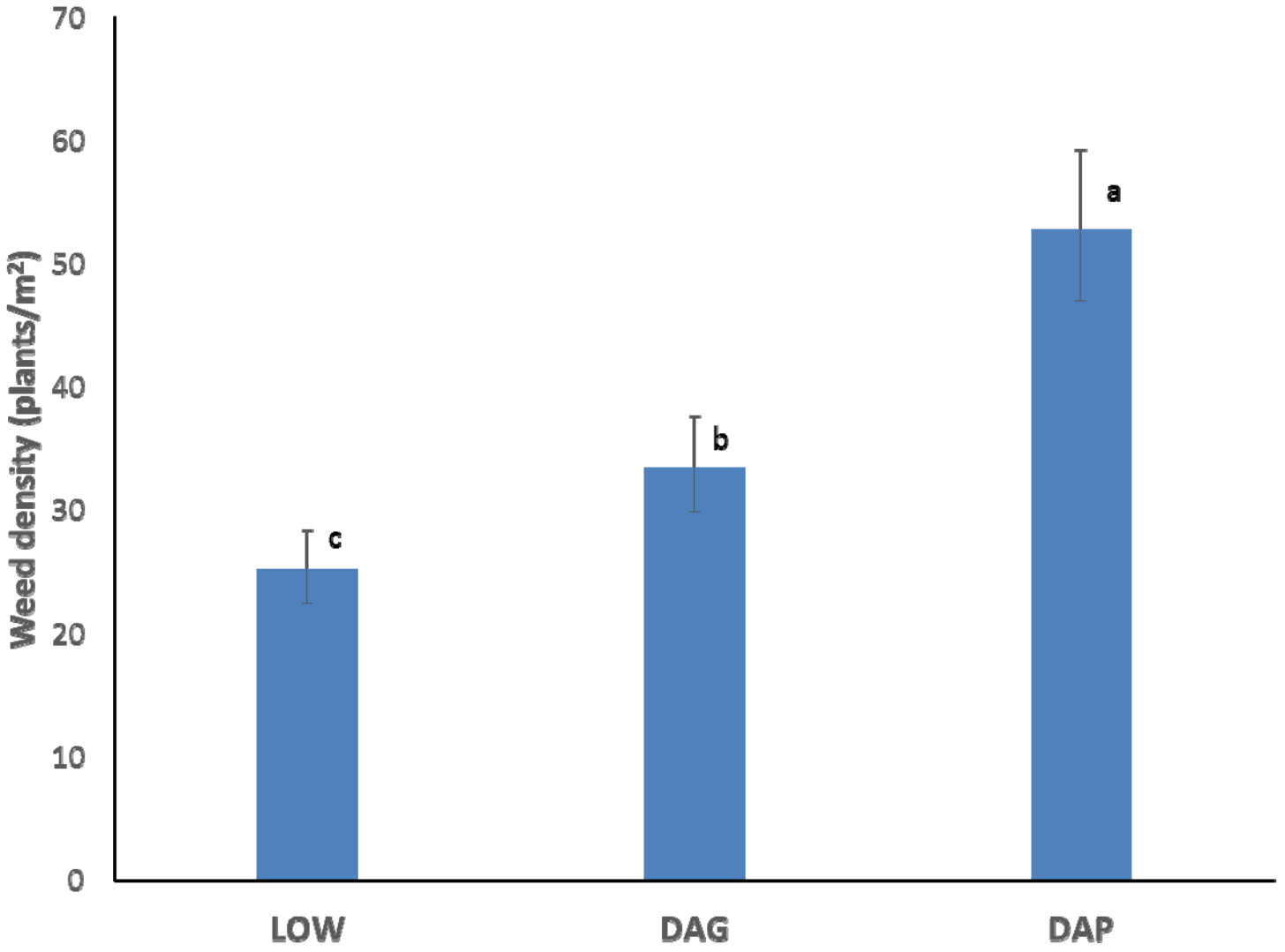
Residual weed density (18 year average in all crop phases)

Differences among input levels

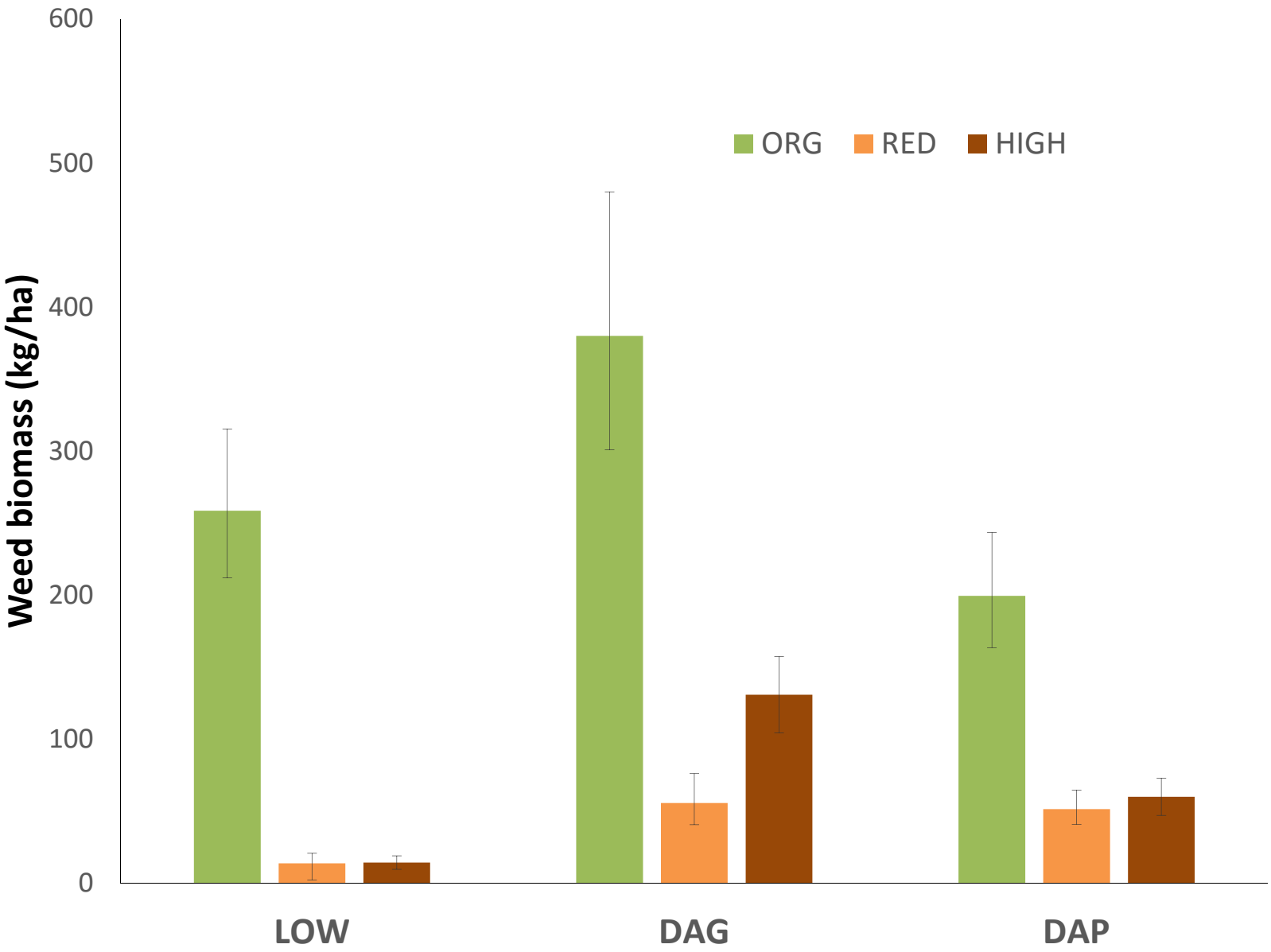


Residual weed density (18 year average)

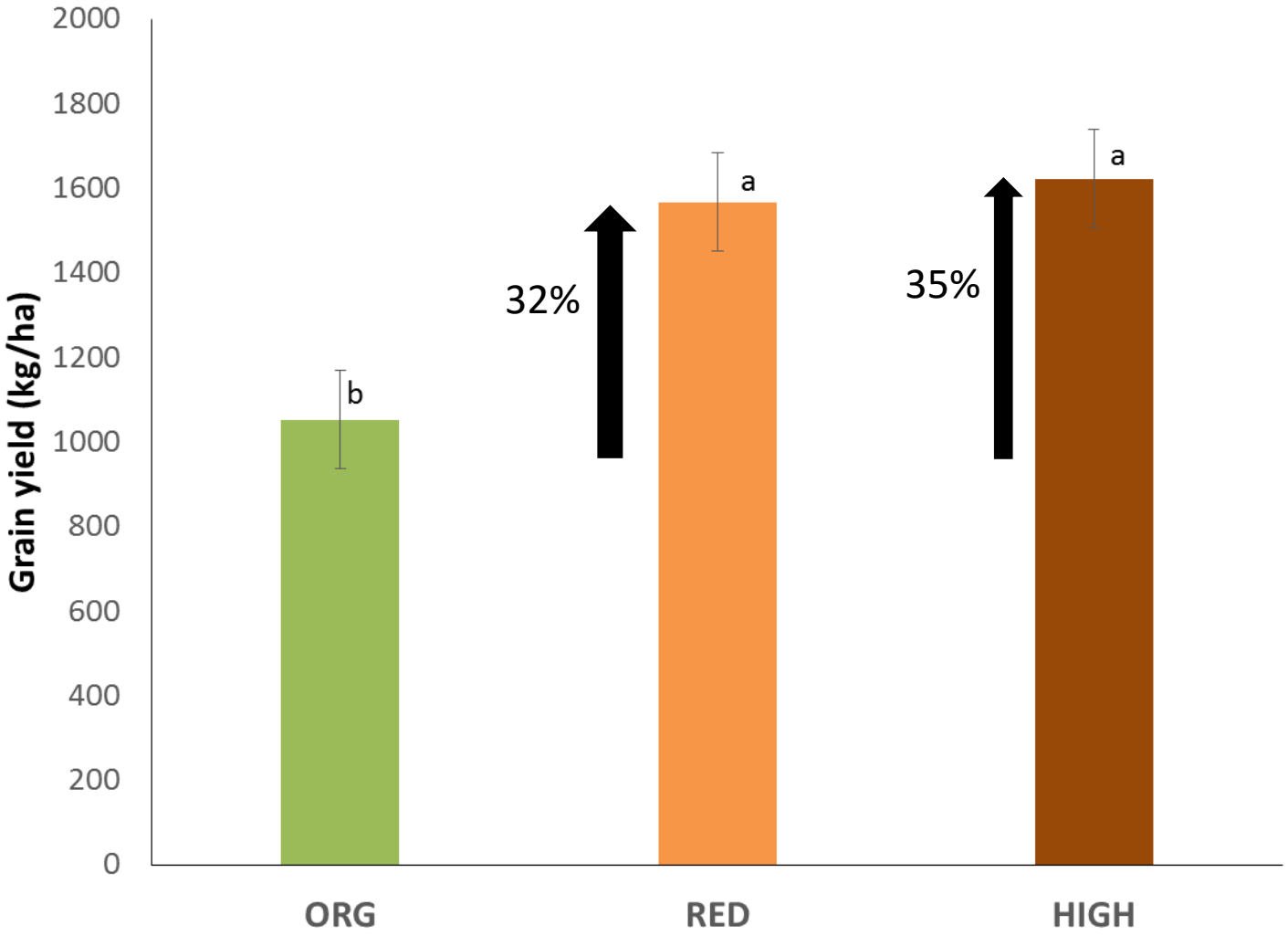
Differences among rotations



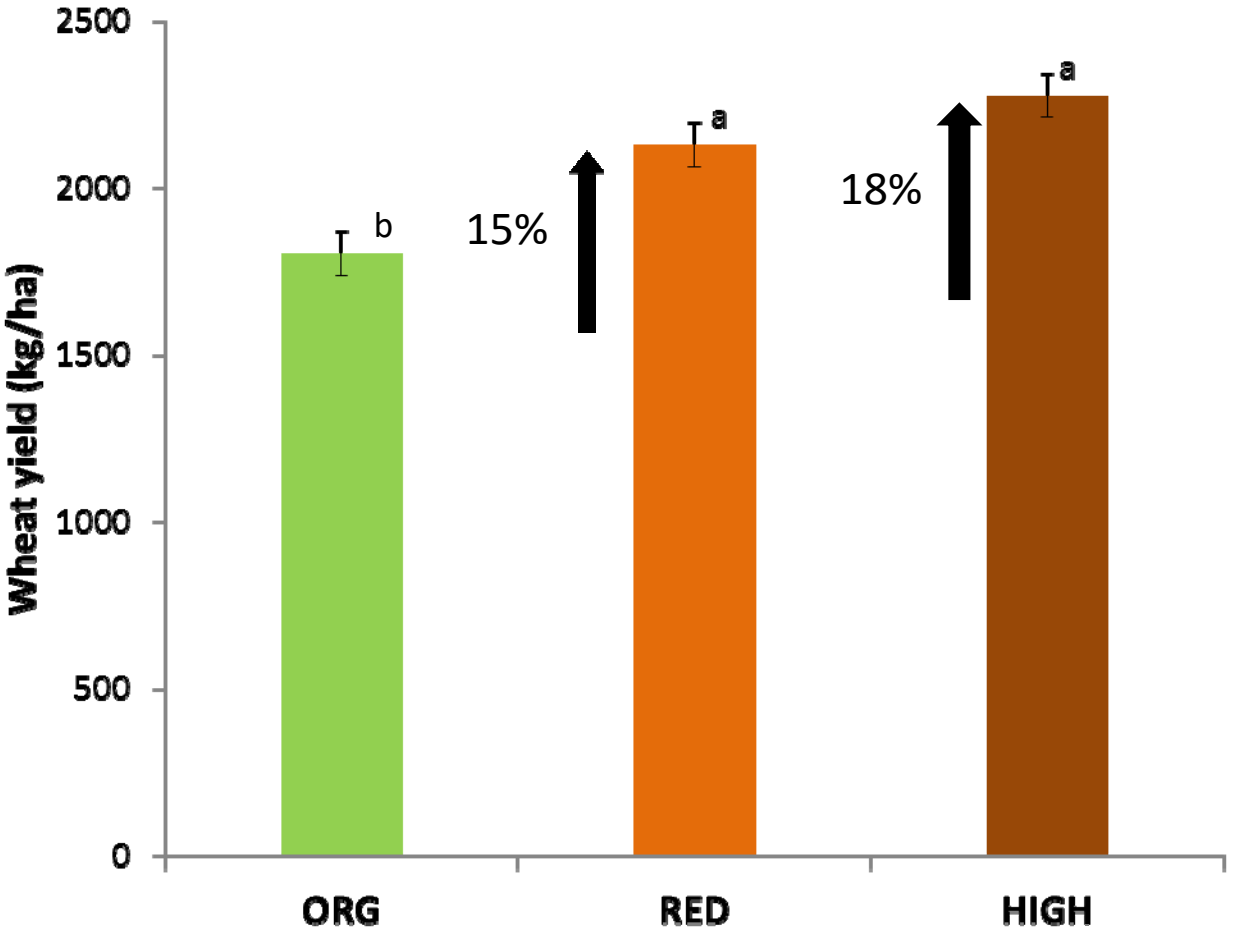
Residual weed biomass (18 year average)



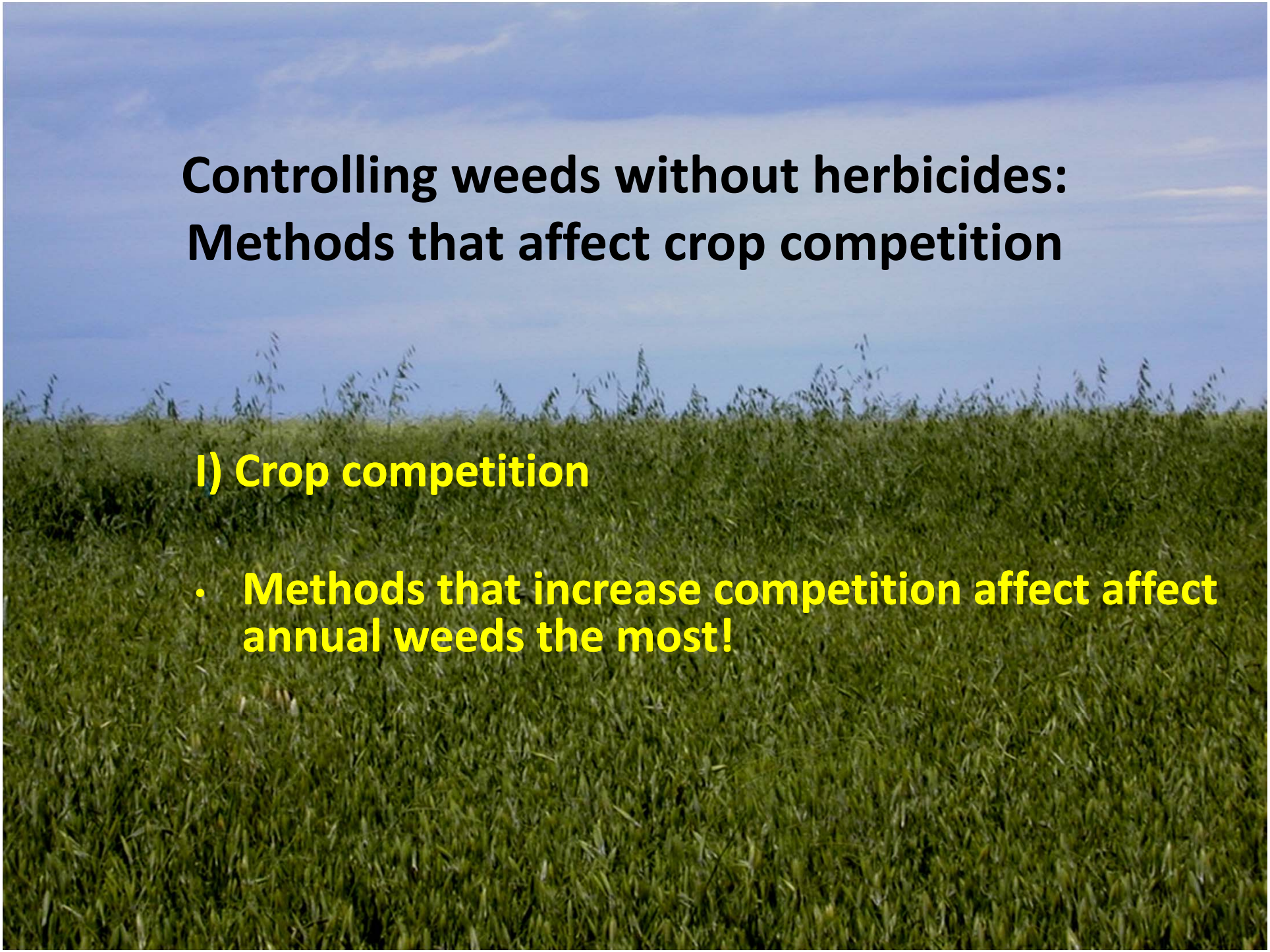
Crop yields (average in all crop phases)



Wheat yields




Controlling weeds without herbicides:
I) Crop seeding rate
II) Mechanical weed control
III) Combining tactics



Controlling weeds without herbicides: Methods that affect crop competition

I) Crop competition

- Methods that increase competition affect affect annual weeds the most!

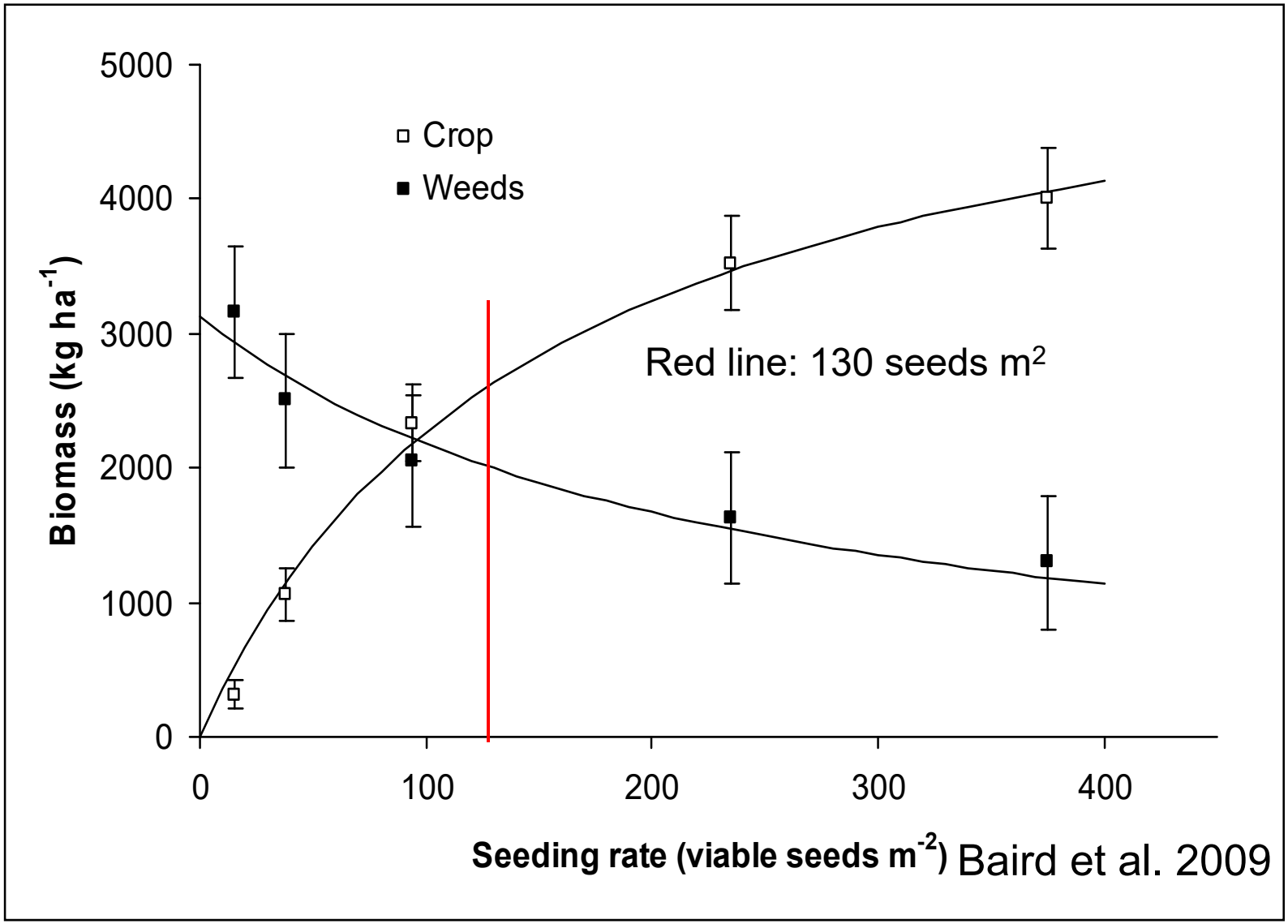
Weed Control and Seeding Rate in Red Lentil

[1]Steve Shirtliffe, [2]Eric Johnson, [2]Yantai Gan, Colleen Redlick, [1]Leah Fedoruk and [1]Julia M. Baird

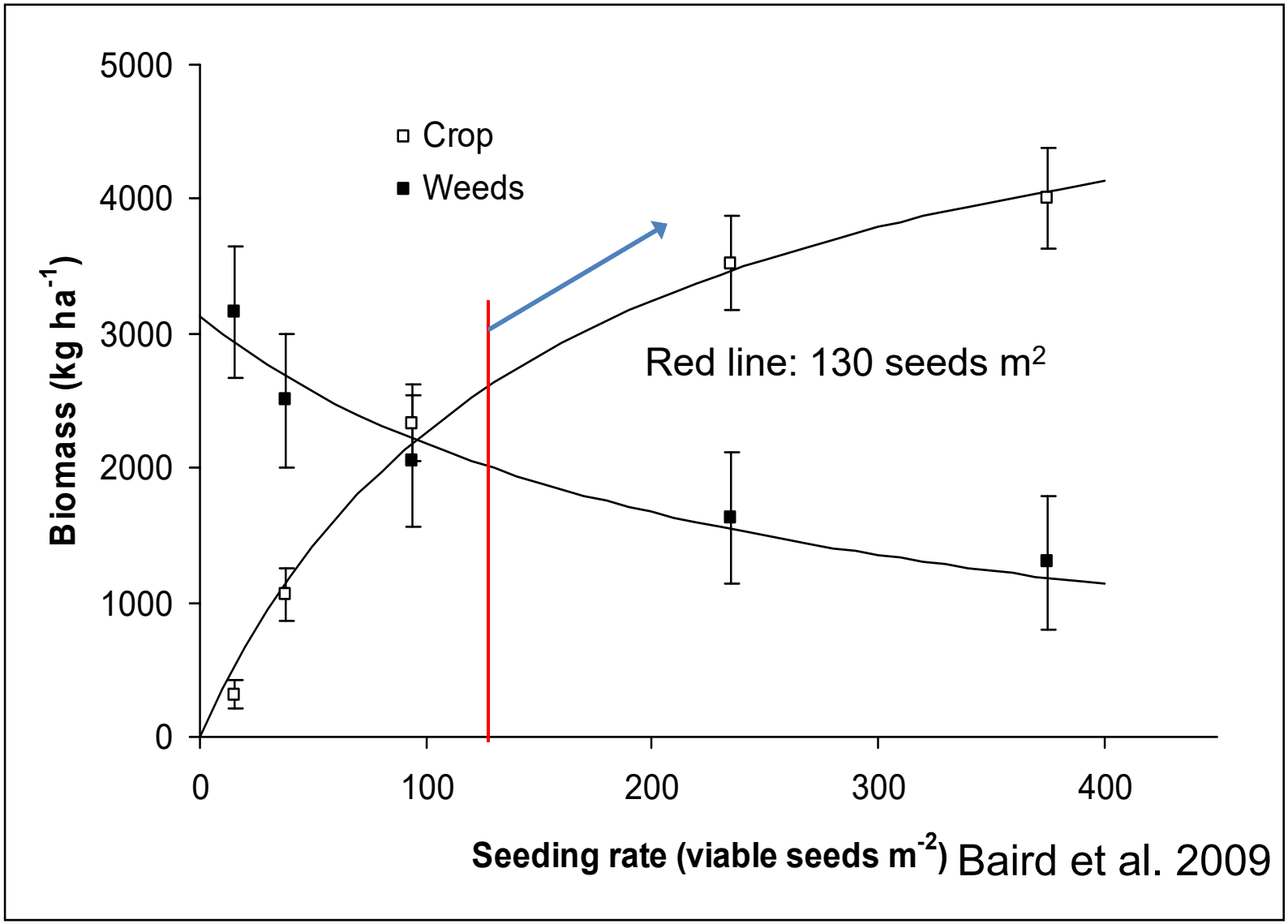
[1]University of Saskatchewan; [2]Agriculture and Agri-food Canada.


Fedoruk et al. 2011

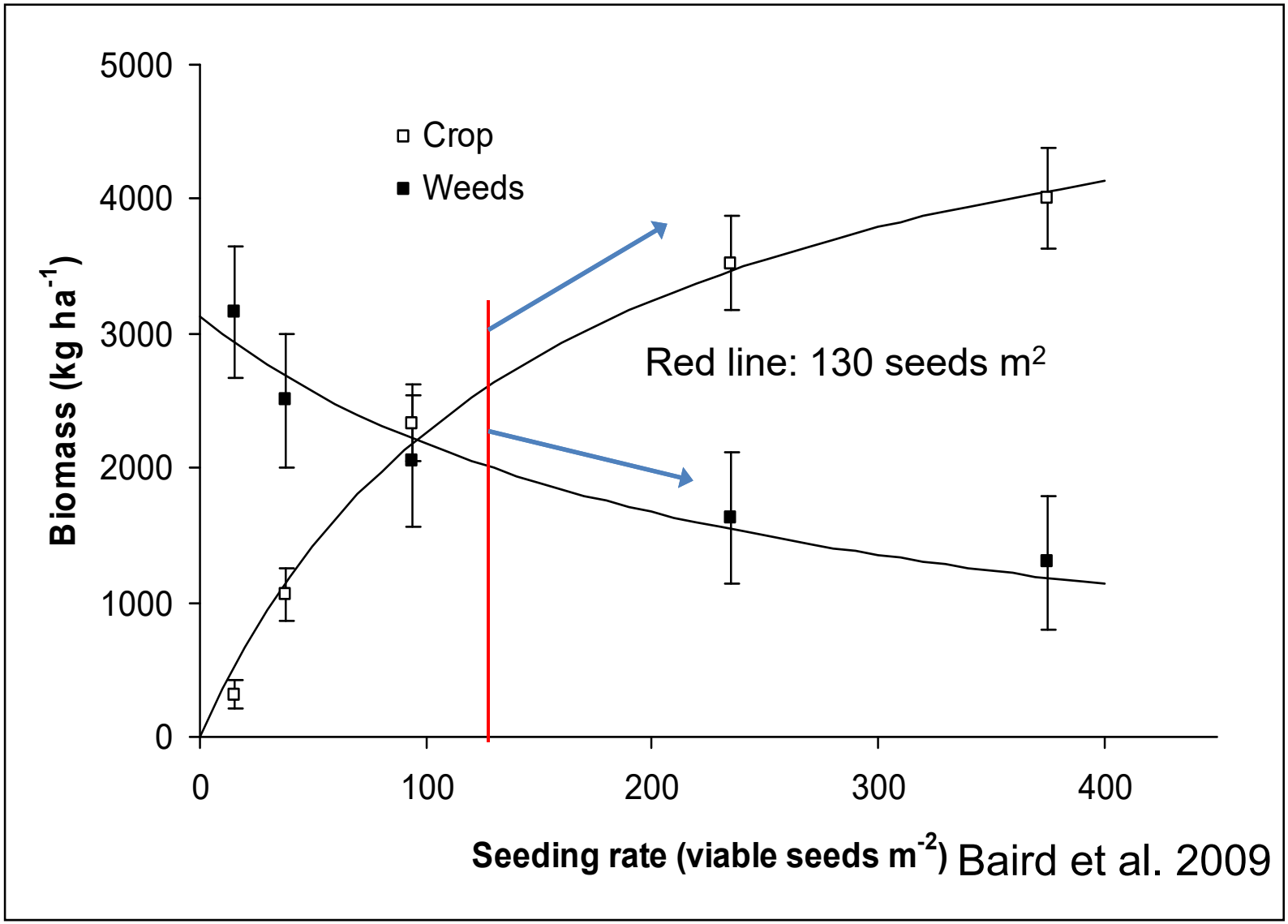
Lentil seeding rate –Organic conditions
Lentil crop and weed biomass



Lentil seeding rate –Organic conditions
Lentil crop and weed biomass



Lentil seeding rate –Organic conditions
Lentil crop and weed biomass



Mechanical In Crop Weed Control

Crop Tolerance to In-crop Harrowing


05.09.2009 06: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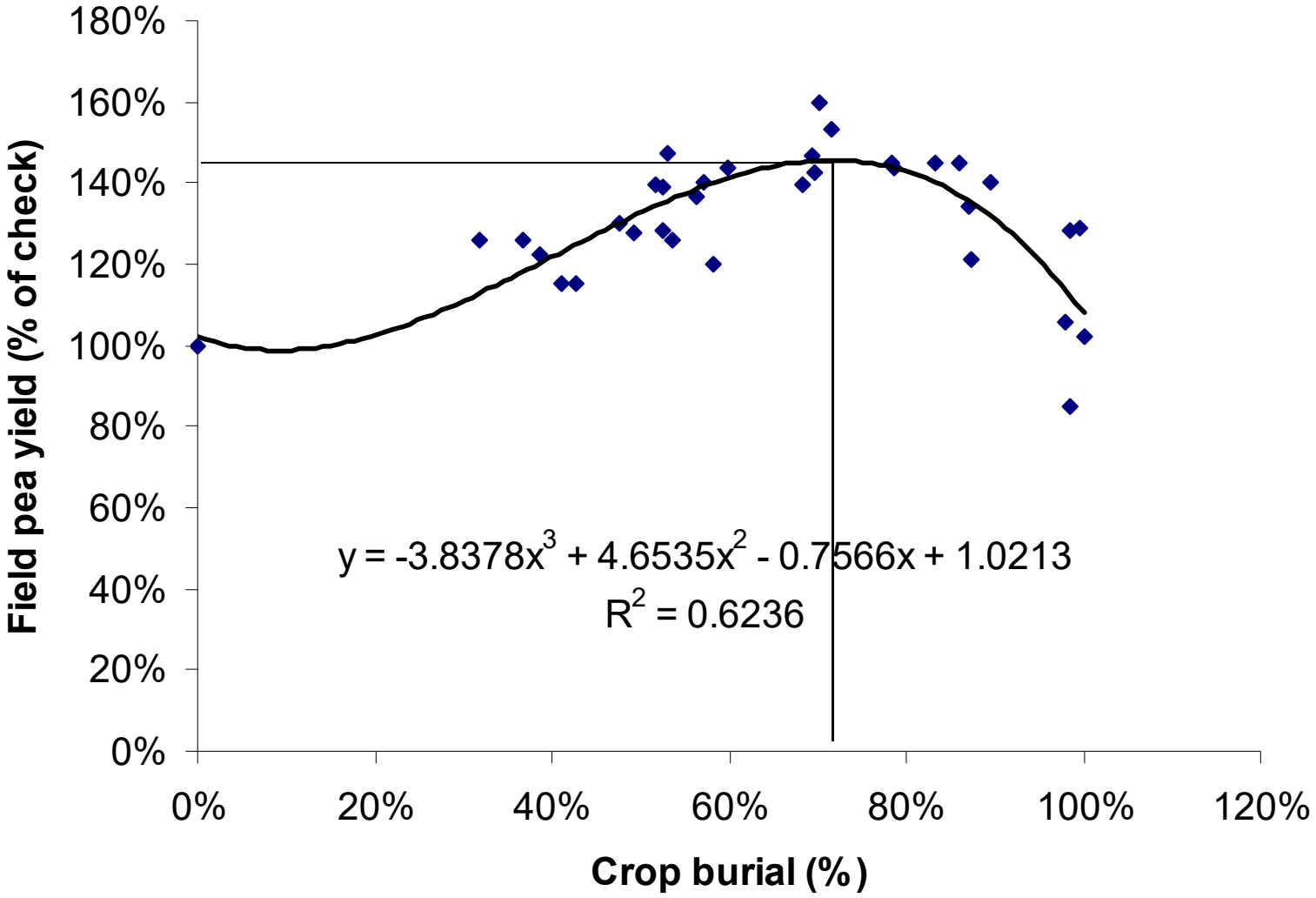
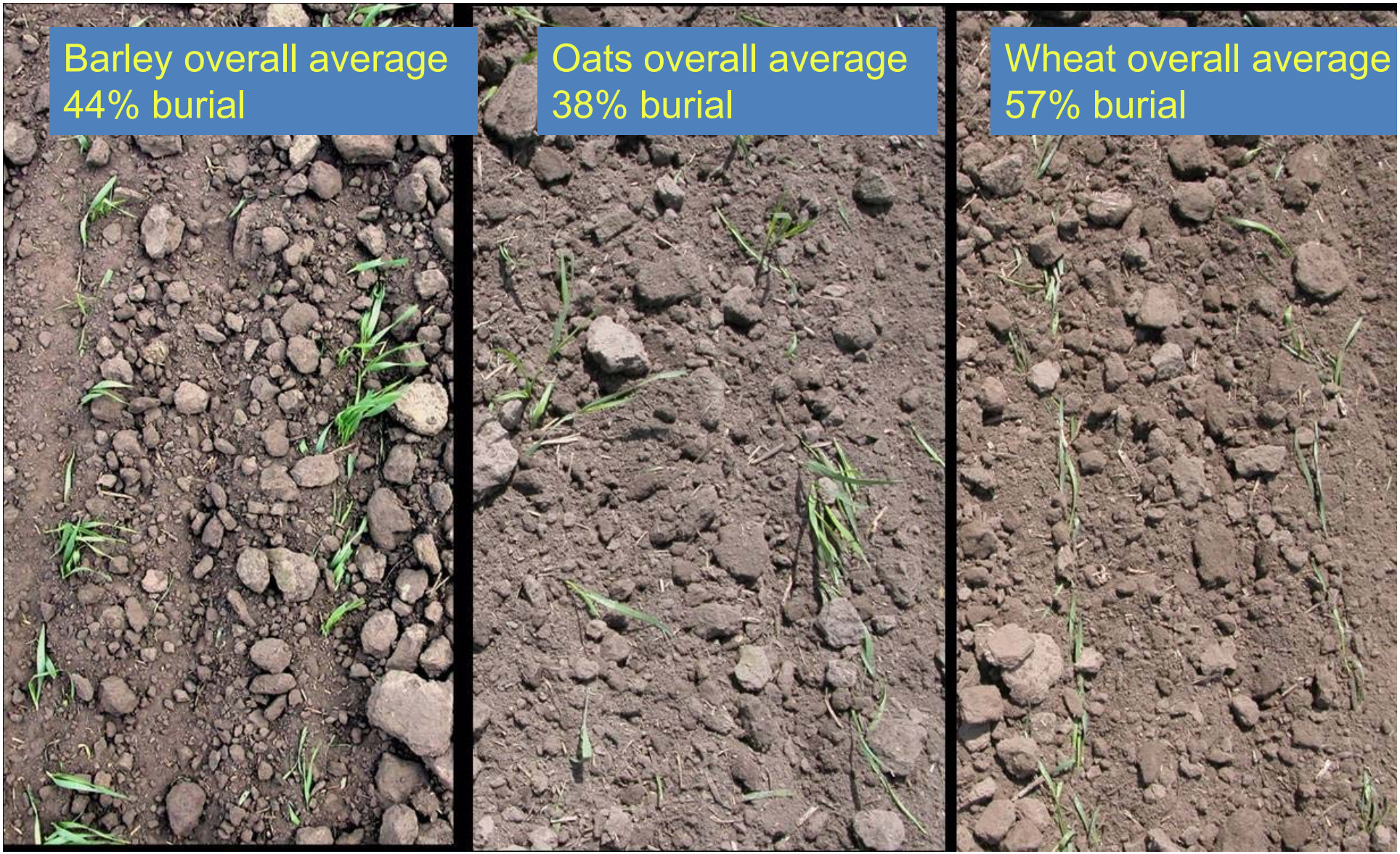
Effect of crop burial on filed pea yield when post-emergence harrowed at 3 node stage. Weedy conditions. 2004 & 2006.



Crop burial of barley, oat and wheat (from left to right) after four passes at the two leaf stage.



Post-emergence harrowing

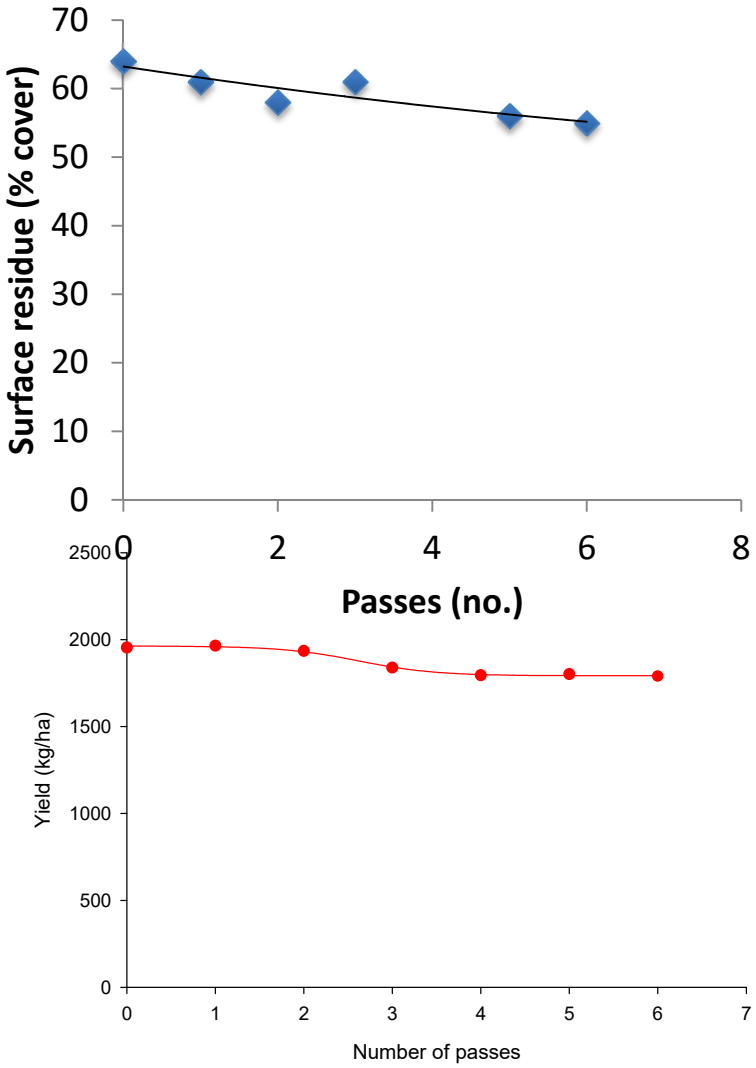
- Selectivity is low
  - Positive weed killing effect
  - Negative crop-covering effect
  - Yield loss can occur even when weeds controlled

Min-Till Rotary Hoe

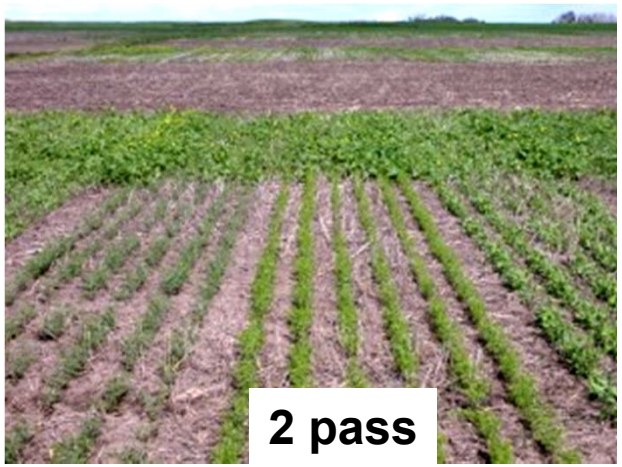
Rotary Hoe

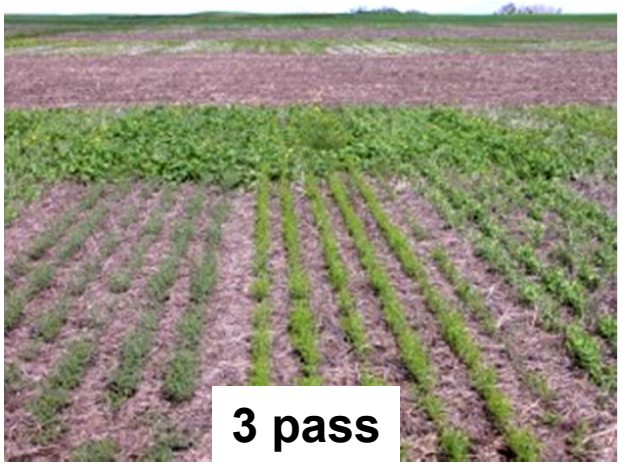
- https://www.youtube.com/watch?v=rBqOdiwFz3Y

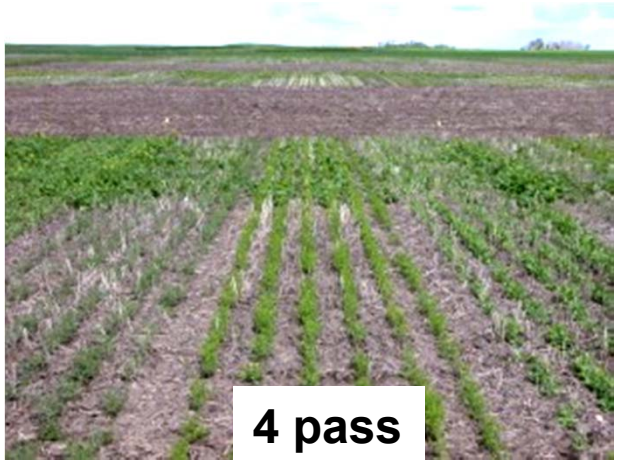
Effect of rotary hoe passes cereal stubble residue and crop tollerence, Scott, SK. 2004 - 06.

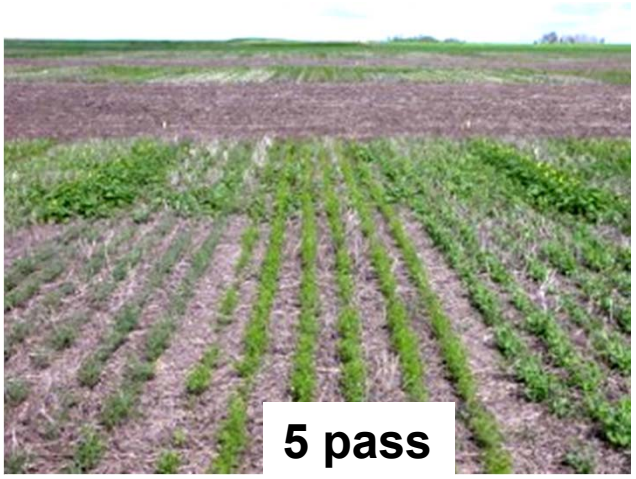


Pulse Tolerance to Rotary hoe

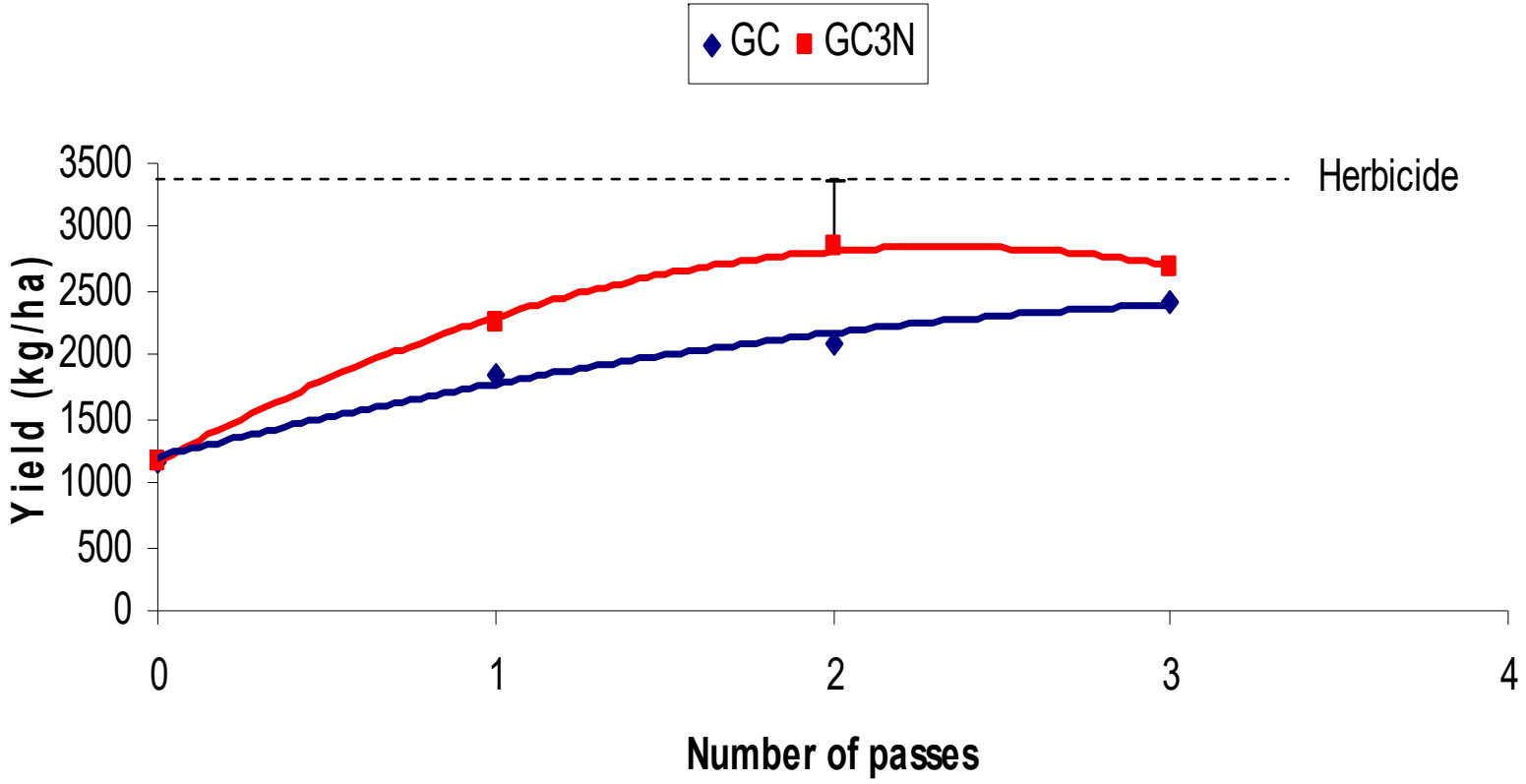








Weed control from rotary hoeing can result in large yield increases in field pea



Eric Johnson, Scott, SK . 2007

Rotary hoeing

- Effectiveness dependent on:
  - Timeliness, timing and
    - effective ONLY on small seedlings emerging from shallow depths
  - Soil conditions
    - soil moisture
    - Soil tilth

The potential for inter-row cultivation in organic pulse production

Katherine Stanley

Inter-row cultivator


Inter-row hoeing in spring barley with ECO-DAN automatic steering system (www.eco-dan.dk)

Results: Field Pea Tolerance

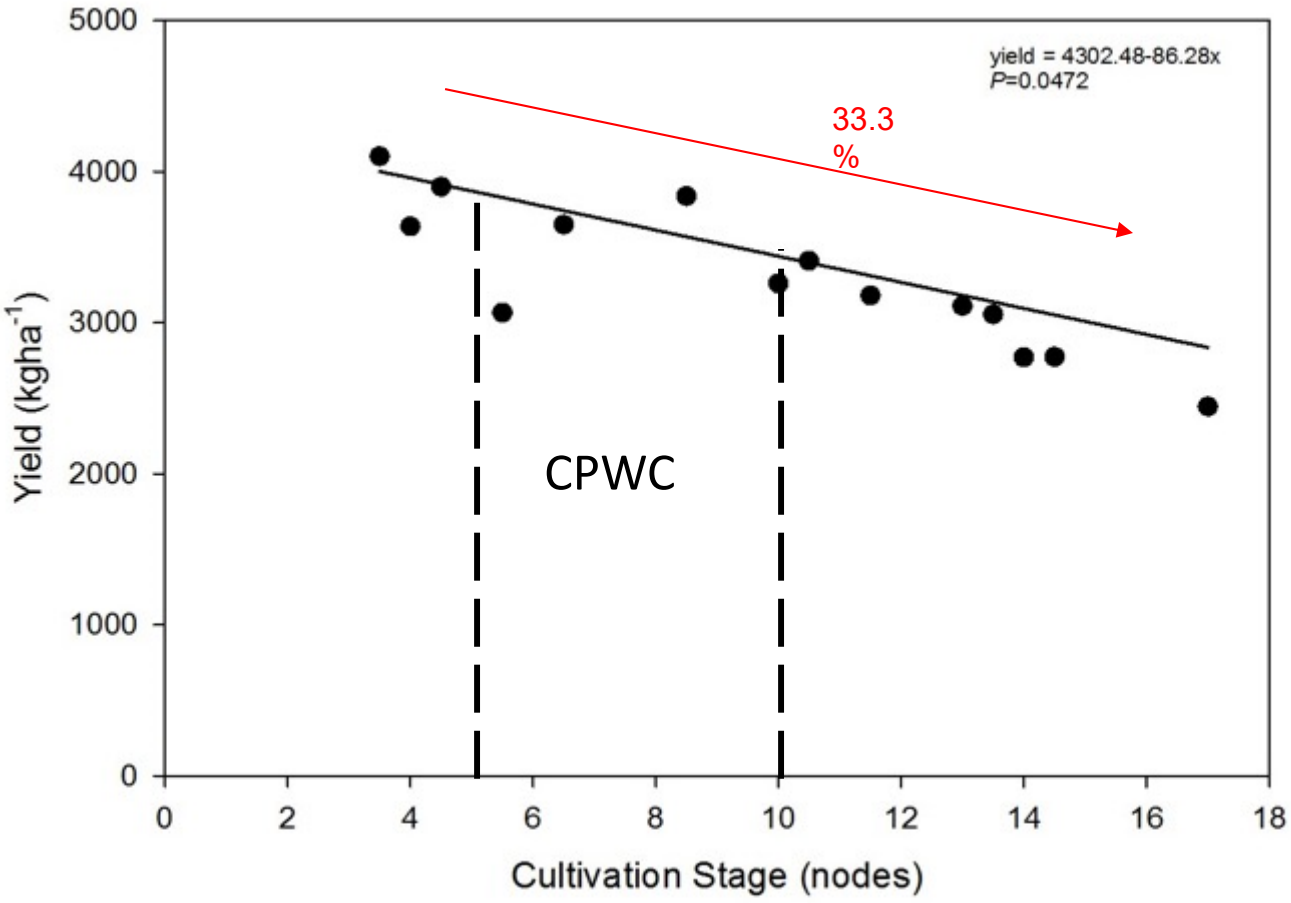


Figure: Effect of single cultivation timing on field pea yield (2014-2015)

Results – Multiple cultivation, field pea

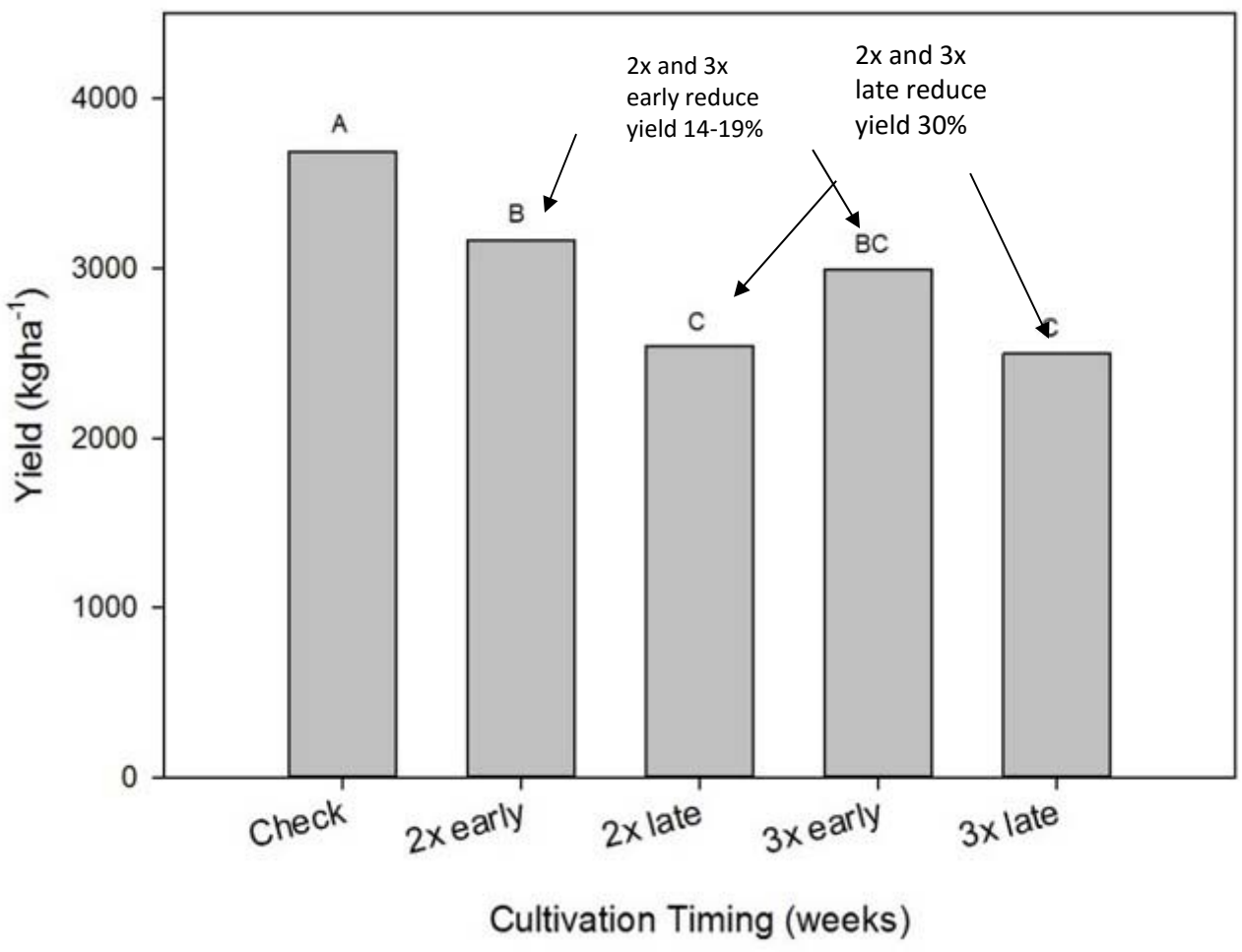


Figure: Effect of multiple cultivation timings on field pea yield (2014-2015)


ZERO


ONE


TWO


THREE

Weed Control

Results – Weed Control

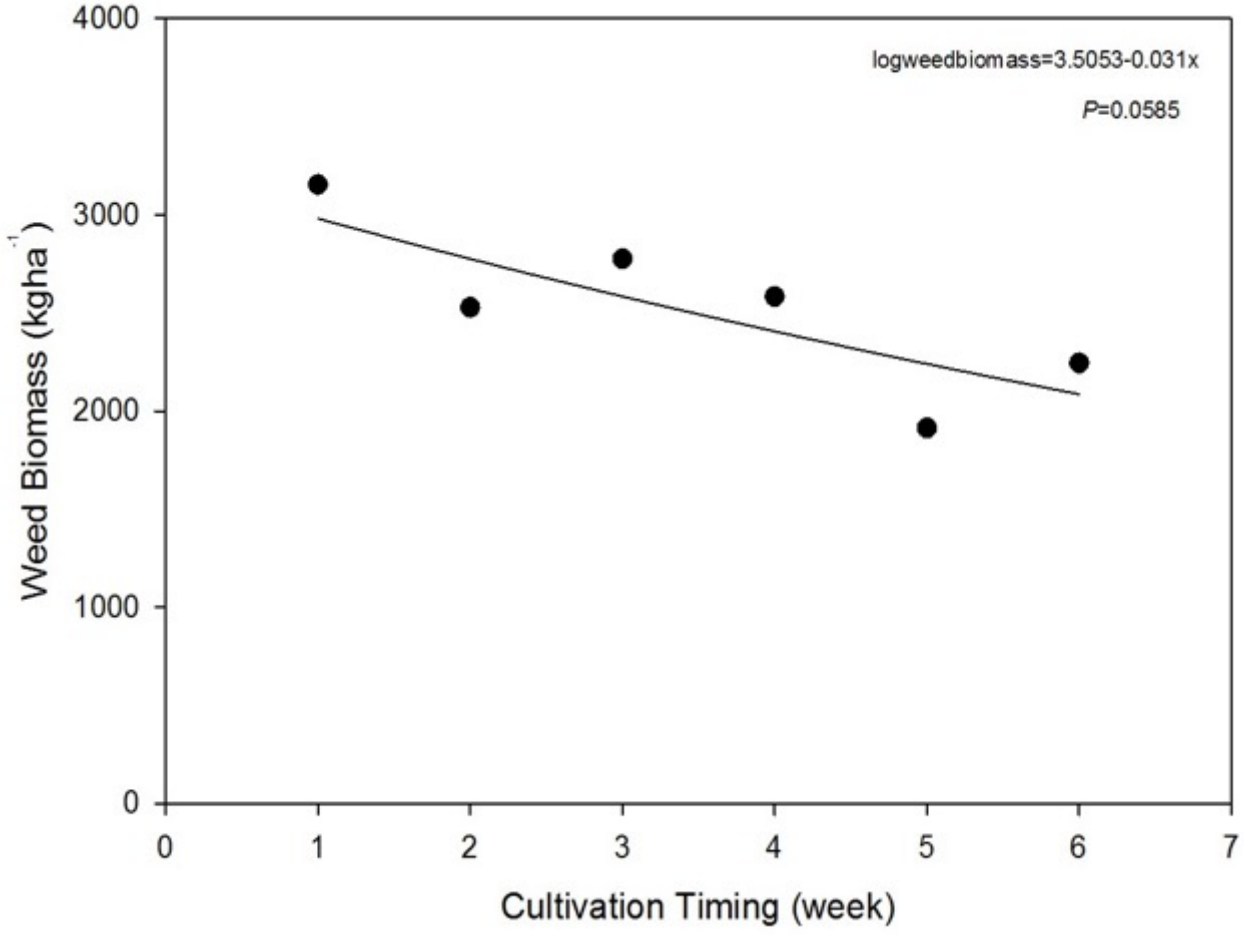


Figure: Reduction in weed biomass in organic field pea with increasing cultivation timing (2015)

Before

After

Experiment 2: Crop Yield

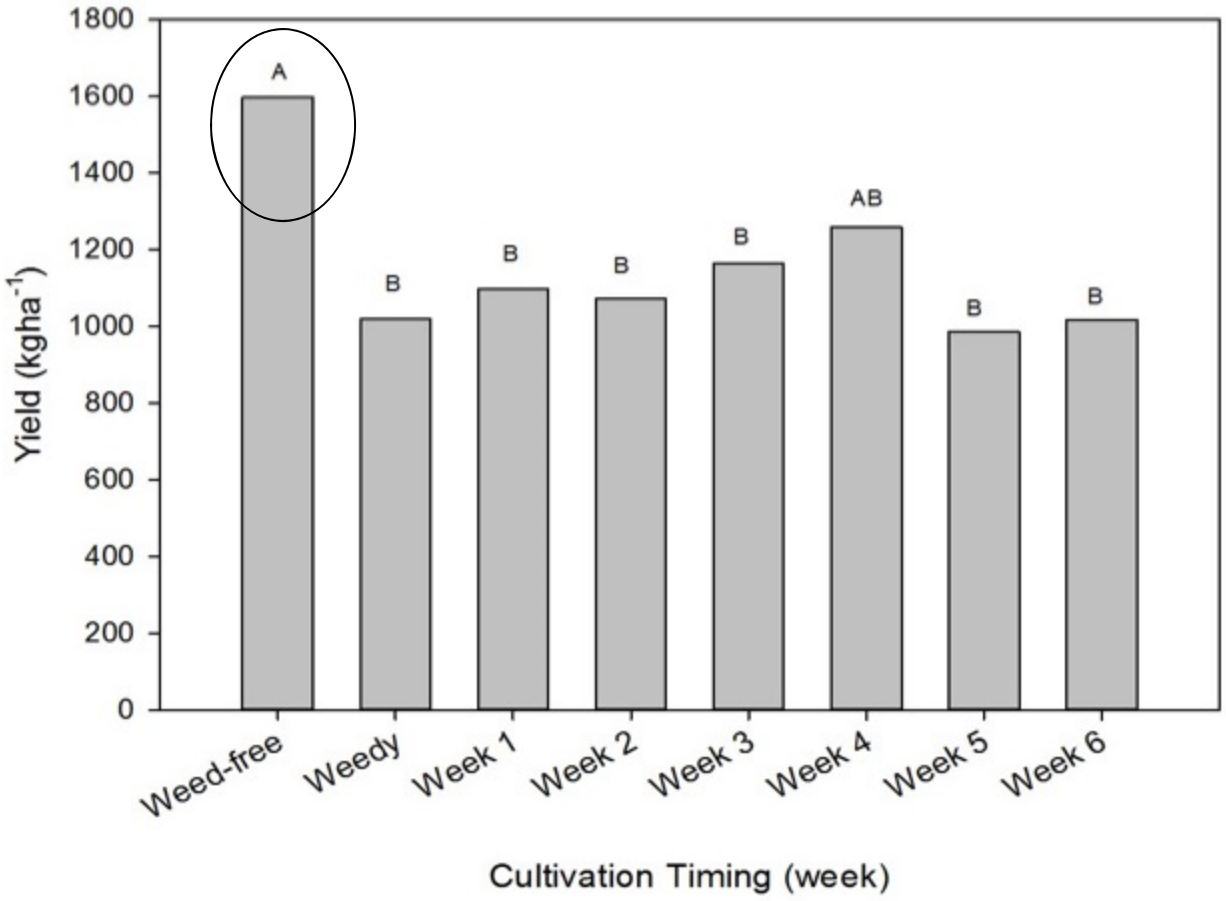


Figure: Effect of cultivation timing on organic field pea yield (2015)

Conclusions

- Inter-row cultivation at early growth stages in field pea and lentil has low risk to yield potential
- Risk in yield loss with late and multiple cultivation timings
- Has advantage of being able to control large weeds
- Preliminary results show limited yield benefits

Which in-crop mechanical weed control is best?

- Check out poster by Alexander Alba!

Other mechanical methods to reduce weed seed production

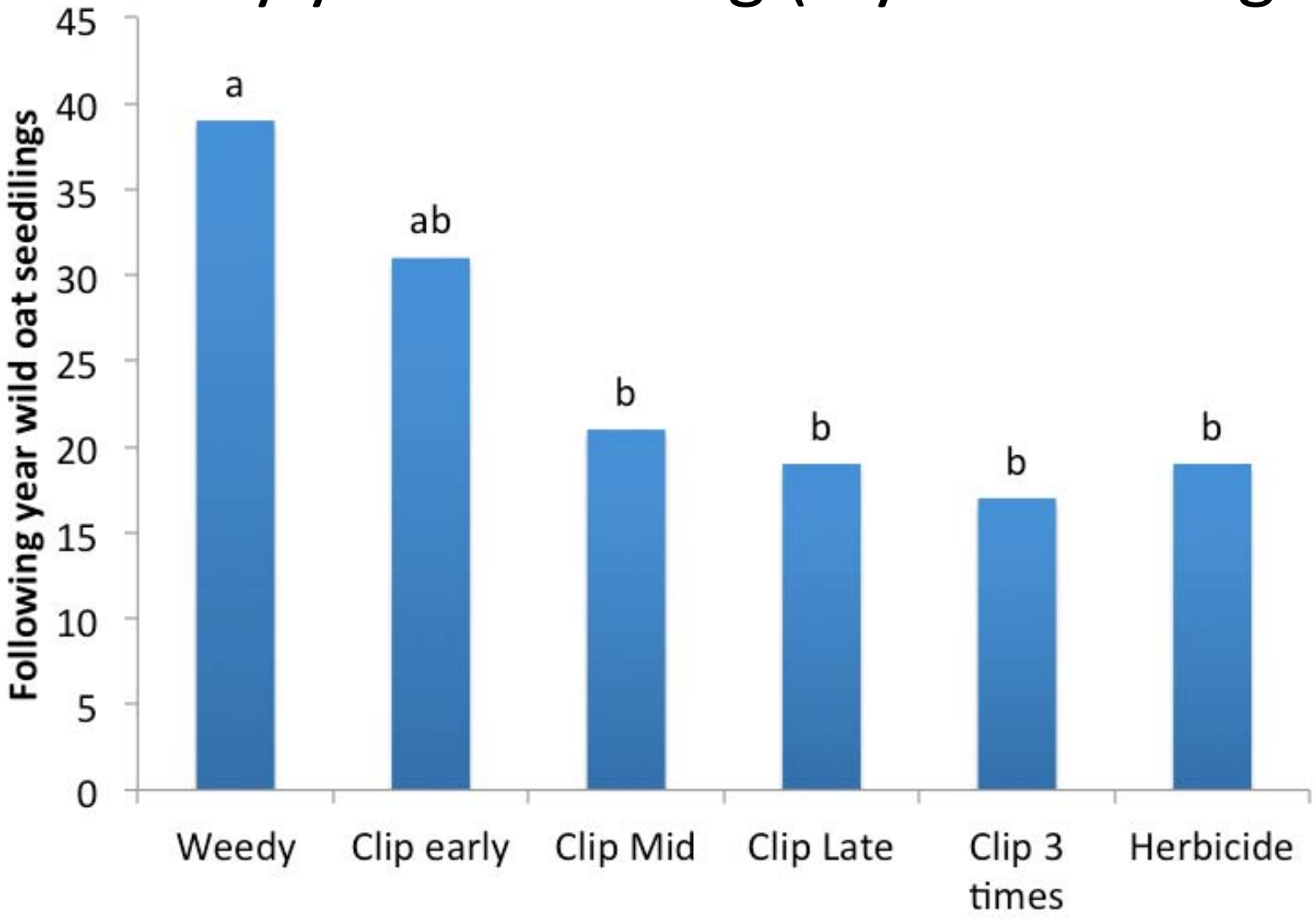
- Target weed seed management and competition

Weed Clipping

- Can be done on short crops – eg. Lentils, flax; short cereals
  - Semi-dwarf varieties obviously preferred
- Can reduce seed production and seed return in subsequent rotational crops.

Above canopy weed clipping

Effect of weed clipping on wild oat seedling density year following (2 years average)



No weed clipping

Weed clipping

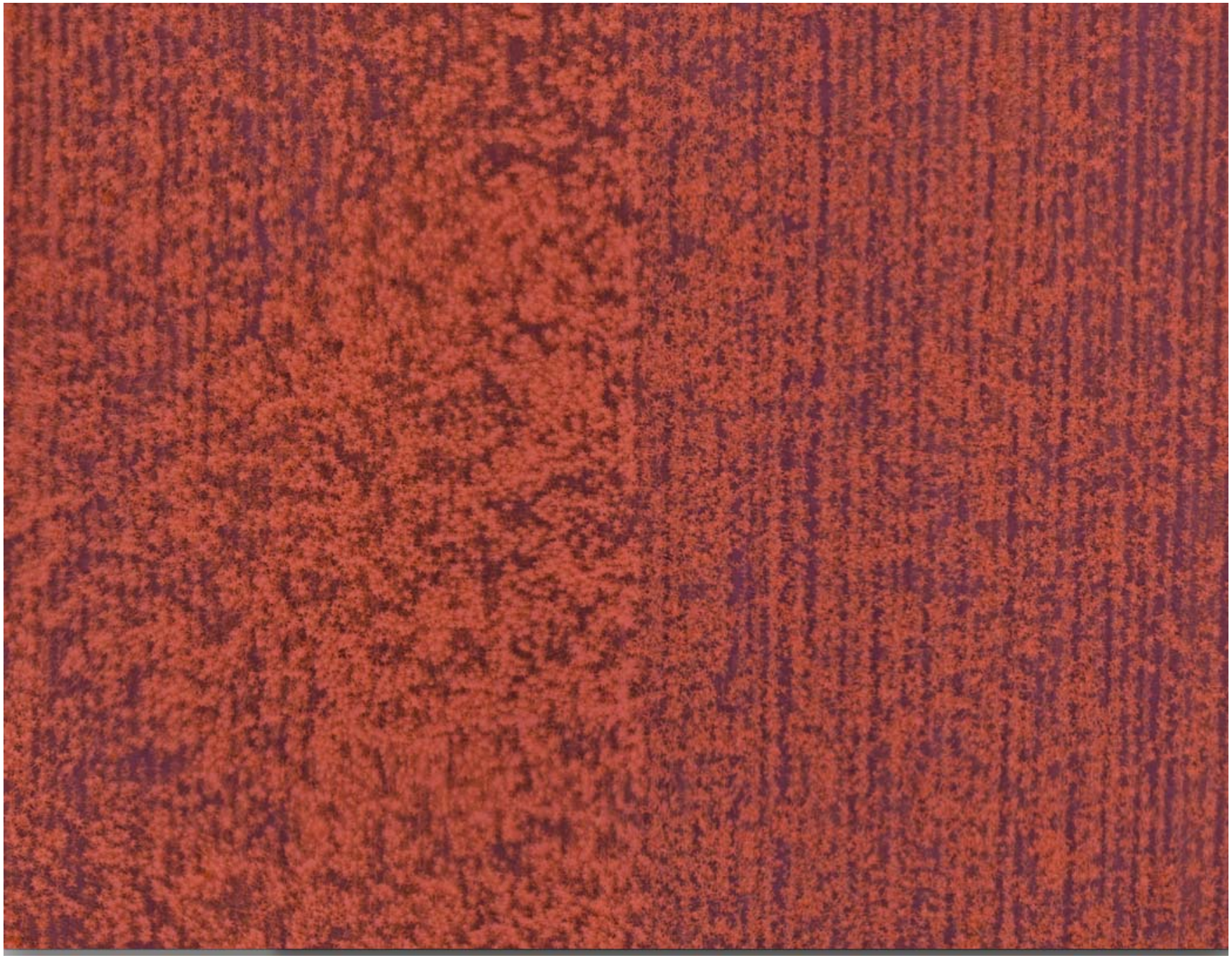
CTM Weed Surfer

Cutting weeds below top of canopy

Combcut

Cutting weeds below top of canopy

Combcut



Other Alternative methods:

Cover crops

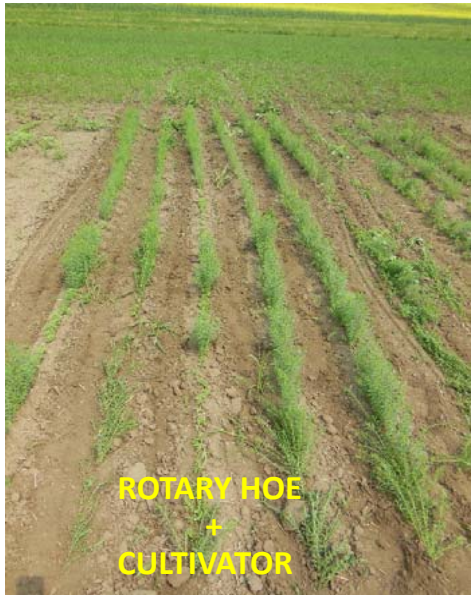
Fall rye as a cover crop

- Reduced weed biomass by 77% in soybezan - Ateh and Doll, 1996
- Continuous ground cover & allelopathic effects

What about using spring seeded fall rye between flax rows?

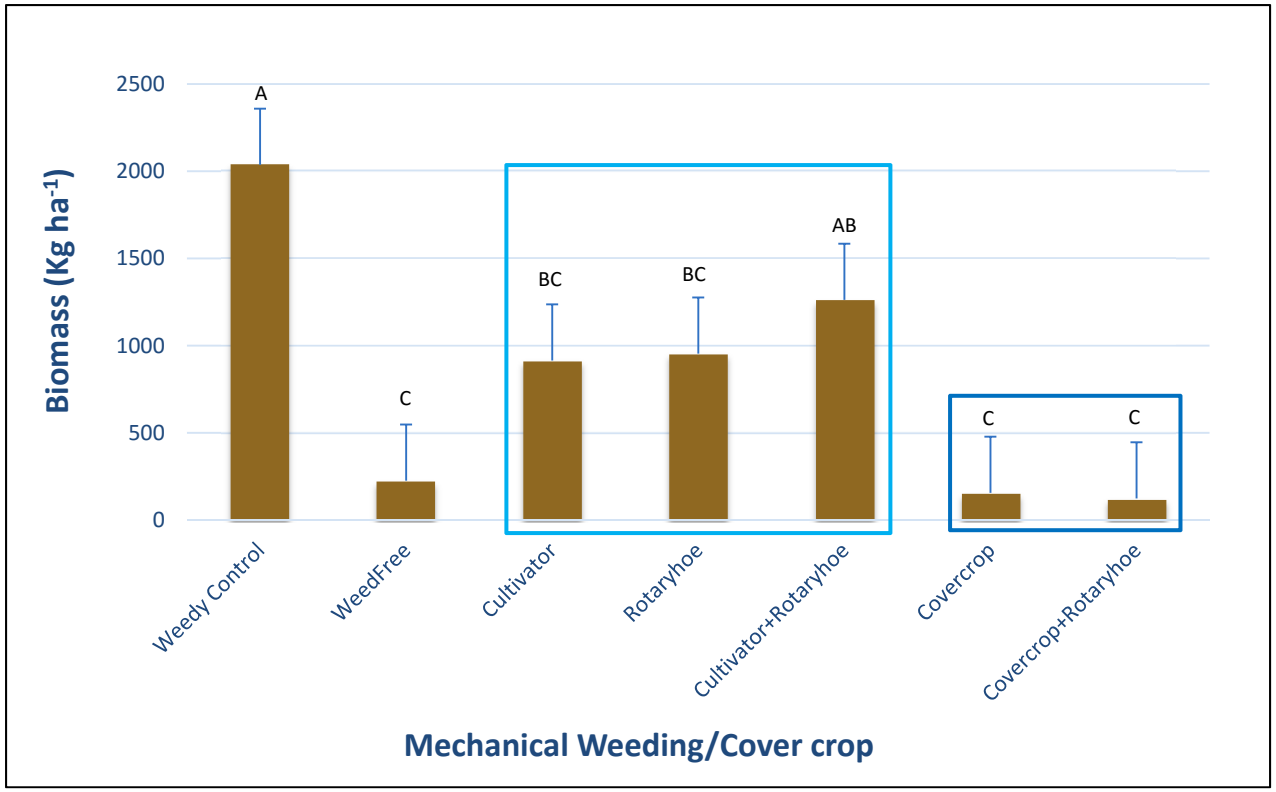

WEEDFREE


CULTIVATOR

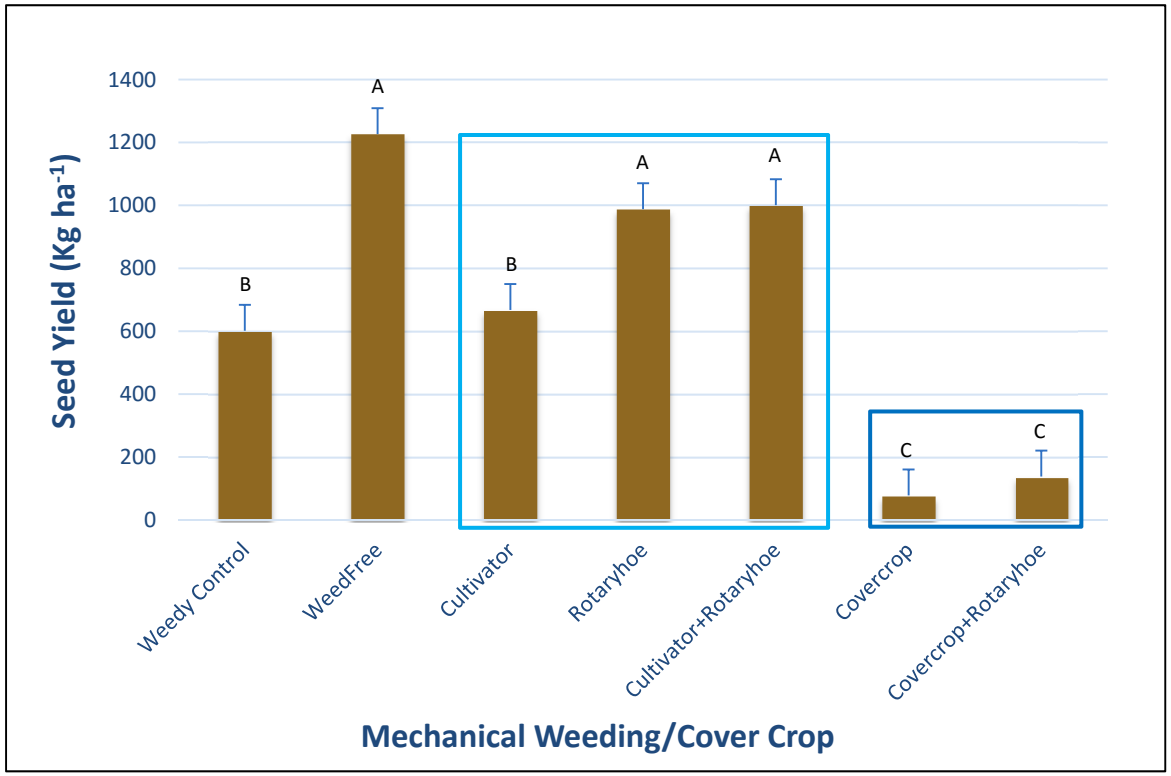

ROTARY HOE
+
CULTIVATOR


COVER CROP

Results - Weed Biomass



Seed Yield


1400
1200
1000
800
600
400
200
0
Seed Yield (Kg ha-1)
B
A
B
A
A
C
C
Weedy Control
WeedFree
Cultivator
Rotaryhoe
Cultivator+Rotaryhoe
Covercrop
Covercrop+Rotaryhoe
Mechanical Weeding/Cover Crop

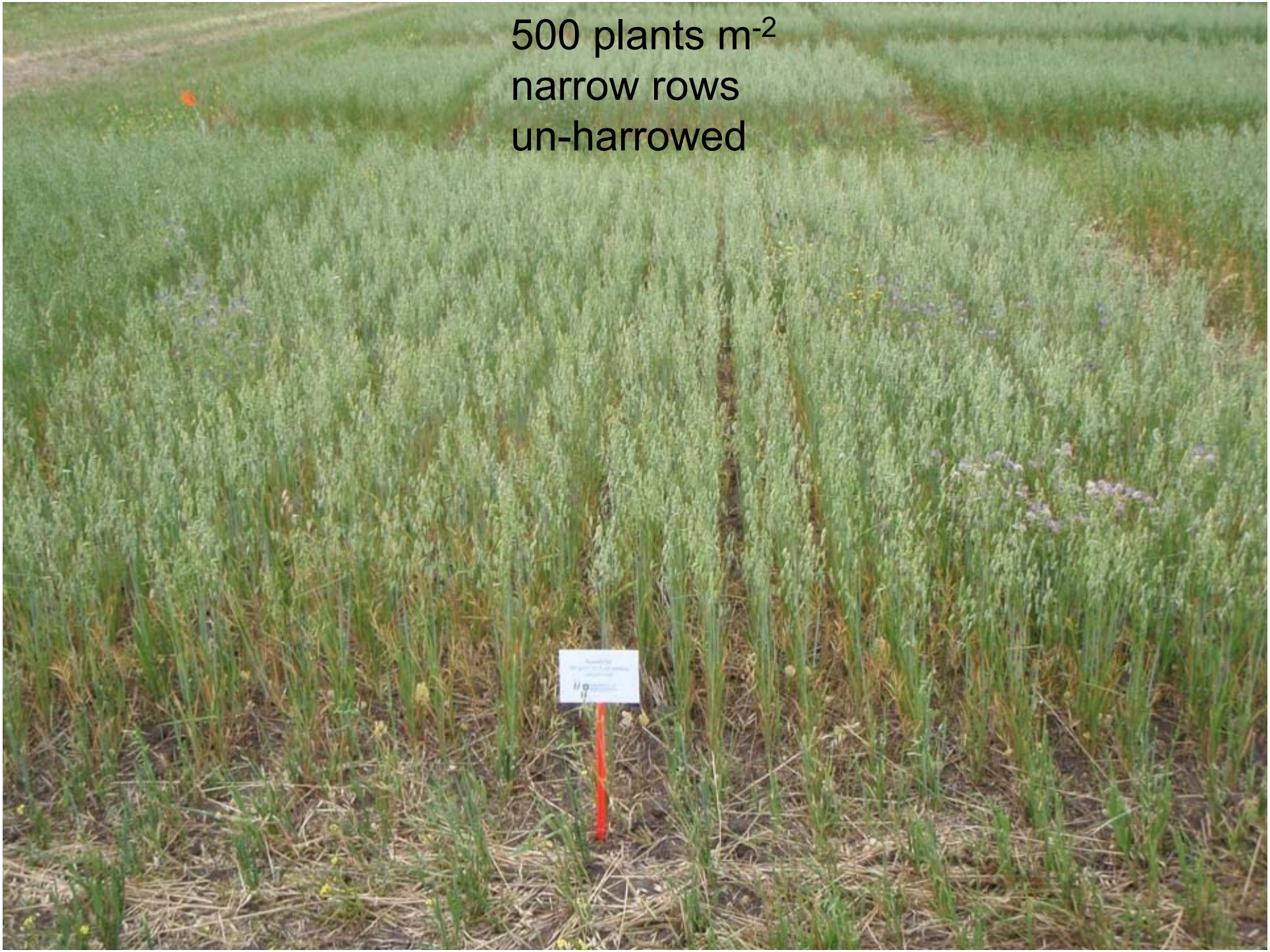
Integrated Weed Management in Oat

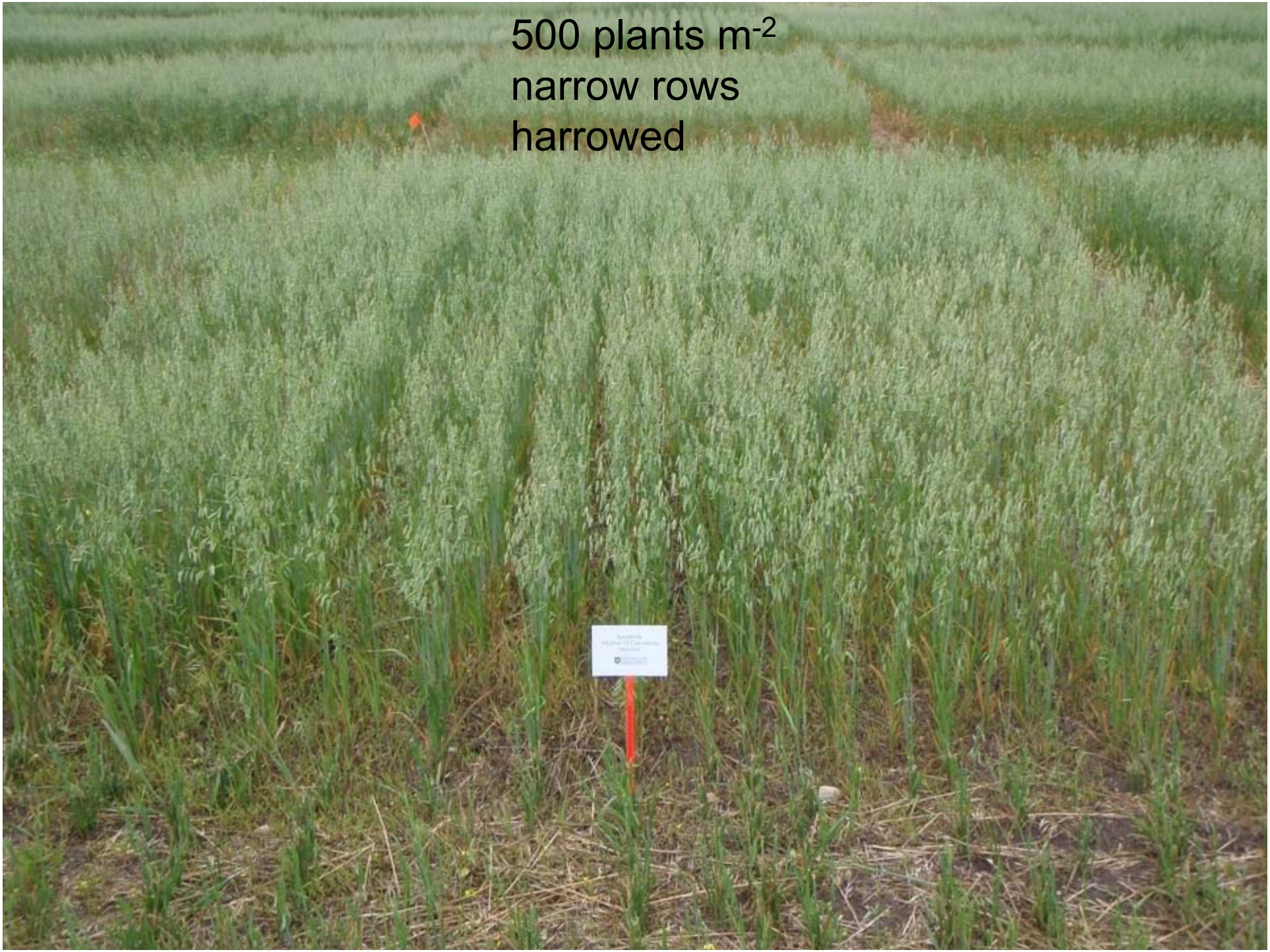
1) Competitive and non competitive variety
2) Seeding rate
3) Row width
4) Mechanical Weed Control -

Agronomy Journal 2013


250 plants m-2
wide rows
un-harrowed


500 plants m-2
wide rows
un-harrowed

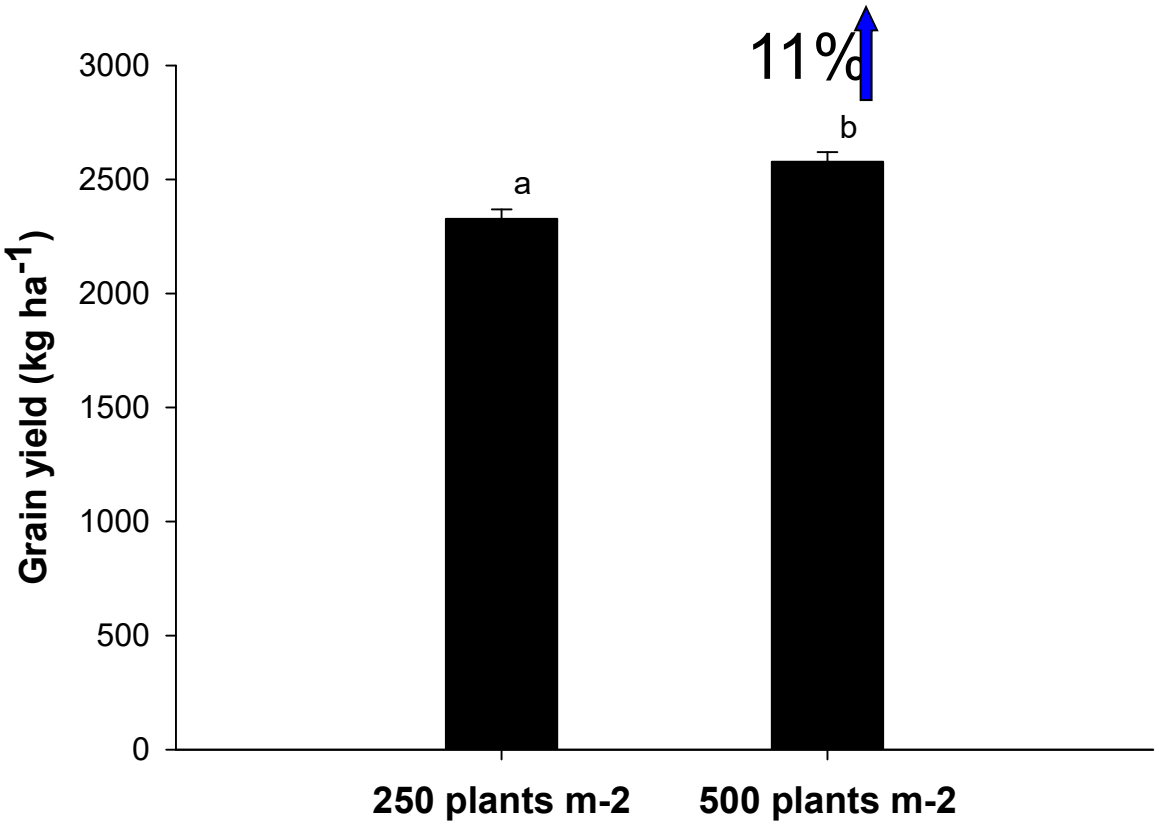

500 plants m-2
narrow rows
un-harrowed


500 plants m-2
narrow rows
harrowed


250 plants m-2
wide rows
un-harrowed

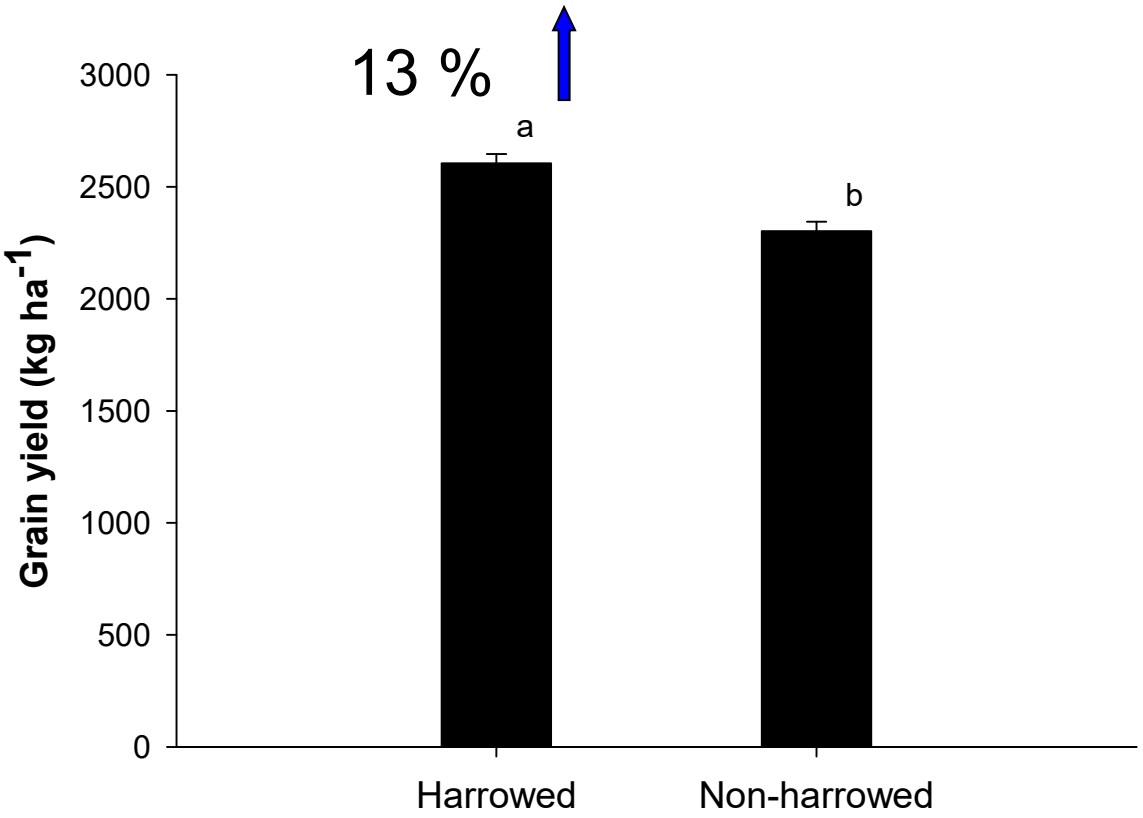
Grain yield

Crop density effect



± Error bars indicates standard error of the mean.
‡ Comparisons are made between treatments with similar letters indicating no significant difference at LSD $_{0.05}$

Harrowing effect



± Error bars indicates standard error of the mean
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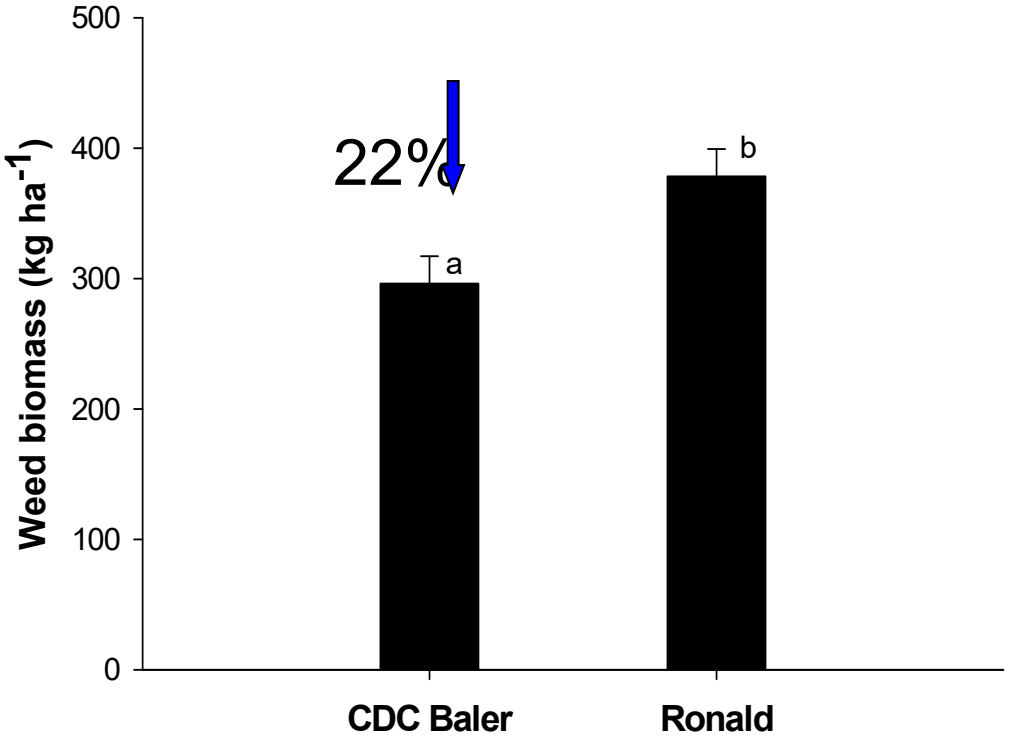
Weed biomass

Genotype effect



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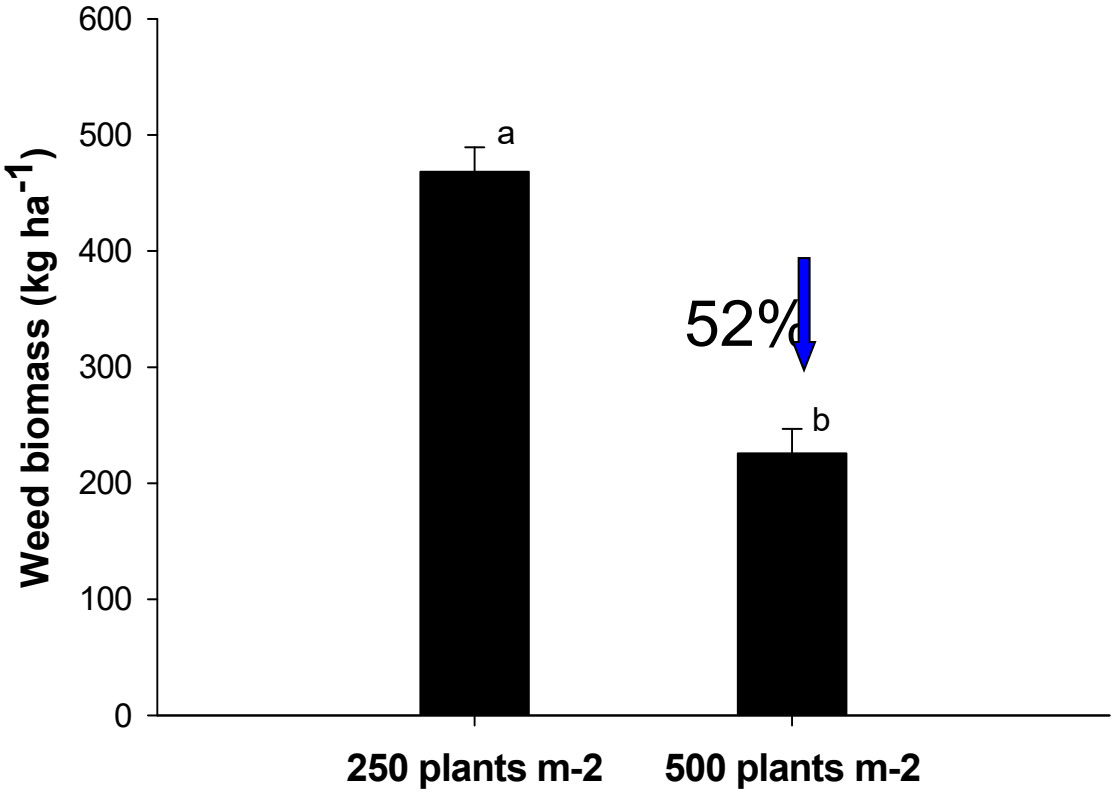
Weed biomass

Crop density



± Error bars indicates standard error of the mean
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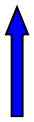
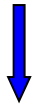
Combined effect vs. standard practices

Grain yield

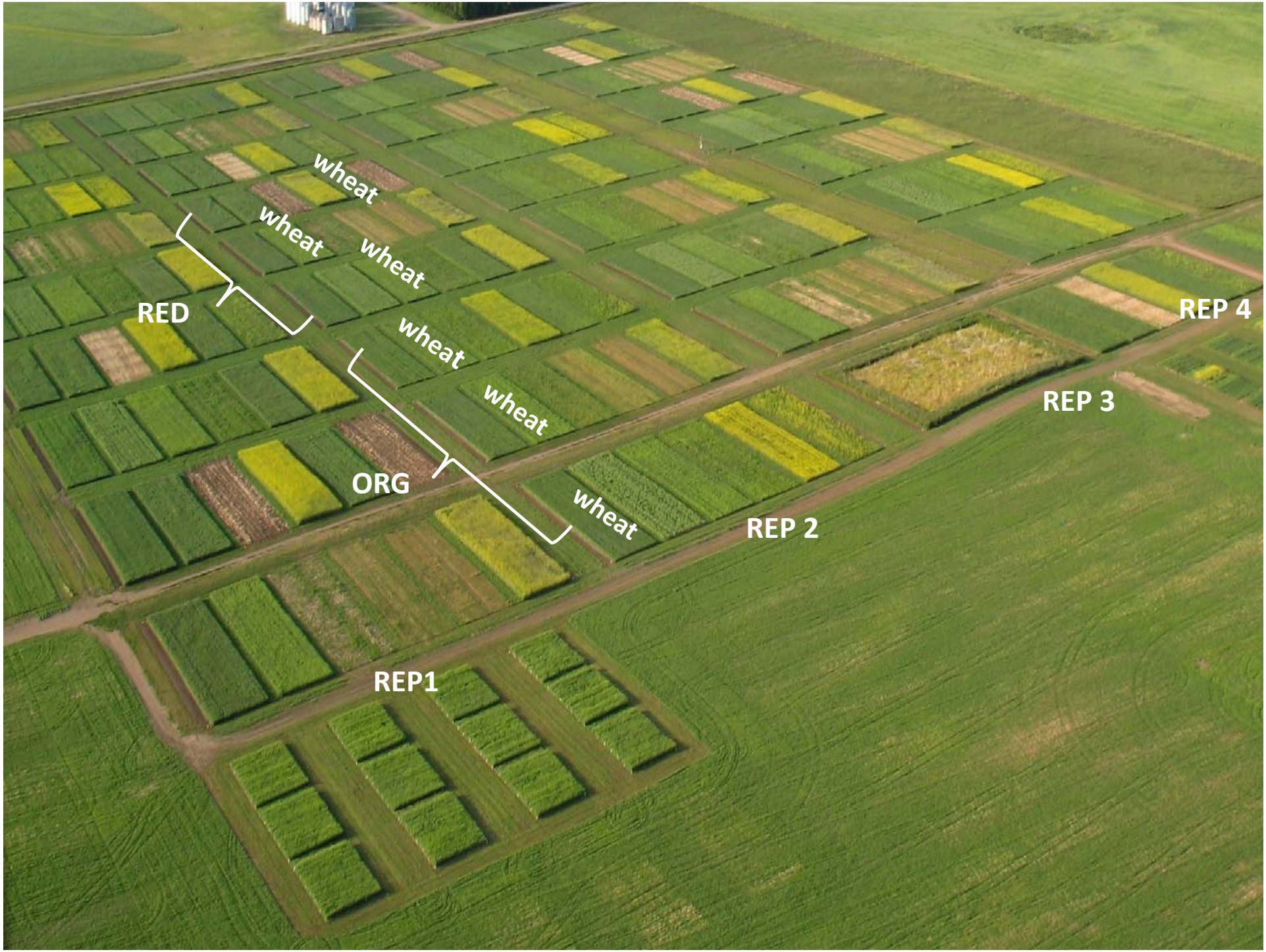
Harrowing + high crop density -  25%

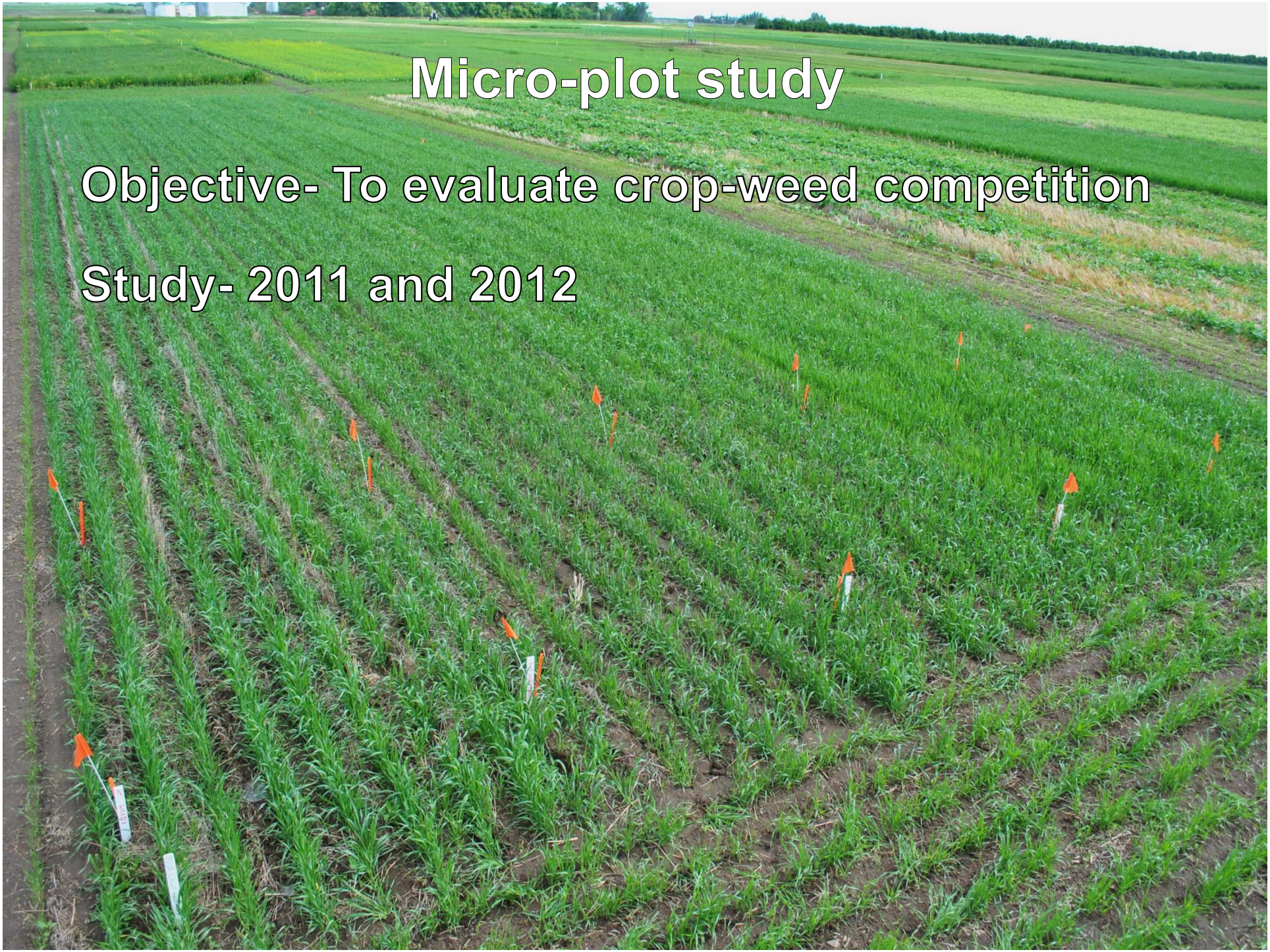
Weed Biomass

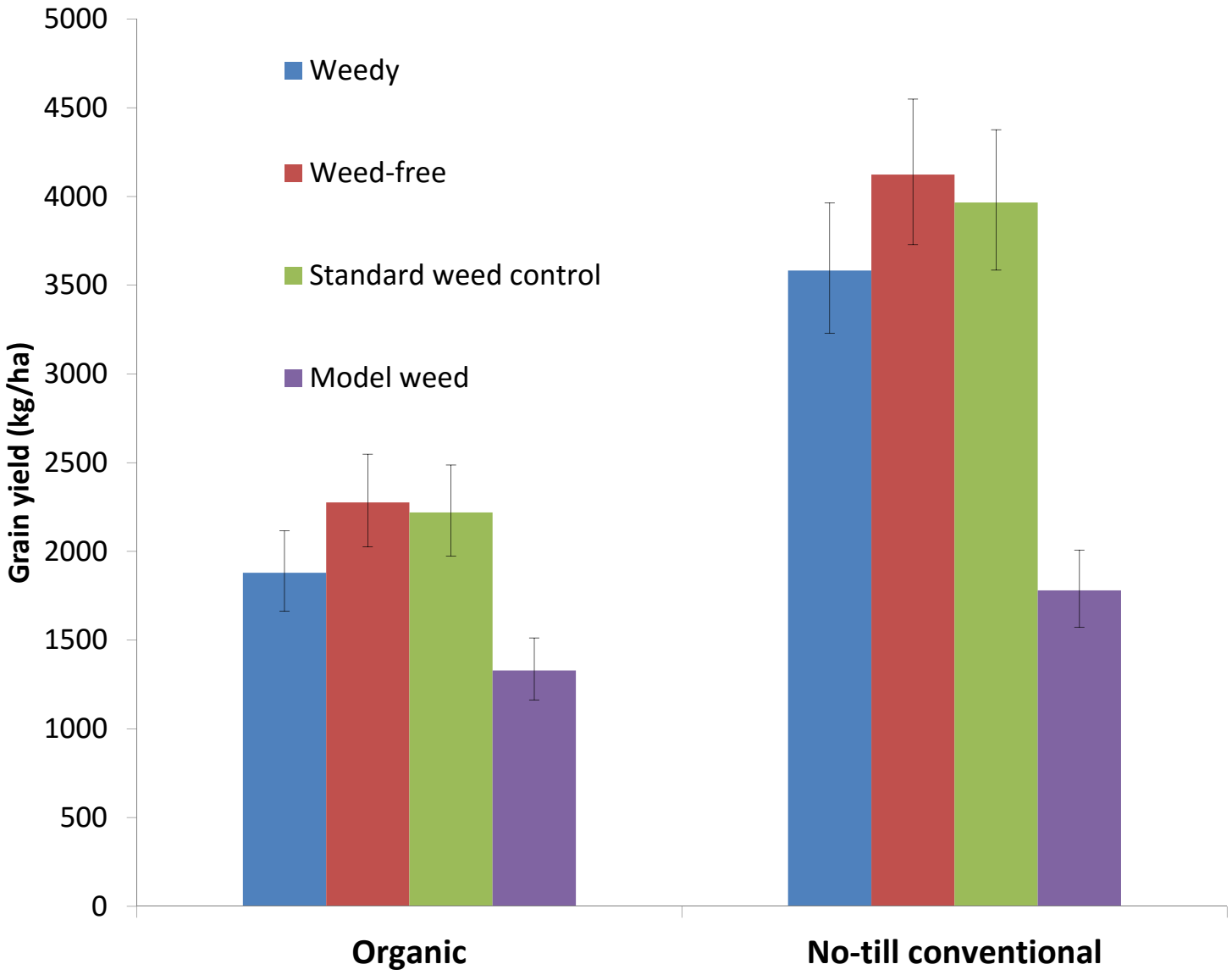
Competitive cultivar + high crop density + harrowing-  71%

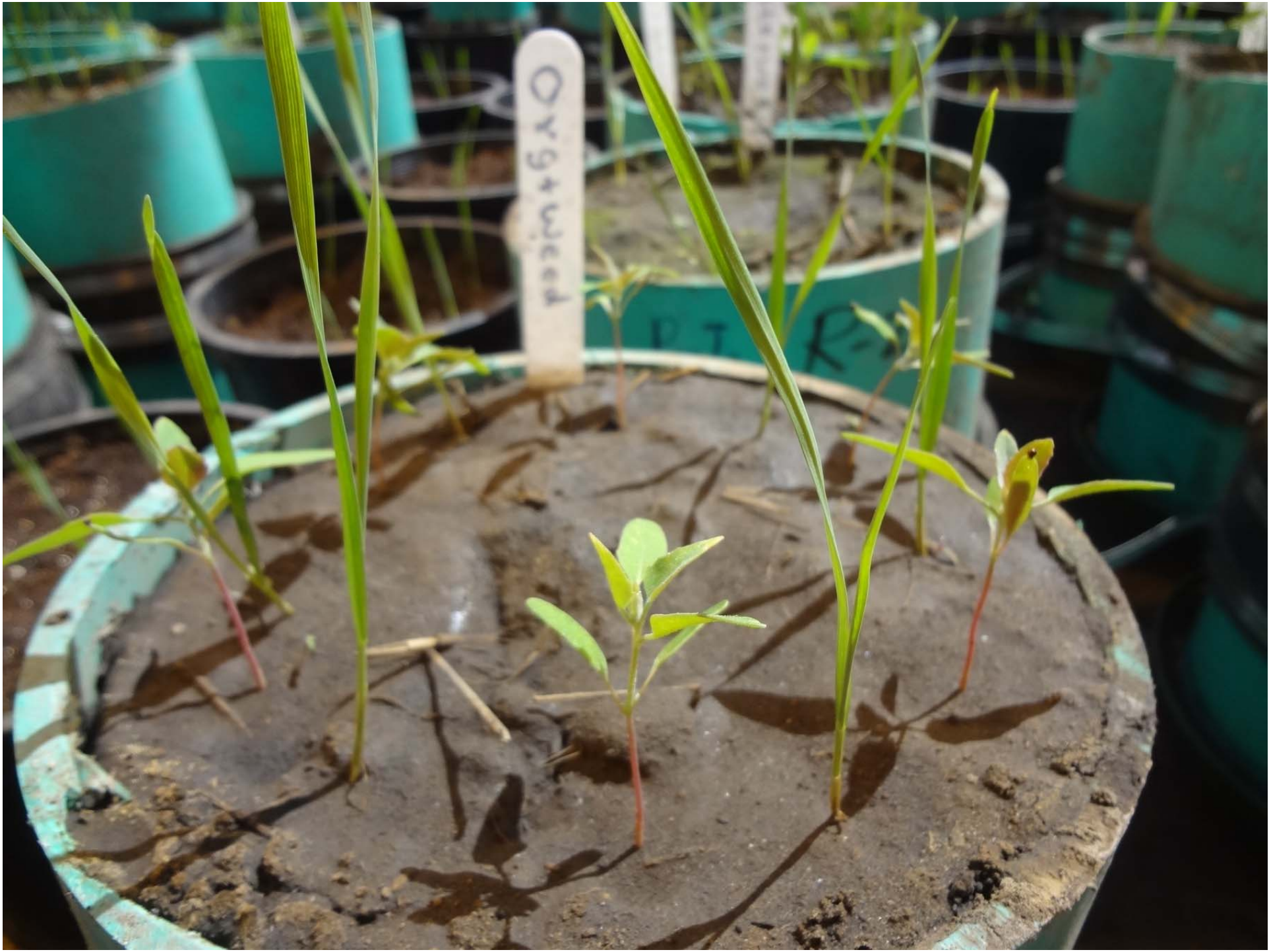
Compared to already good agronomy!!

Is it weeds causing the low yields in organic?


wheat
wheat
wheat
wheat
RED
wheat
wheat
ORG
wheat
REP 4
REP 3
REP 2
REP1

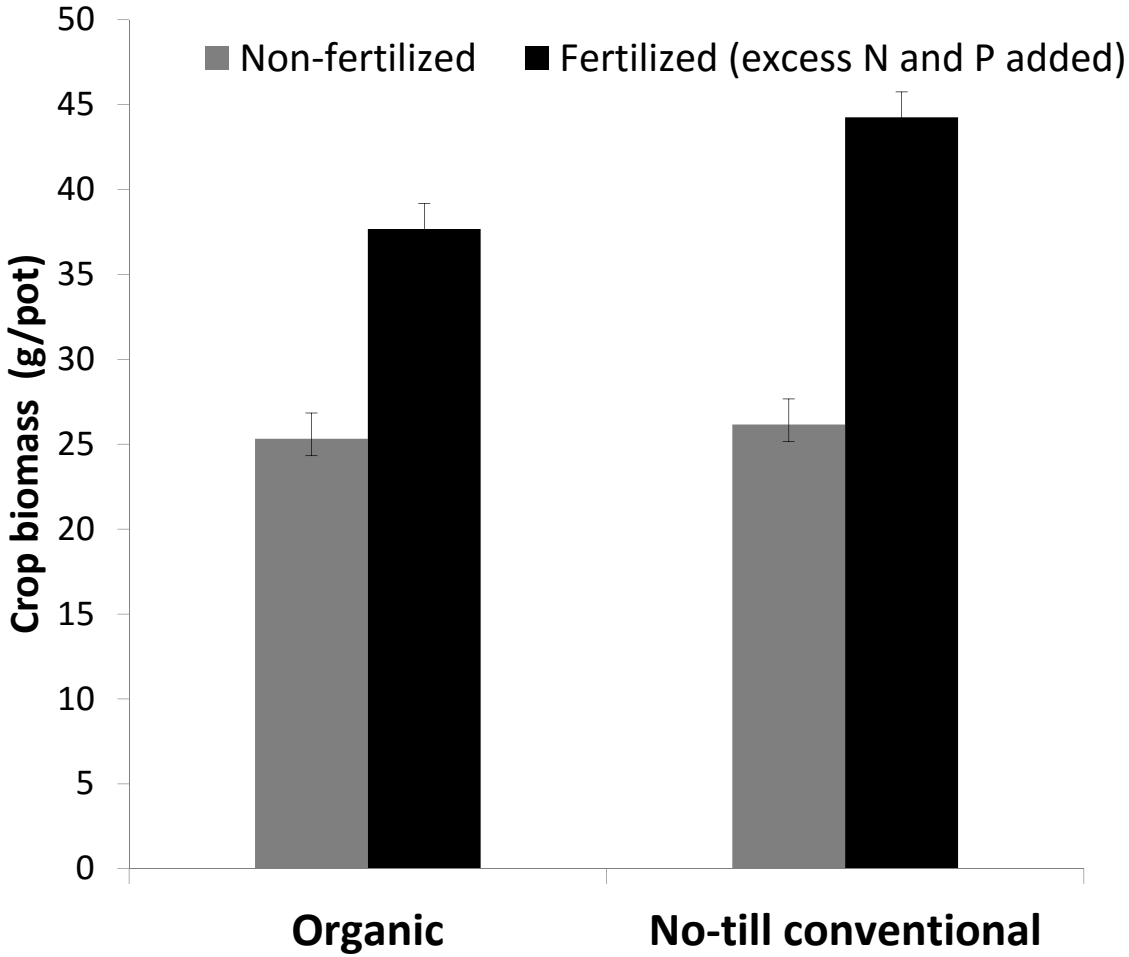

Micro-plot study
Objective- To evaluate crop-weed competition
Study- 2011 and 2012


5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Grain yield (kg/ha)
Weedy
Weed-free
Standard weed control
Model weed
Organic
No-till conventional


Oryza sativa


R-3
T30

Crop biomass with and without fertilizer



Thank you!

2016

INTERNATIONAL YEAR OF PULSES

Acknowledgements

- Twitter
  - @ProfAgronomy
- Technical & Research Staff:
  - Agronomy Research Crew: Shaun Campbell, Lena Syrovy & others

University of Saskatchewan

Growing Forward 2 | Cultivons l'avenir 2

Saskatchewan Ministry of Agriculture

Saskatchewan Oat Development Commission

NSERC CRSNG

Saskatchewan Pulse Growers

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

QUESTIONS?