

Managing Weeds in Organic Cereal Production: How to Maximize your Crops Competitive with Weeds



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Introduction

- **Have been doing research on organic farms since 2000**
- **Agronomic techniques to reduce crop yield loss to weeds and to reduce weed seed production**
- **Increase the competition of the crop with the weed**
- **good agronomy is more effective than herbicides in weed control**

Increasing crop competition with weeds

- 1) Crop variety selection**
- 2) Crop seeding rate**
- 3) Crop seed size**
- 4) Seed row width**
- 5) Combining tactics**

1) Crop variety selection

- *Principle – Select a more competitive crop variety if available and known*

1) Crop variety selection

Organic Variety Trials

- Variety trials on organic farms
- Varieties were divided into:
 - Heritage
 - Modern
 - Low input genotypes (Barley and Oats only)

Average wheat yields

| Variety | Yield (kg/ha) |
|----------|---------------|
| Redfife | 1412.86 |
| Superb | 1340.95 |
| Lee | 1295.09 |
| Redbobs | 1278.87 |
| Barrie | 1266.42 |
| Marquis | 1259.16 |
| Thatcher | 1212.62 |
| Apex | 1142.32 |

- Red Fife differed significantly from the rest
- no difference in rest
- AC Superb was highest at high nutrient site

THE CURIOUS CASE OF RED FIFE

- Pridham and Entz (2007) Manitoba
 - Red Fife yielded comparably to modern wheat genotypes and mixture
 - Marquis was not as good as modern cultivars
- Carr (2006) Minnesota and North Dakota
 - Red Fife low yield under organic conditions
 - Average of 72% of maximum
 - One location yield 40% of maximum

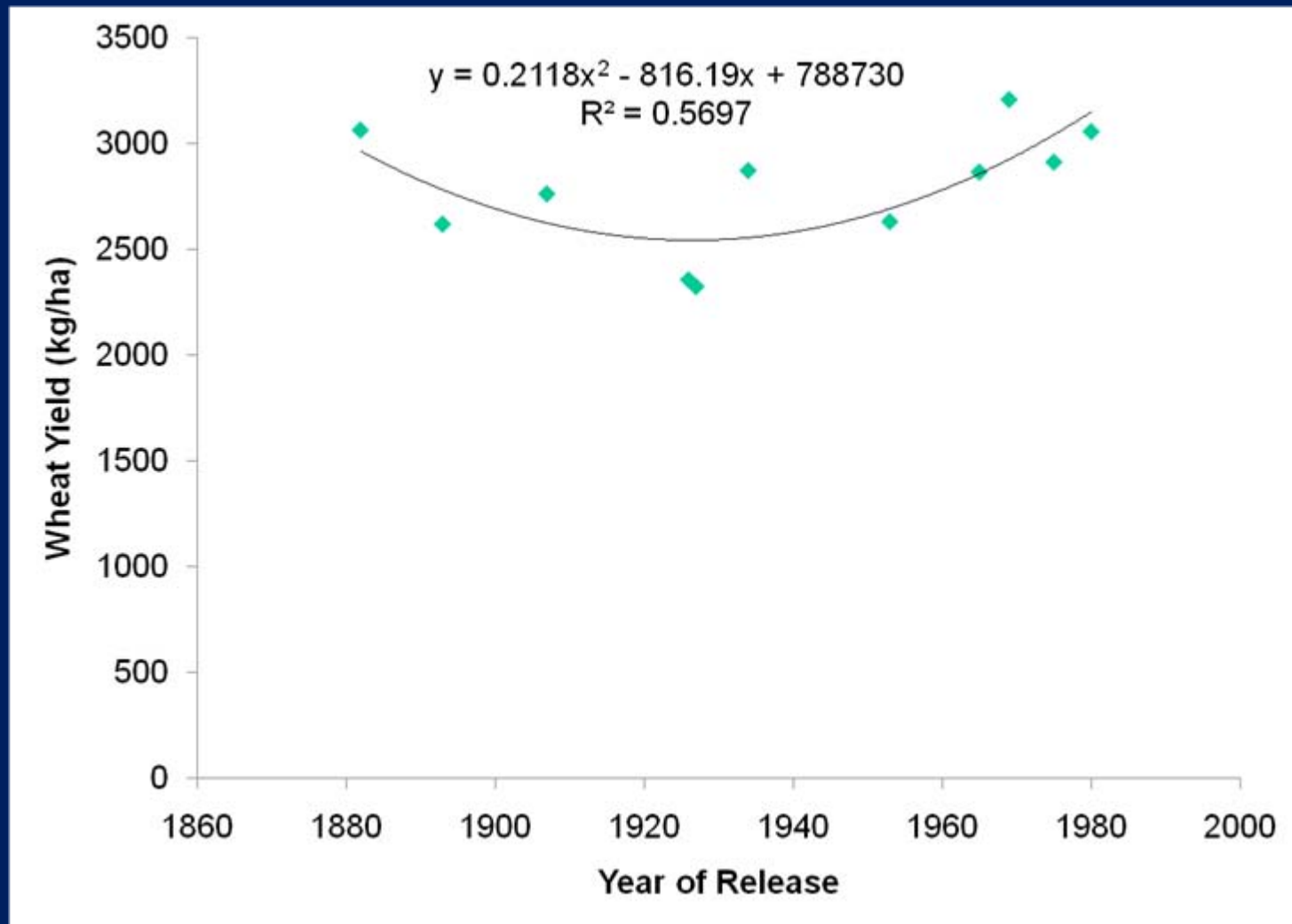
THE CURIOUS CASE OF RED FIFE

- Mason et al. (2007) Alberta
 - Red Fife yield 65% of the highest yielding cultivar, Park
 - Shorter season of Park?

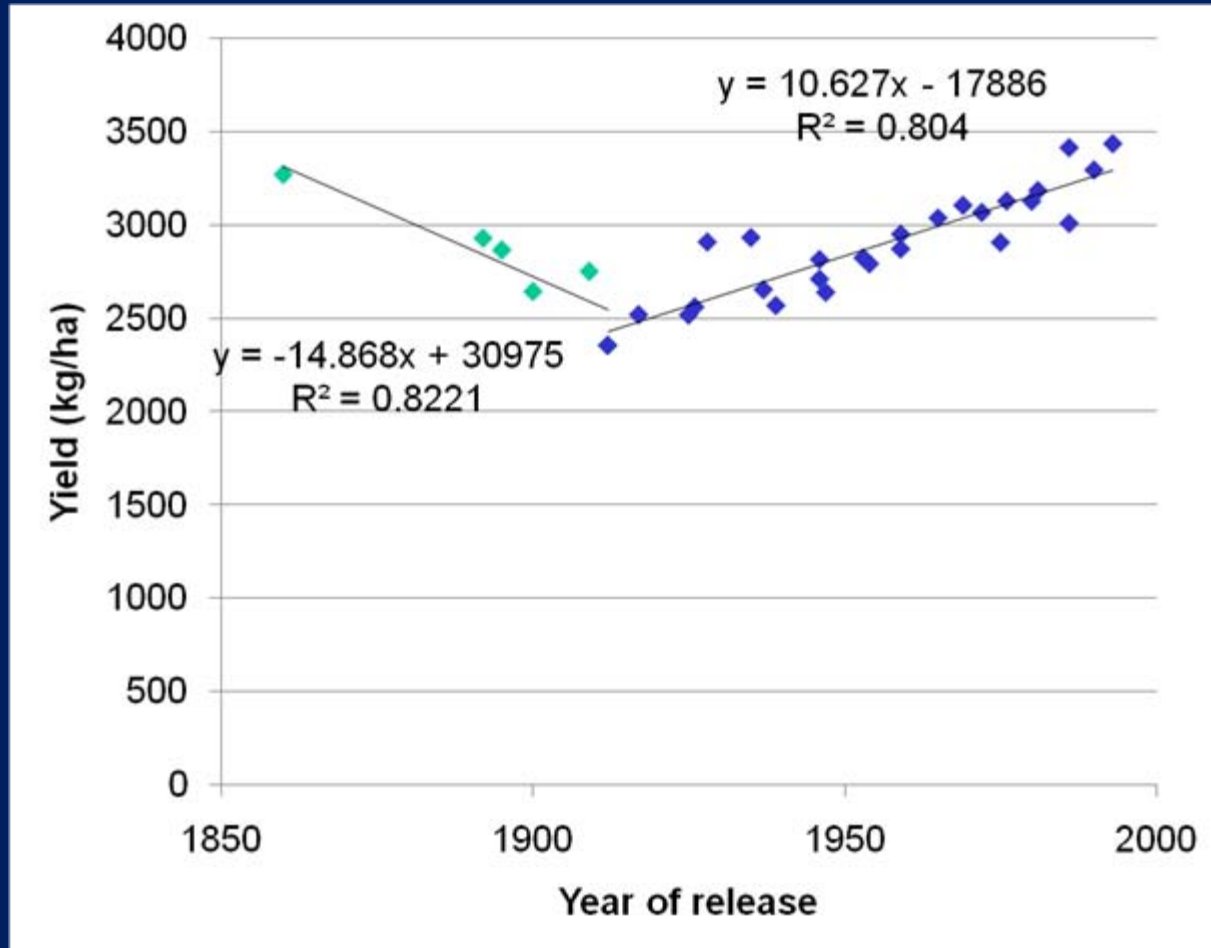
How has the yield potential of CWRS wheat changed over time?

- McCaig and DePauw (1995)
 - analysis of variety trials
 - removed agronomic and environmental effects
 - increase of 6-9 kg ha/yr since Marquis

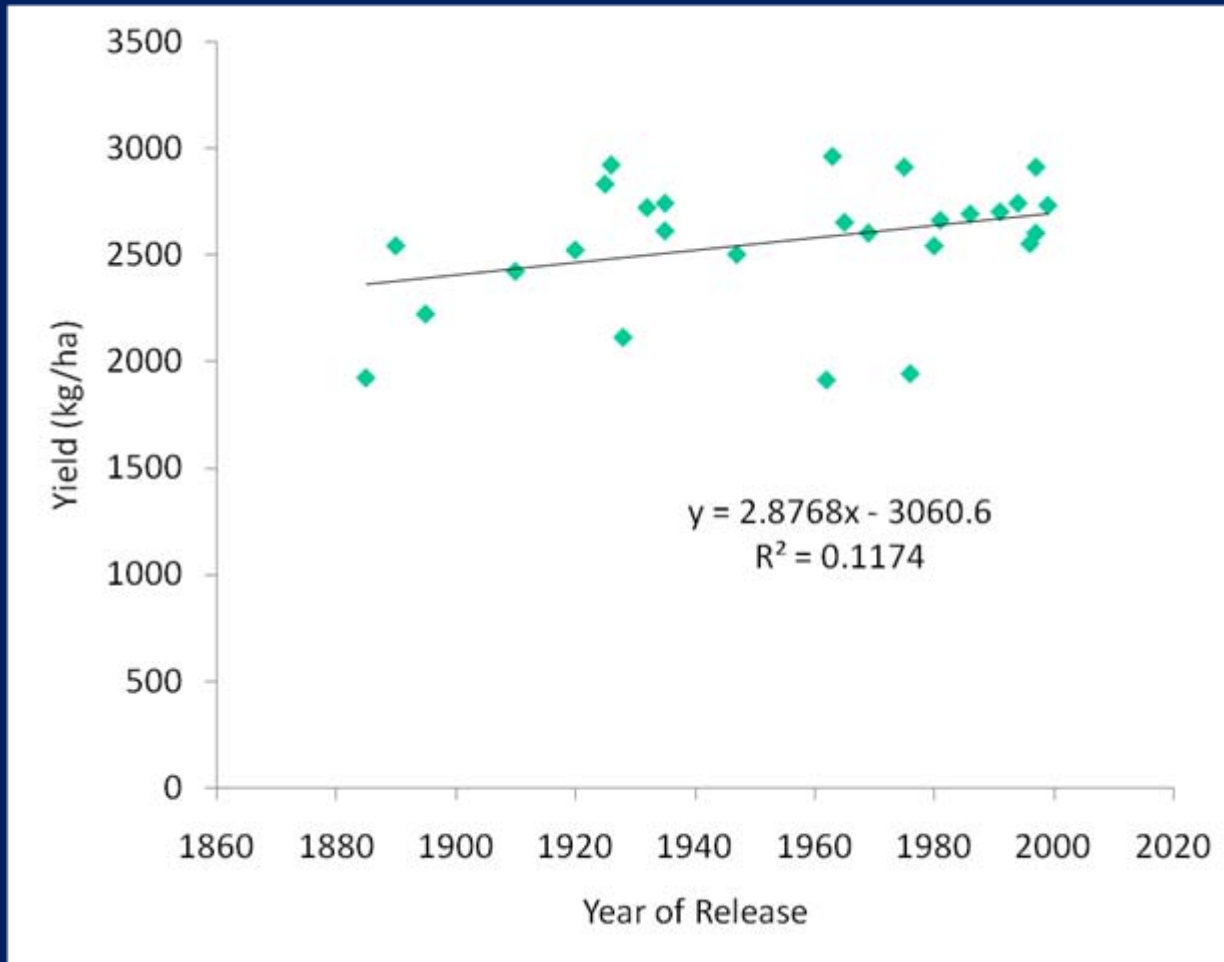
Yield potential of CWRS lines over time (reanalysis of Hucl and Baker 1987)



Yield potential of CWRS lines over time (reanalysis of Hucl (submitted 2009))



Yield potential of historic CWRS grown under organic conditions (reanalysis of Mason et al. 2007)



THE CURIOUS CASE OF RED FIFE

- Issues with Red Fife Production
 - long season
 - rust issues
 - low protein
 - poor baking quality (Mason et al. 2006)
 - loaf volume
 - soft kernels
- need to have a market for it
- Organic ideotype?

1) Crop variety selection-Barley

| Variety | Yield (kg/ha) |
|--------------|---------------|
| SB98340 | 2111.29 |
| CDC Cowboy | 2103.48 |
| Manley | 2082.26 |
| CDC Dolly | 2065.89 |
| CDC Copeland | 2038.65 |
| Hannchen | 1987.4 |
| Betzes | 1964.11 |
| Conquest | 1925.54 |
| Huskey | 1888.48 |
| McGwire | 1795.98 |
| SH97088 | 1767.71 |
| Scout | 1559.58 |
| OAC21 | 1345.12 |
| HB353 | 1018.04 |
| Tupper | 1015.9 |

- Modern low input varieties show promise
- CDC Cowboy (feed barley)

1) Crop variety selection - Oats

| Variety | Yield (kg/ha) |
|----------------|---------------|
| Morgan | 1978.6 |
| SA98084 | 1898.48 |
| Calibre | 1862.5 |
| SA98511 | 1750.52 |
| CDC Dancer | 1700.09 |
| AC Assiniboine | 1624.73 |
| Garry | 1611.11 |
| Harmon | 1542.6 |
| Victory | 1536.77 |

Modern yielded higher than heritage

Modern yielded higher than all others

Low input yielded higher than all others

1) Crop variety selection

- *Principle – Select a more competitive crop variety if available and known*
- *Reality:*
- *Often we don't know what varieties are more competitive*
- *Modern varieties often yield the highest*
- *Differences between most varieties are not very consistent between environments*

2) Crop seeding rate

- *Principal: Increase seeding rate to aid in competition with weeds*





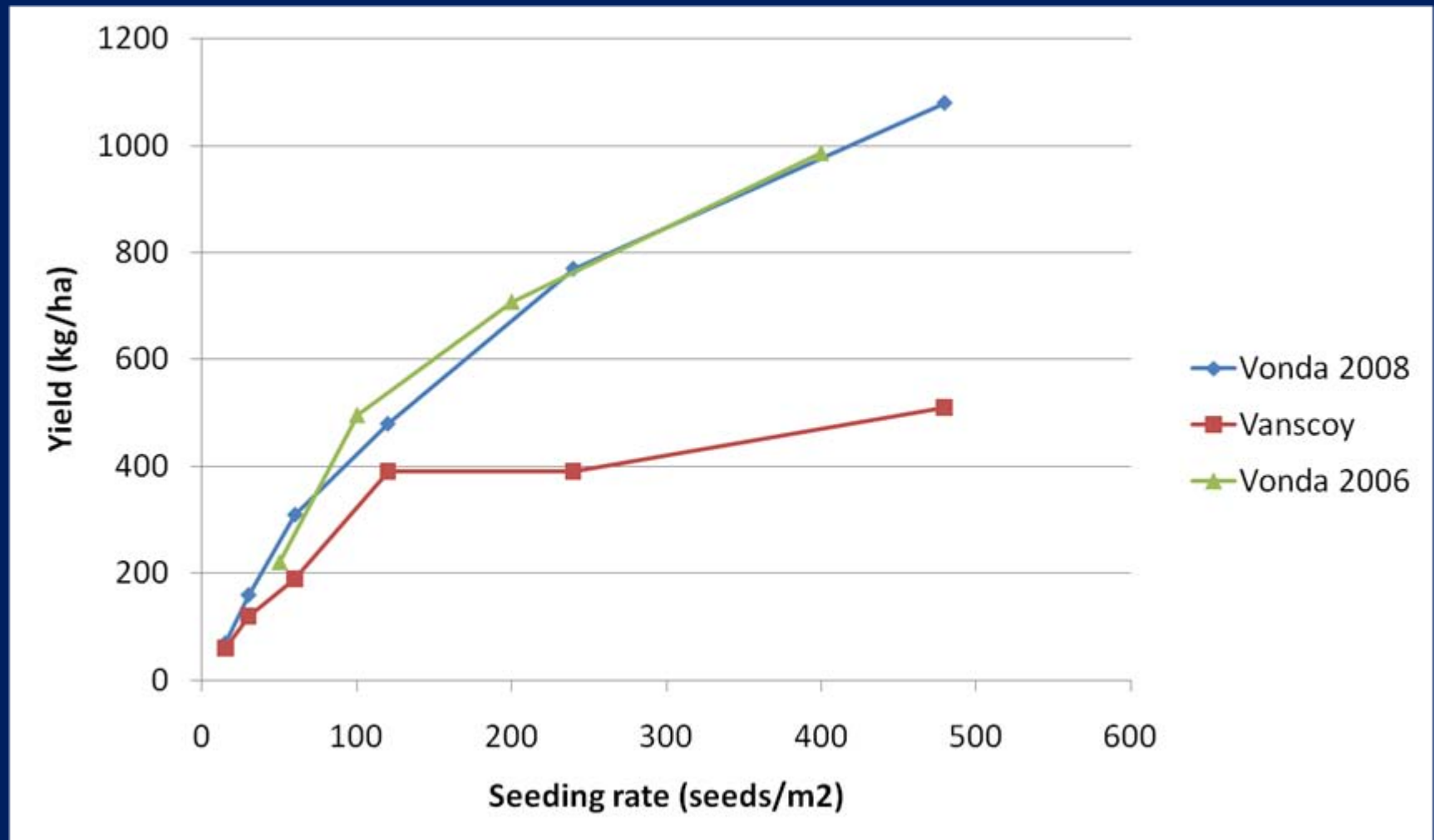




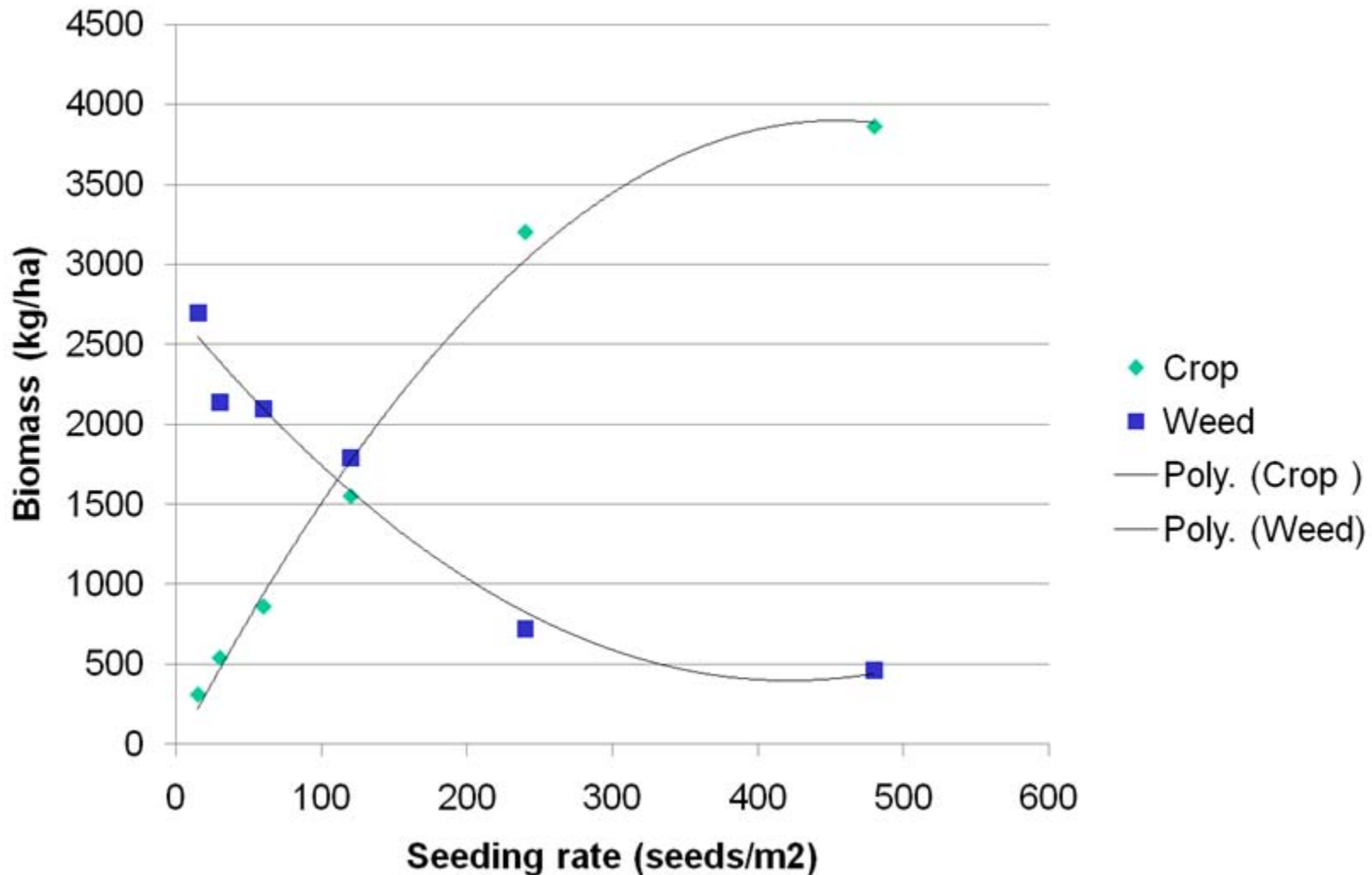


The effect of seeding rate on wheat yield

250 seeds/m² = ~ 1.5 bu/ac



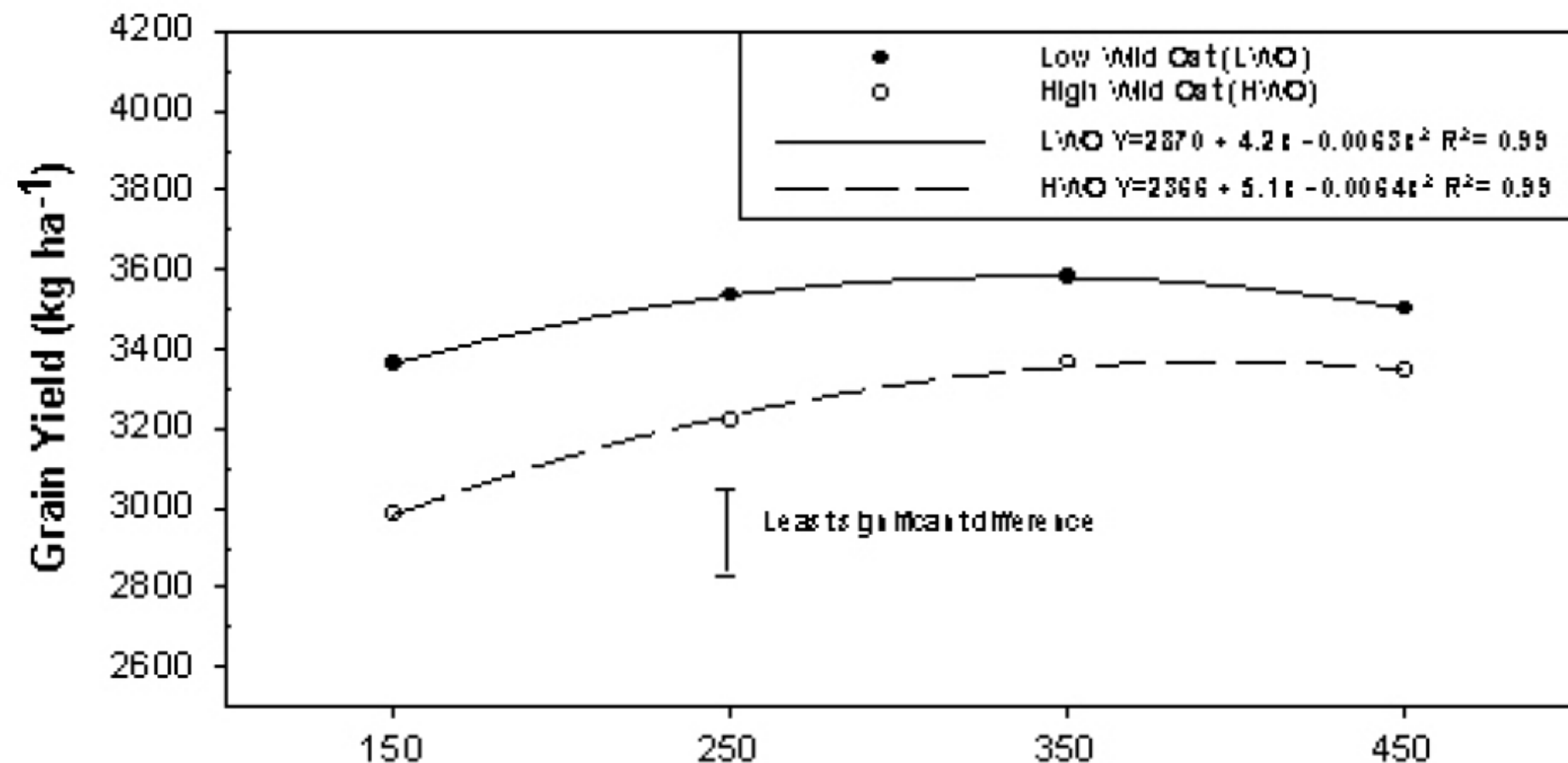
The effect of seeding rate in wheat yield on crop and weed biomass (Vonda 2008)



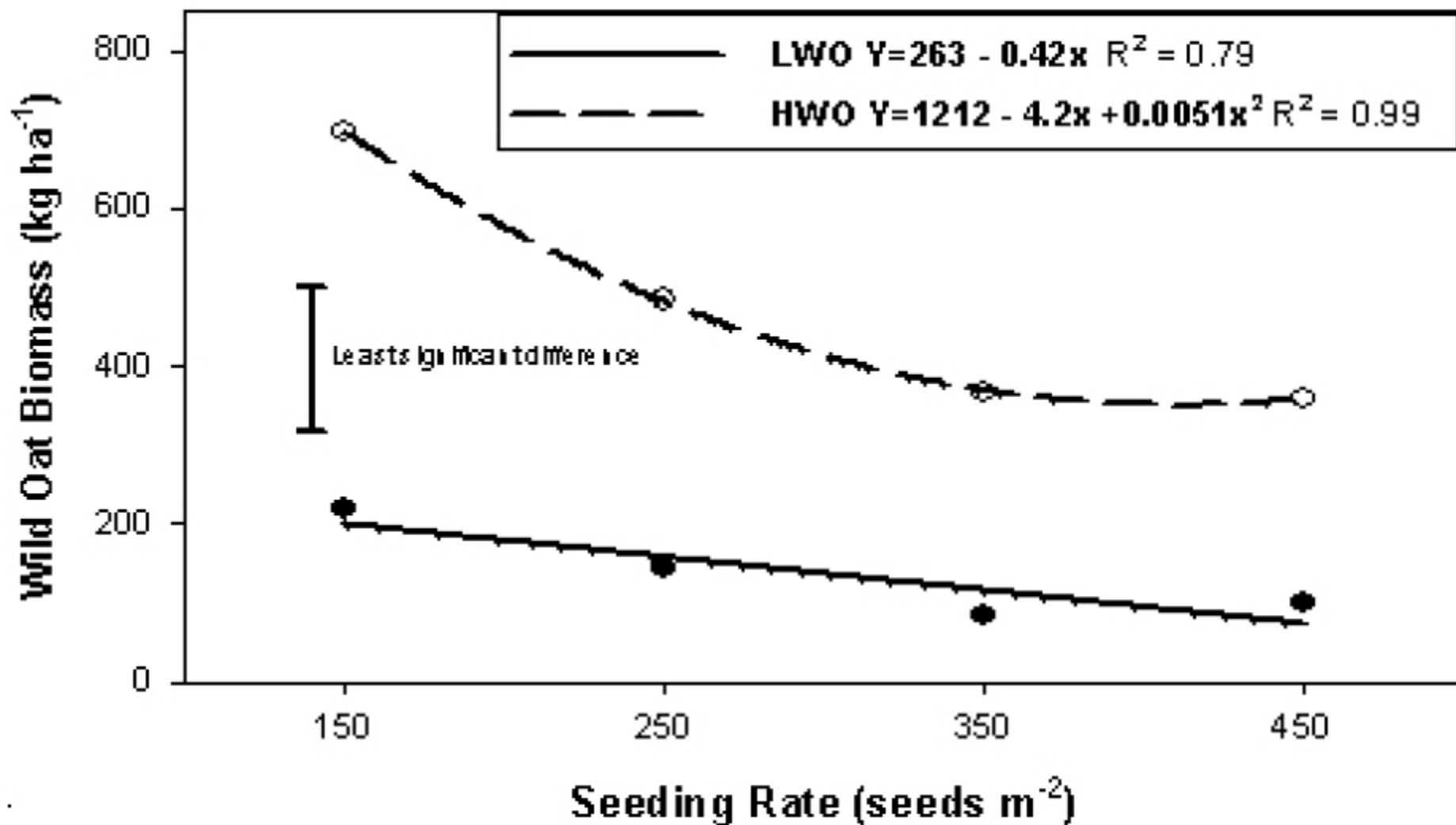
Organic Wheat seeding rates

- Mason et al. (2007)
- 300 and 600 wheat seeds m⁻²
- yield of the wheat varieties was 10% higher at double seeding rate
- weed biomass reduced 33%
- economic gains of \$35 - \$54/ha
- barley less responsive

Effect of oat seeding rate and wild oat presence on oat yield (May et al, 2009)



Effect of oat seeding rate and wild oat presence on wild oat biomass (May et al, 2009)



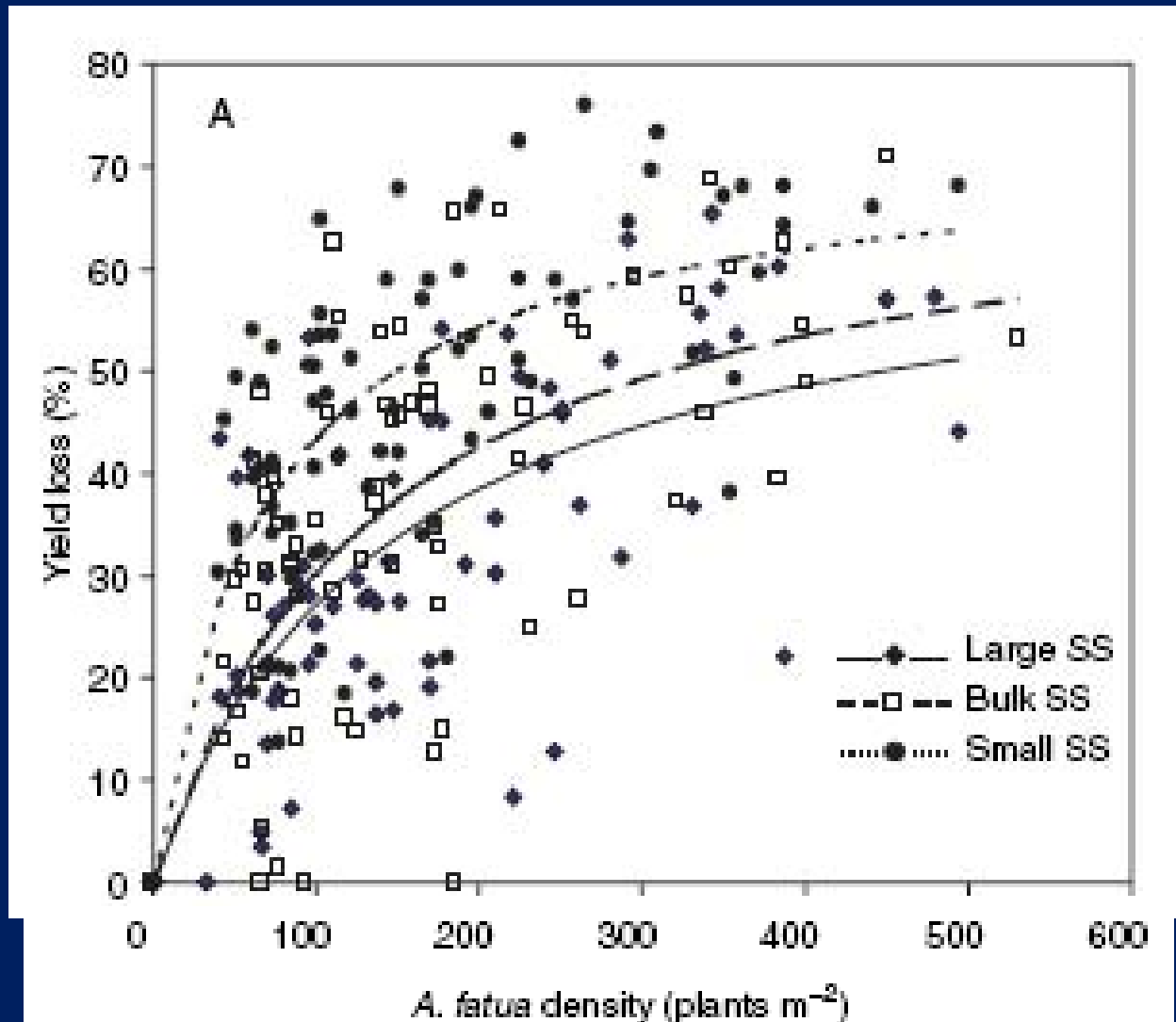
2) Crop seeding rate

- *Principal: Increase seeding rate to aid in competition with weeds*
- *Reality:*
 - *This is the MOST effective way to increase BOTH the crop yield and reduce weed growth available*
 - *the seeding rate for most crops should be at least 1.5 times what the recommended is*

3) Crop seed site

- *Principal: Seed large vigorous seed*

Yield loss in wheat from wild oat as affected by wheat seed size (Stougaard and Xue , 2004)



Groat size 30 mg



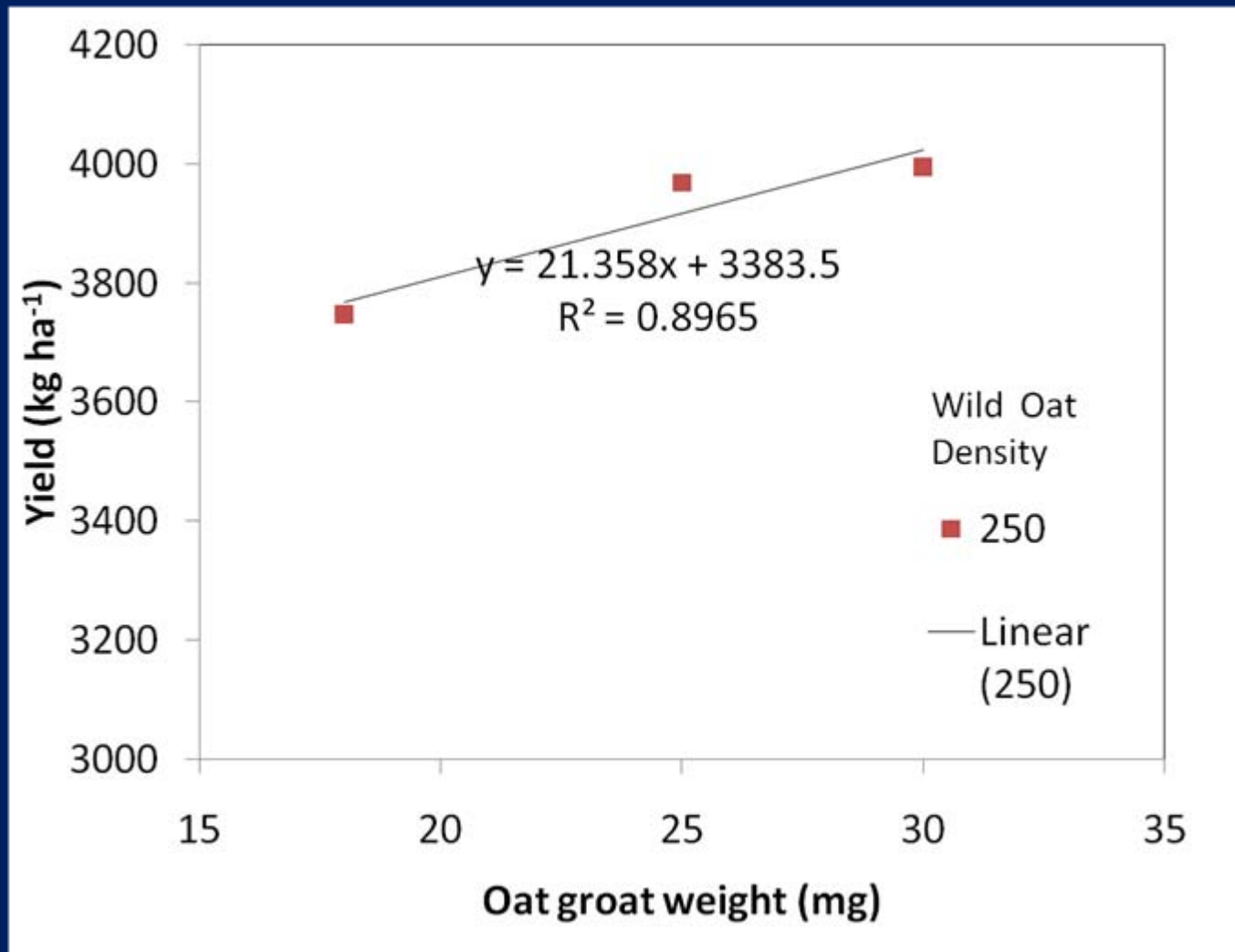
Groat size 25 mg



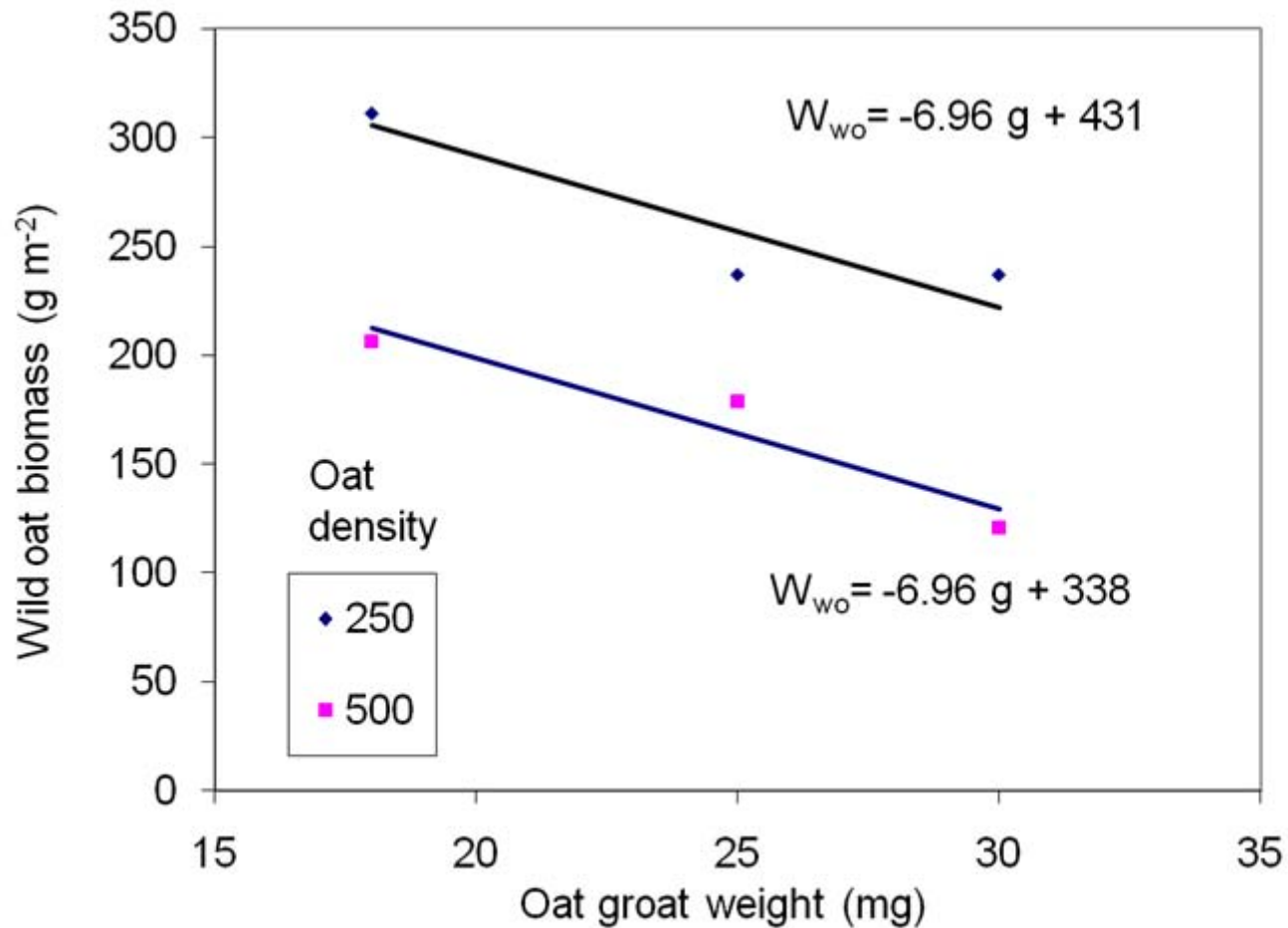
Groat size 18 mg



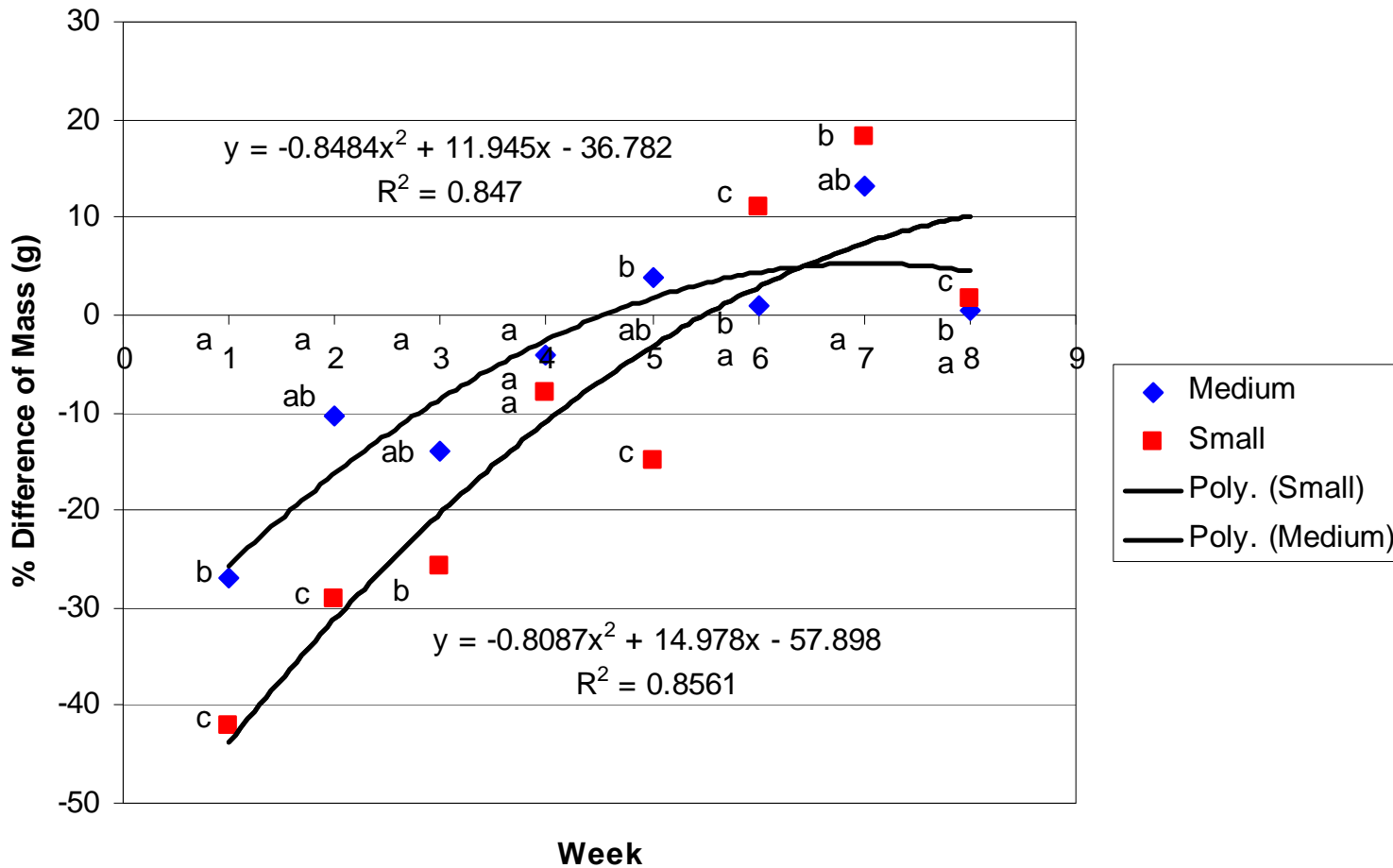
Effect of oat groat size on oat yield at 0 and 250 wild oat plants m⁻². Average of four site years.



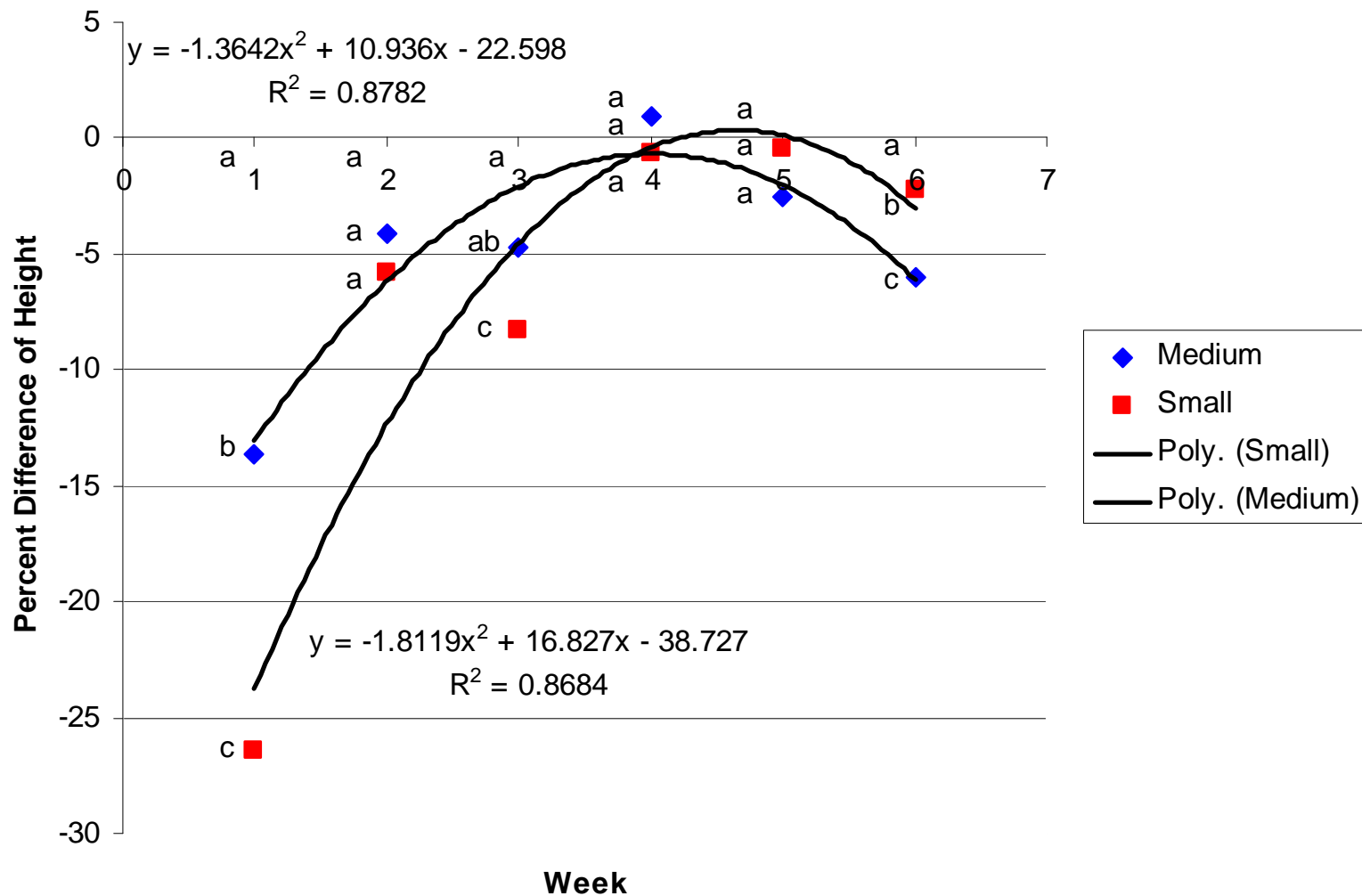
Effect of oat groat size on wild oat biomass at 250 and 500 oat plants m⁻². Average of four site years.



Difference of oat mass over time of small and medium oat seed relative to large oat seed (Fowler and Shirtliffe, 2009)



Difference of oat height over time of small and medium oat seed relative to large oat seed (Fowler and Shirtliffe, 2009)



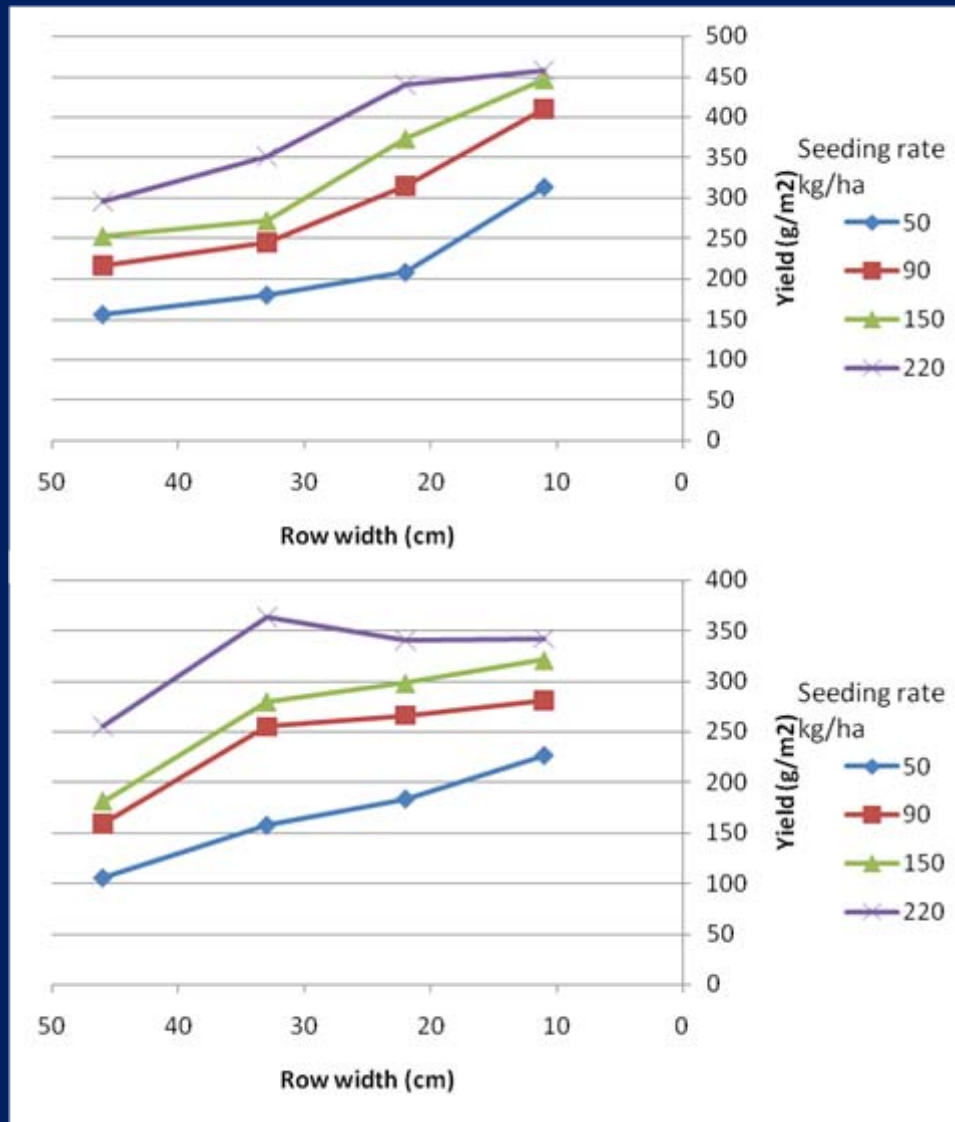
3) Crop seed size

- *Principal: Seed large vigorous seed*
- *Reality:*
 - *Seed size and seed number probably compensate for each other*
 - *if seed size is small most farmers will by default seed more seeds per unit area*

4) Crop row spacing

- *Principal: Use as narrow a seed row as practically possible*

The effect of row width and seeding rate on Barley yield over two years (Kirland, 1993).



4) Crop row spacing

- *Principal: Use as narrow a seed row as practically possible*
- *Reality:*
- *There is little evidence for differences between “normal” row spacing*
- *seeding rate may overcome this affect*
- *expensive option*
 - *new seeder*
 - *crop residue clearance may be an issue*

5) Combining tactics

- *Principal: Combine as many tactics as possible to increase the crops competition with the weed*

5) Combining tactics

Four levels of treatments:

- 1) Competitive and non competitive variety (2007 – Peas)
 - Carrera – non-competitive
 - Eclipse – competitive
- 2) Low and High Seeding rate
 - Peas – 50 and 100 viable seeds/m²
- 3) Row width – 11.5cm and 23cm
- 4) Harrowing – in-crop harrowing and none

Early analysis of 2nd year

- Always a positive response to seeding rate
 - sometimes quite high
- Variety sometimes has effect
 - Wheat CDC Rama looks very good
- Harrowing has effect sometimes
 - Scott in 2008 doubled pea yield
 - Saskatoon 2008 stimulated weeds to grow
- Row spacing effect rarely seen
 - sometimes wider is better

5) Combining tactics

- *Principal: Combine as many tactics as possible to increase the crops competition with the weed*
- *Reality:*
- *some tactics work much better than others*
 - *seeding rate is **very important** for yield when weedy*
 - *perhaps interactions?*

Acknowledgements



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Ministry of
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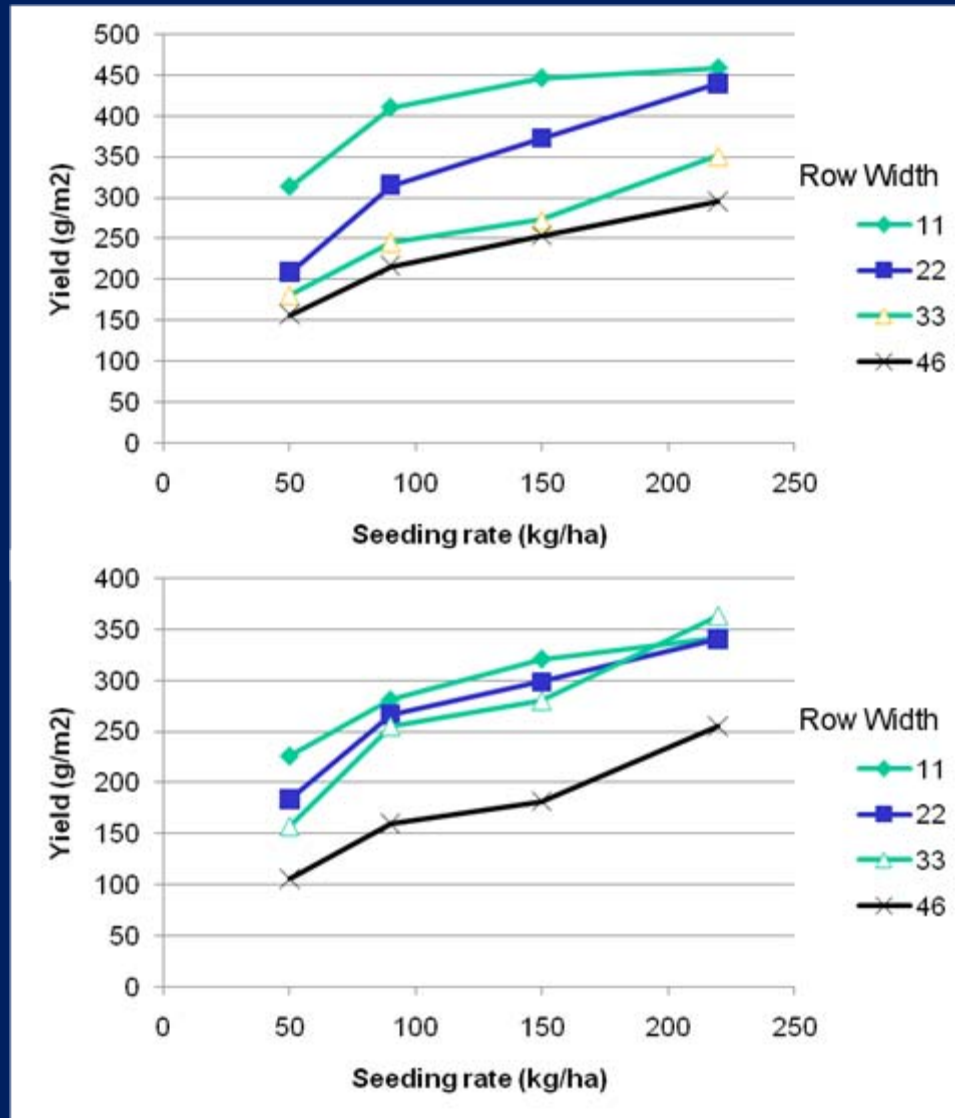
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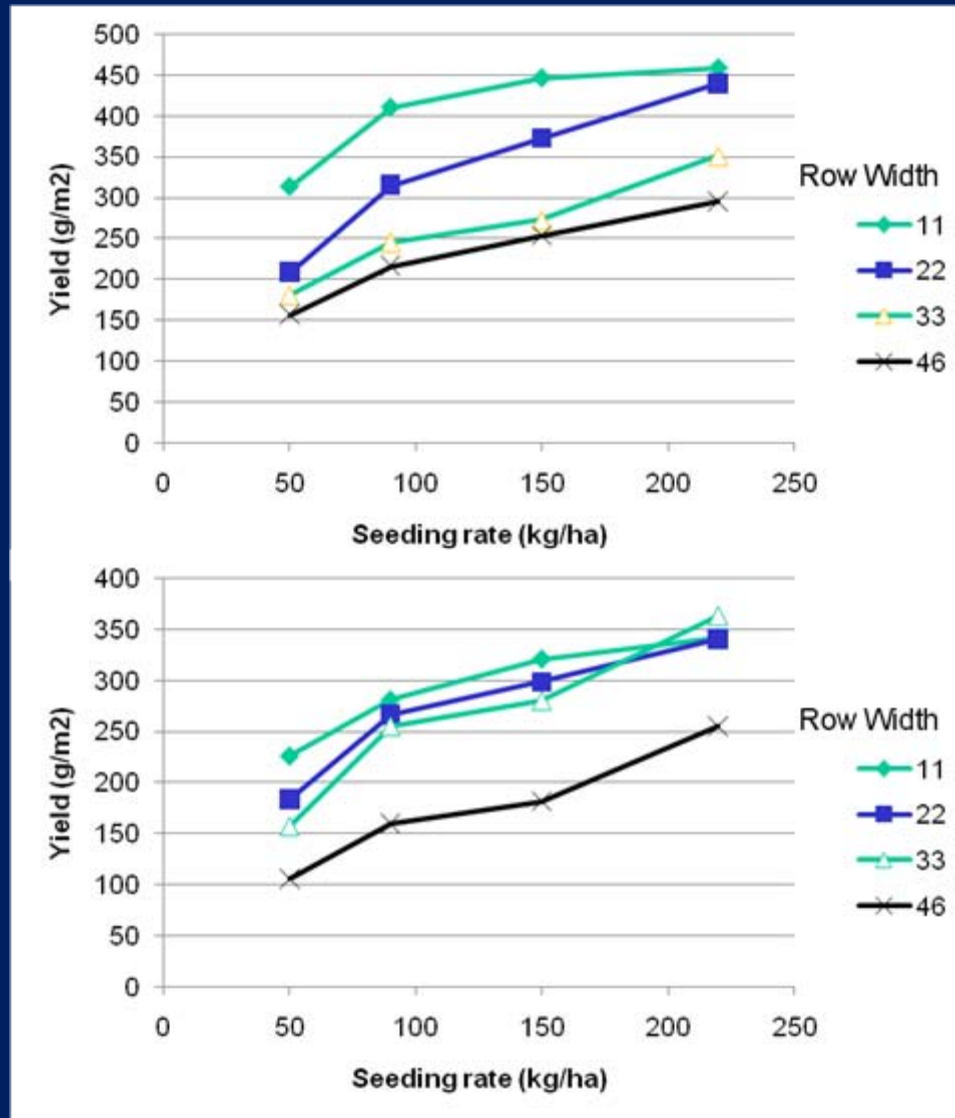
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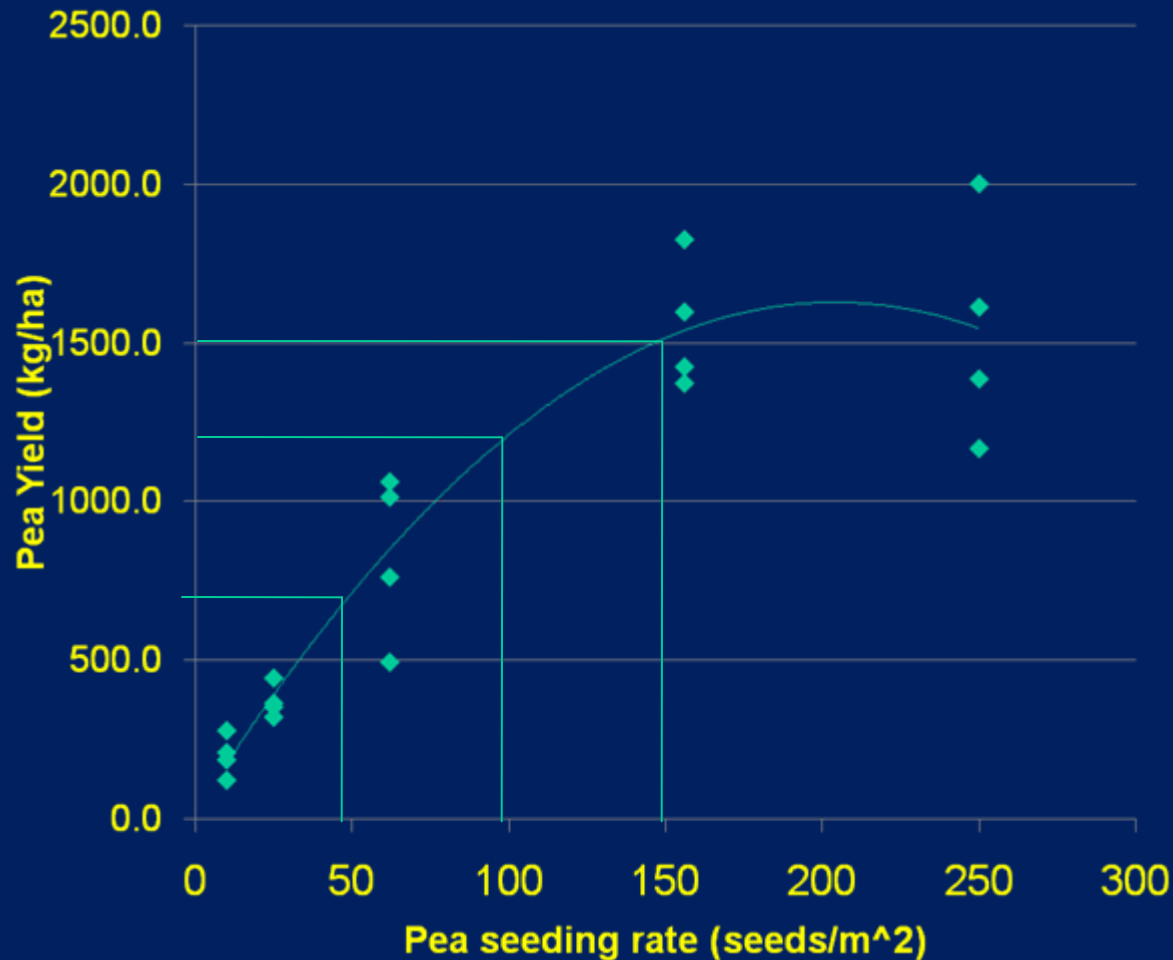
The effect of row width and seeding rate on Barley yield over two years (Kirland, 1993).



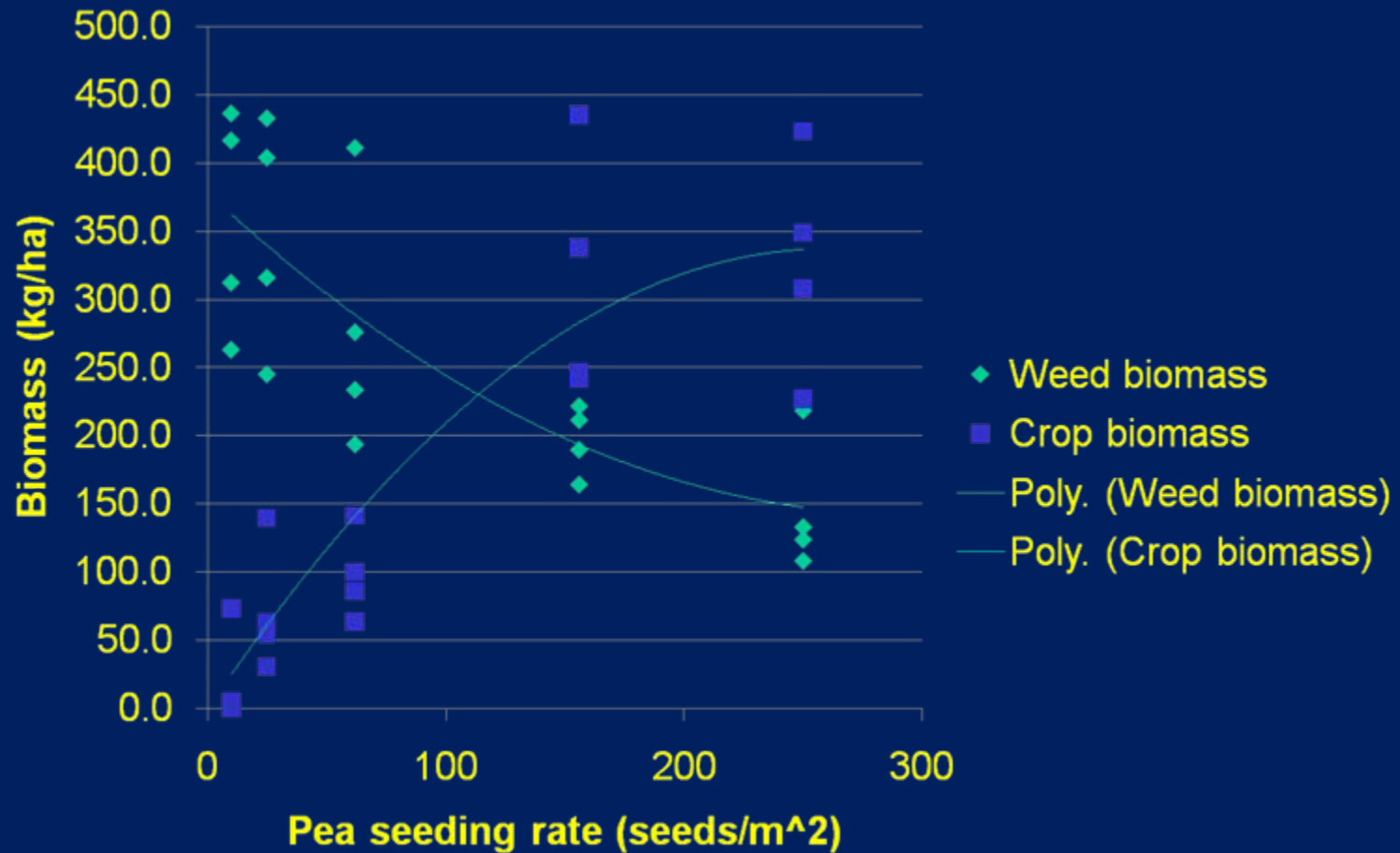
The effect of row width and seeding rate on Barley yield over two years (Kirland, 1993).



The effect of seeding rate on yield of organically grown peas (Vonda 2007)

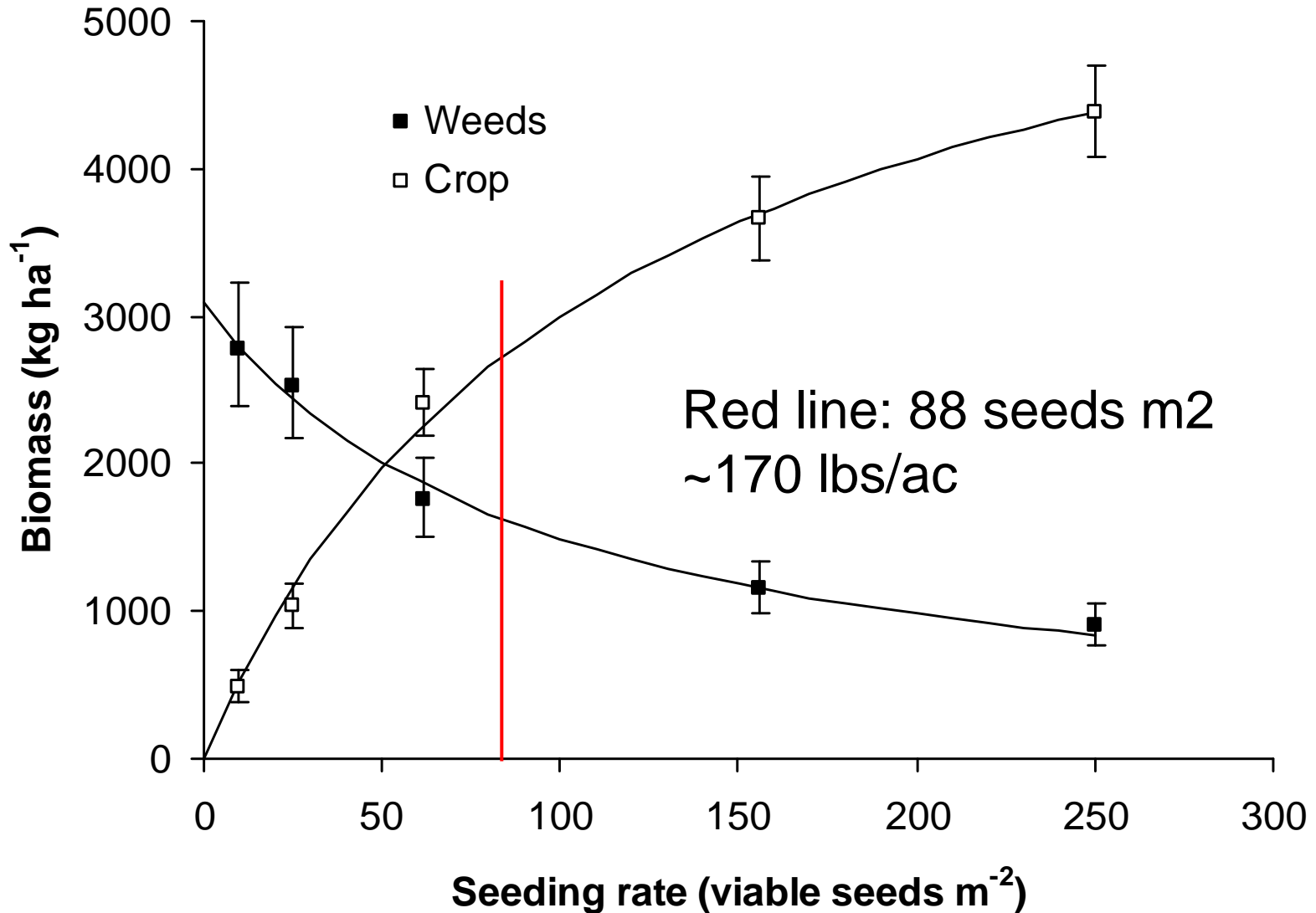


The effect of seeding rate on the crop and weed biomass of organically grown peas (Vonda 2007)



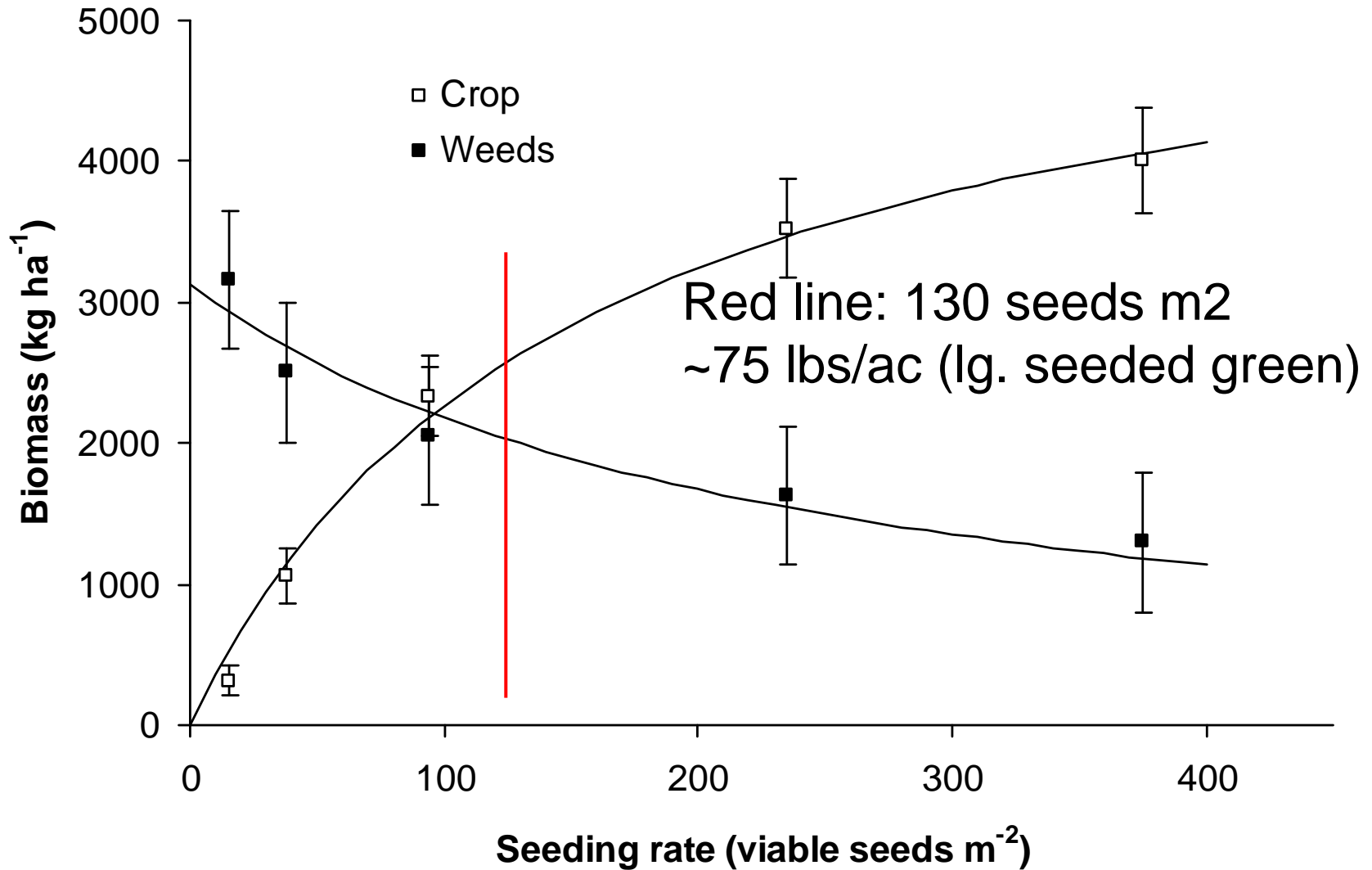
2) Crop seeding rate

Field pea crop and weed biomass

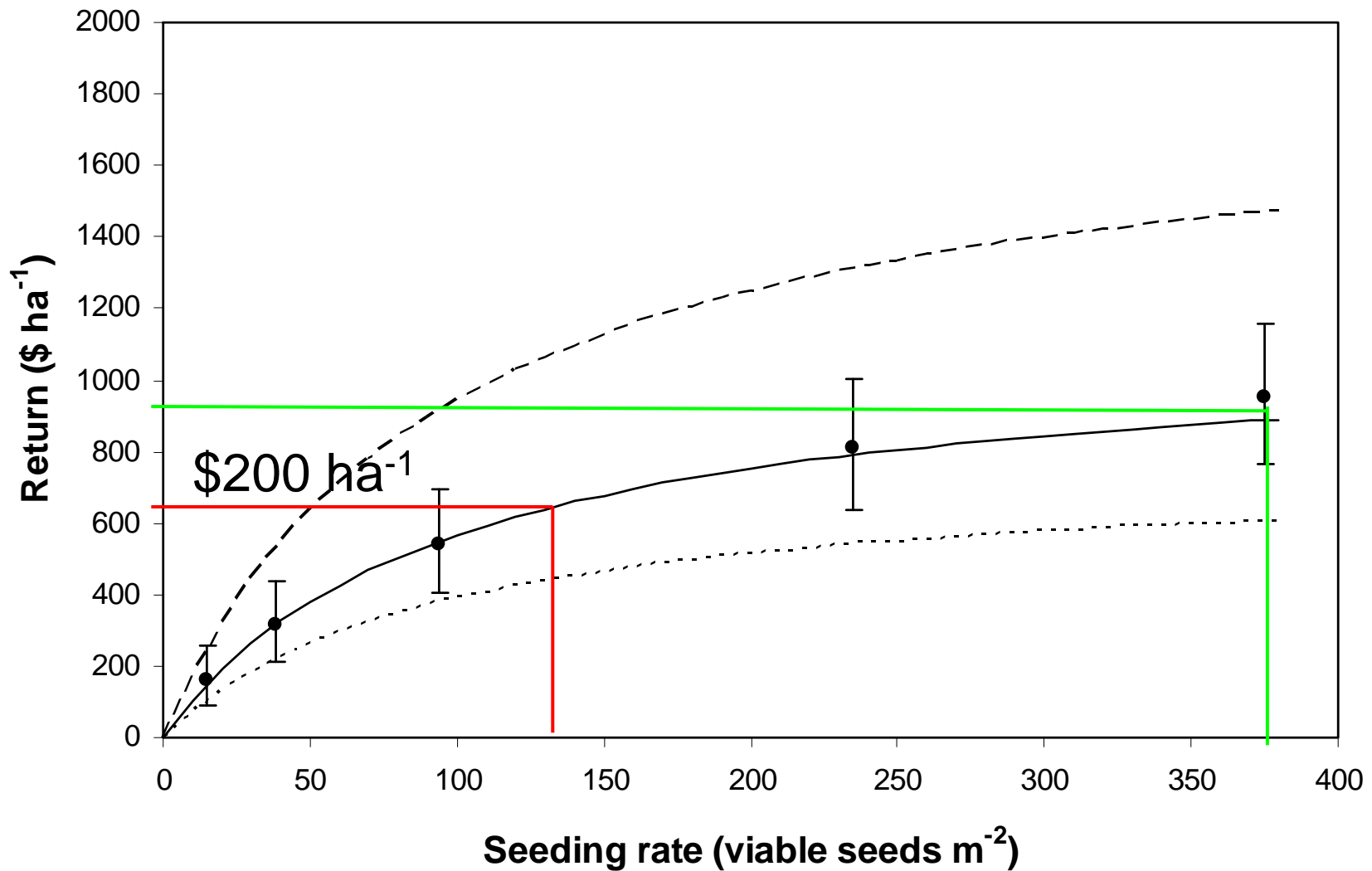


2) Crop seeding rate

Lentil crop and weed biomass

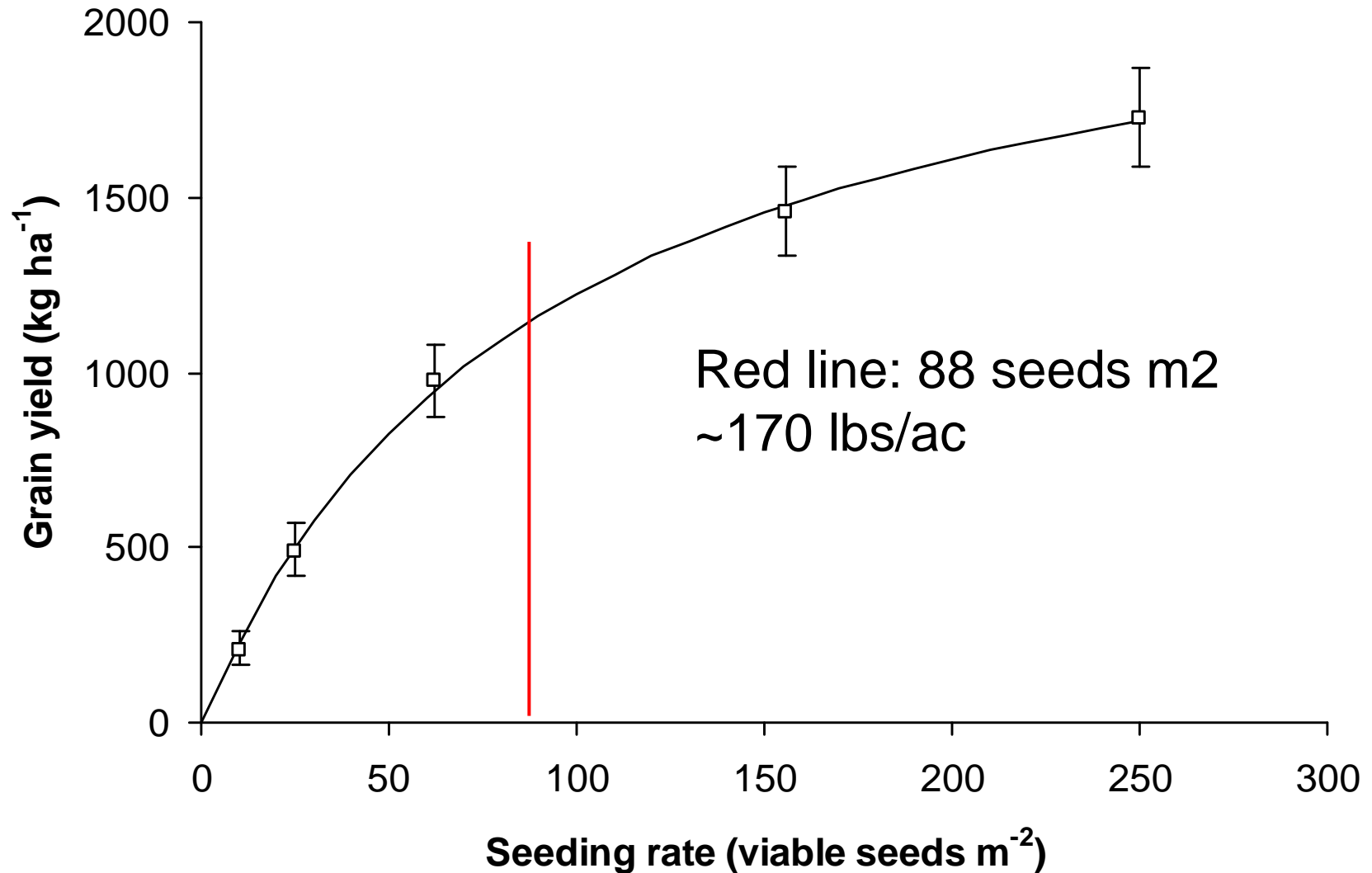


Lentil profit curve (4 site-years)

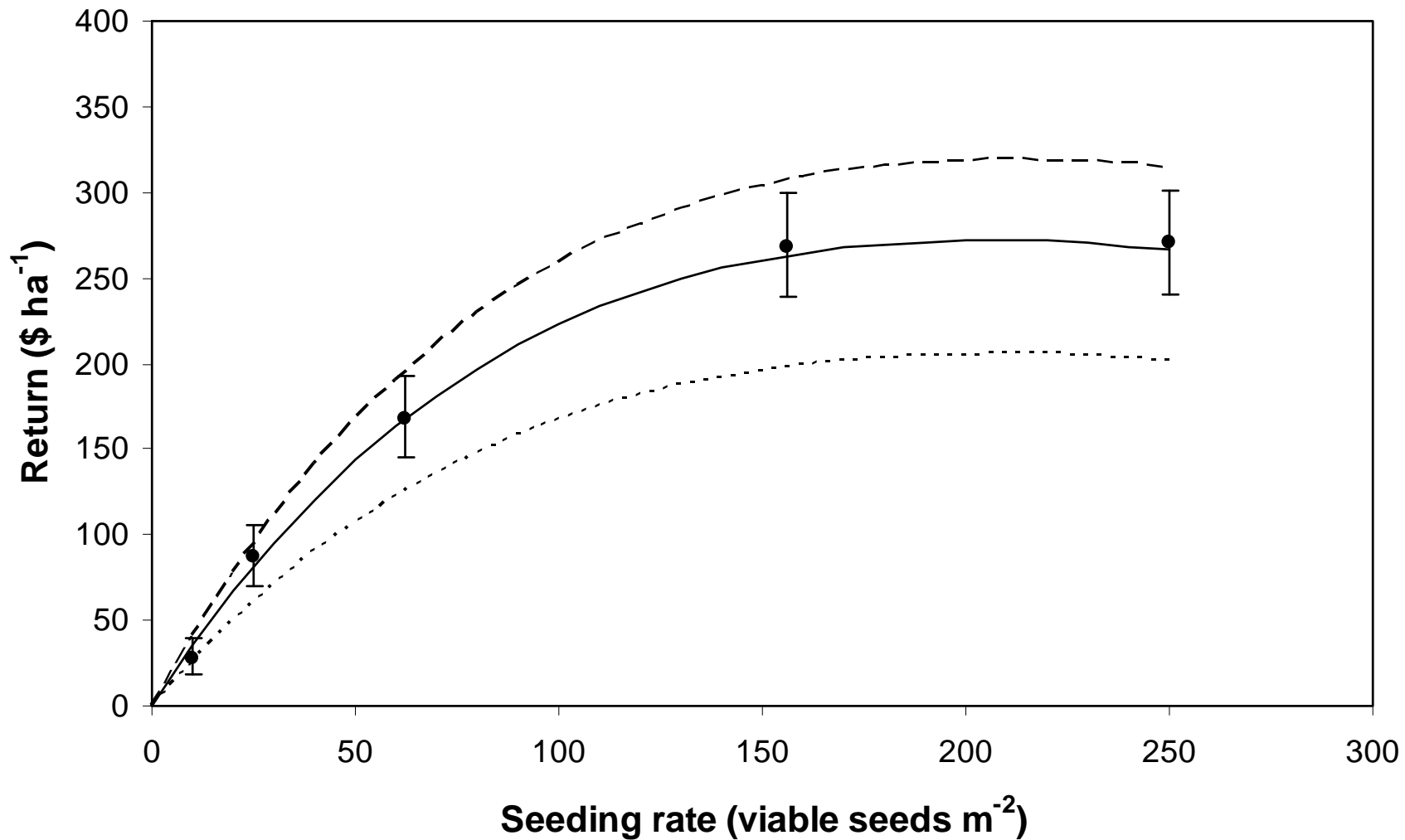


2) Crop seeding rate

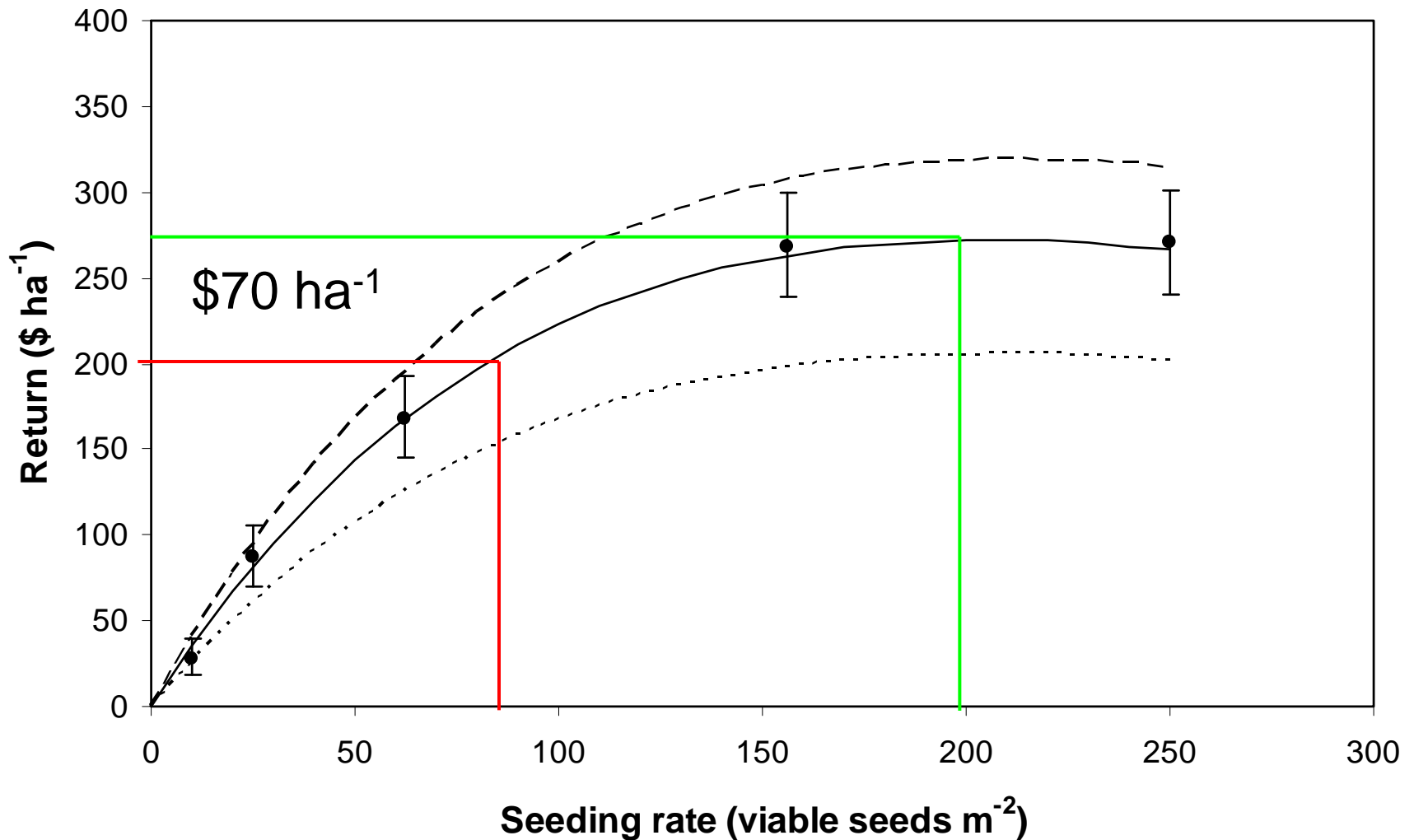
Field pea grain yield



Field pea profit curve



Field pea profit curve



Effect of pea seeding rate on field pea (weed free)



10 plants/m²



30 plants/m²



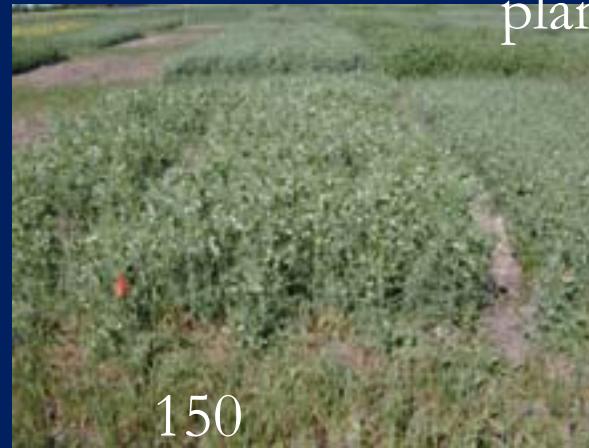
90

plants/m²



120

plants/m²

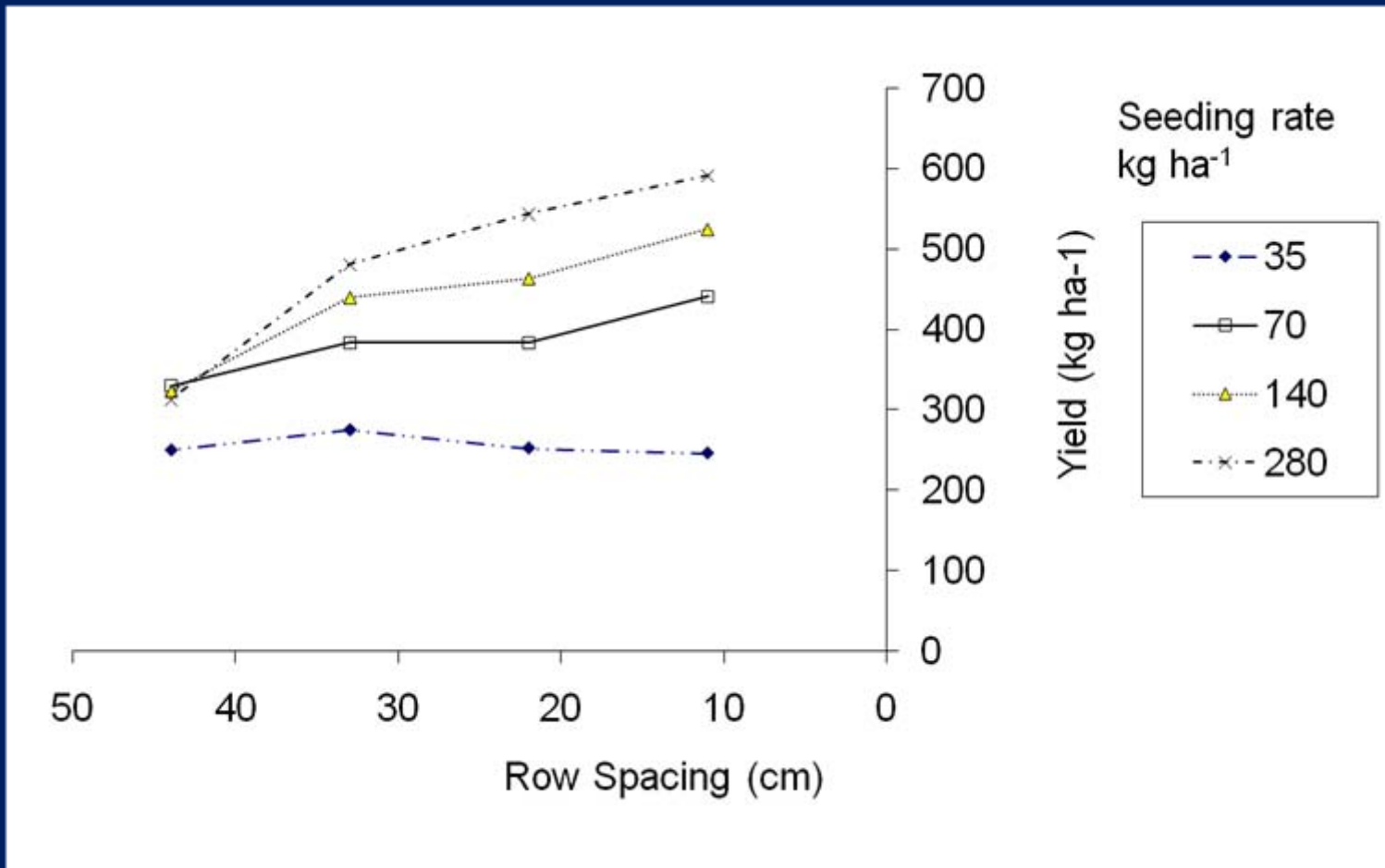


150

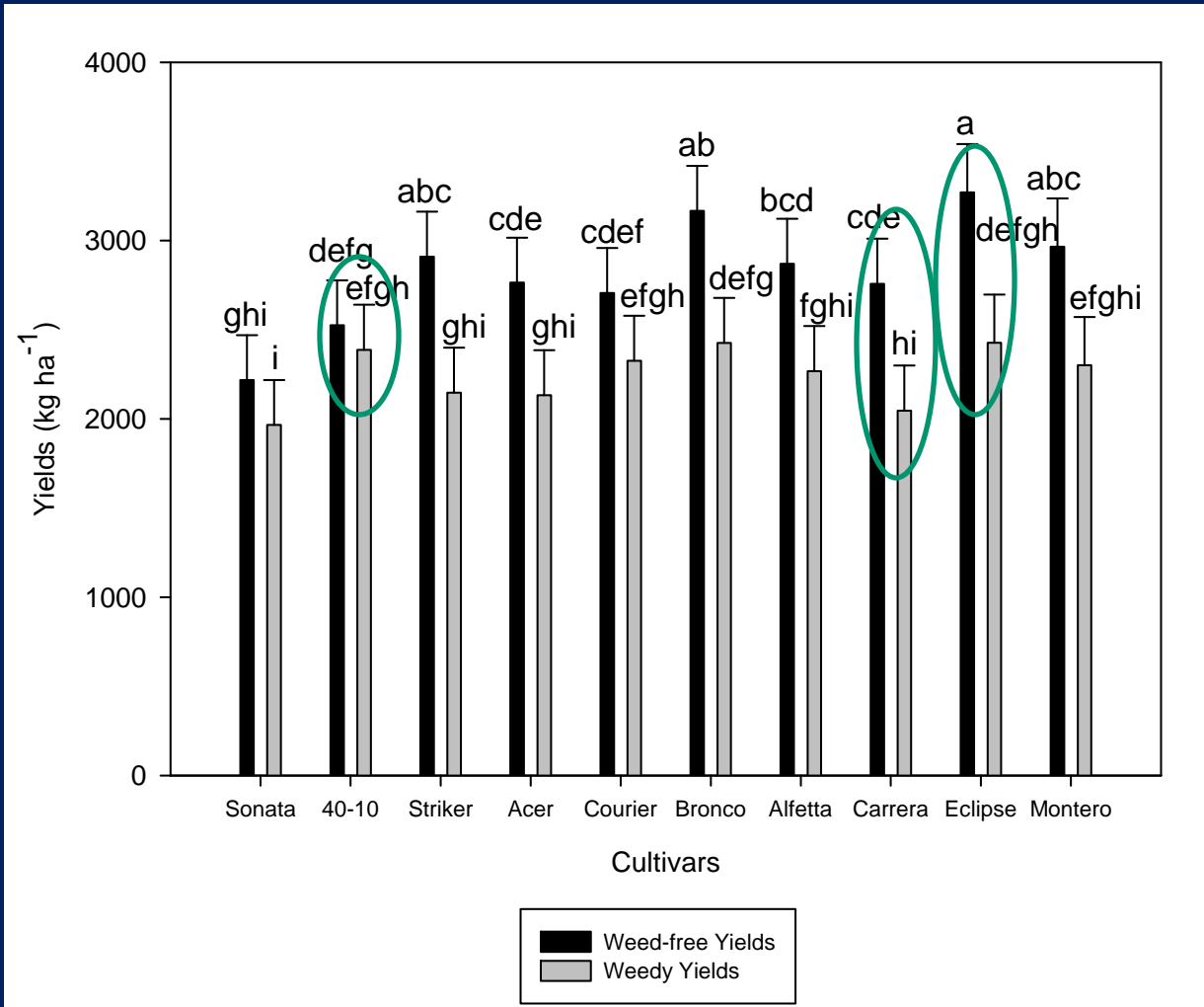
plants/m²



The effect of seeding rate and row spacing on lentil yield grown under weedy conditions (Johnson, 2002)



Crop yield of pea varieties as affected by weed presence or absence. Average of six site-years.



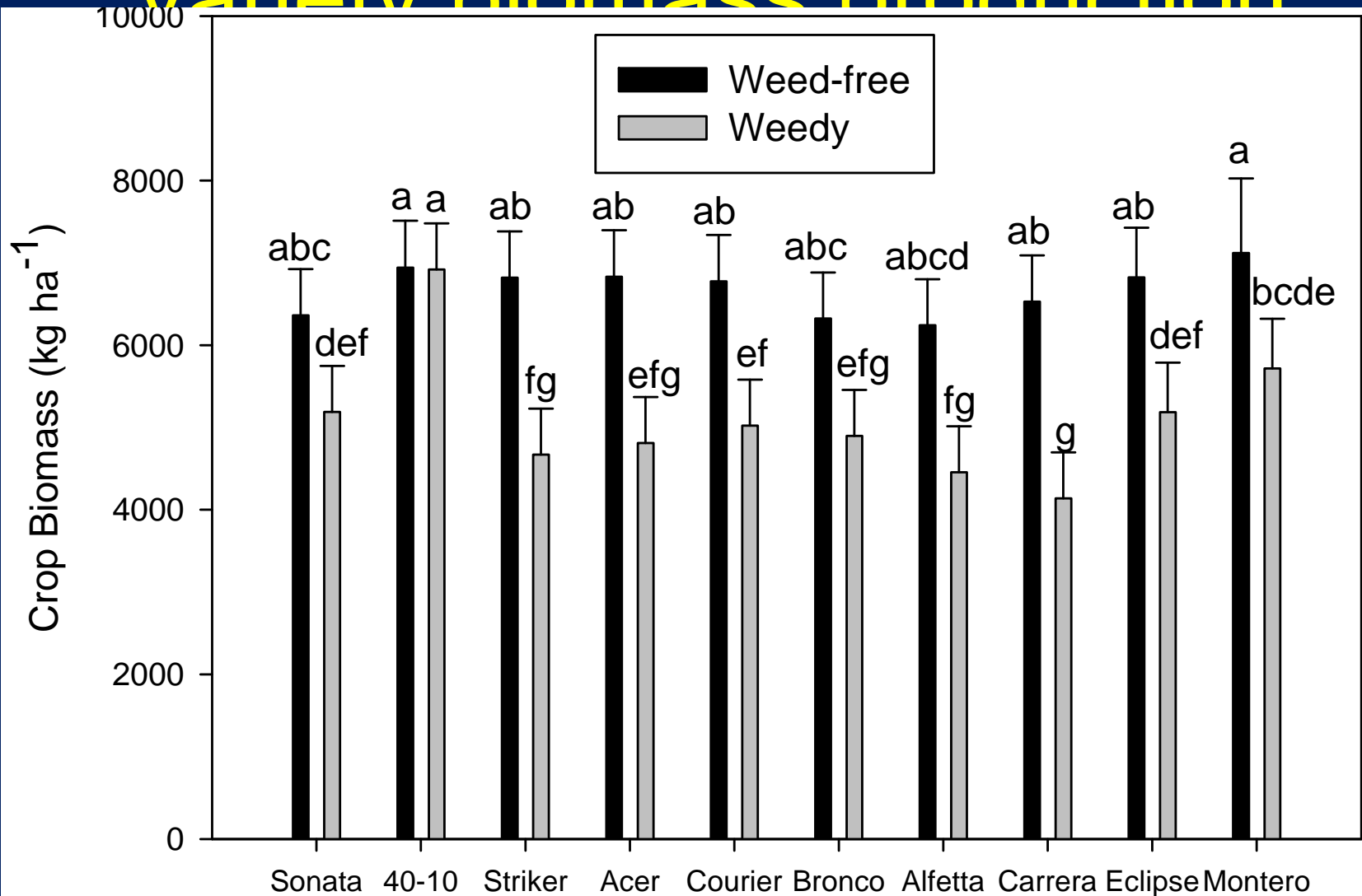
Effect of using a competitive pea



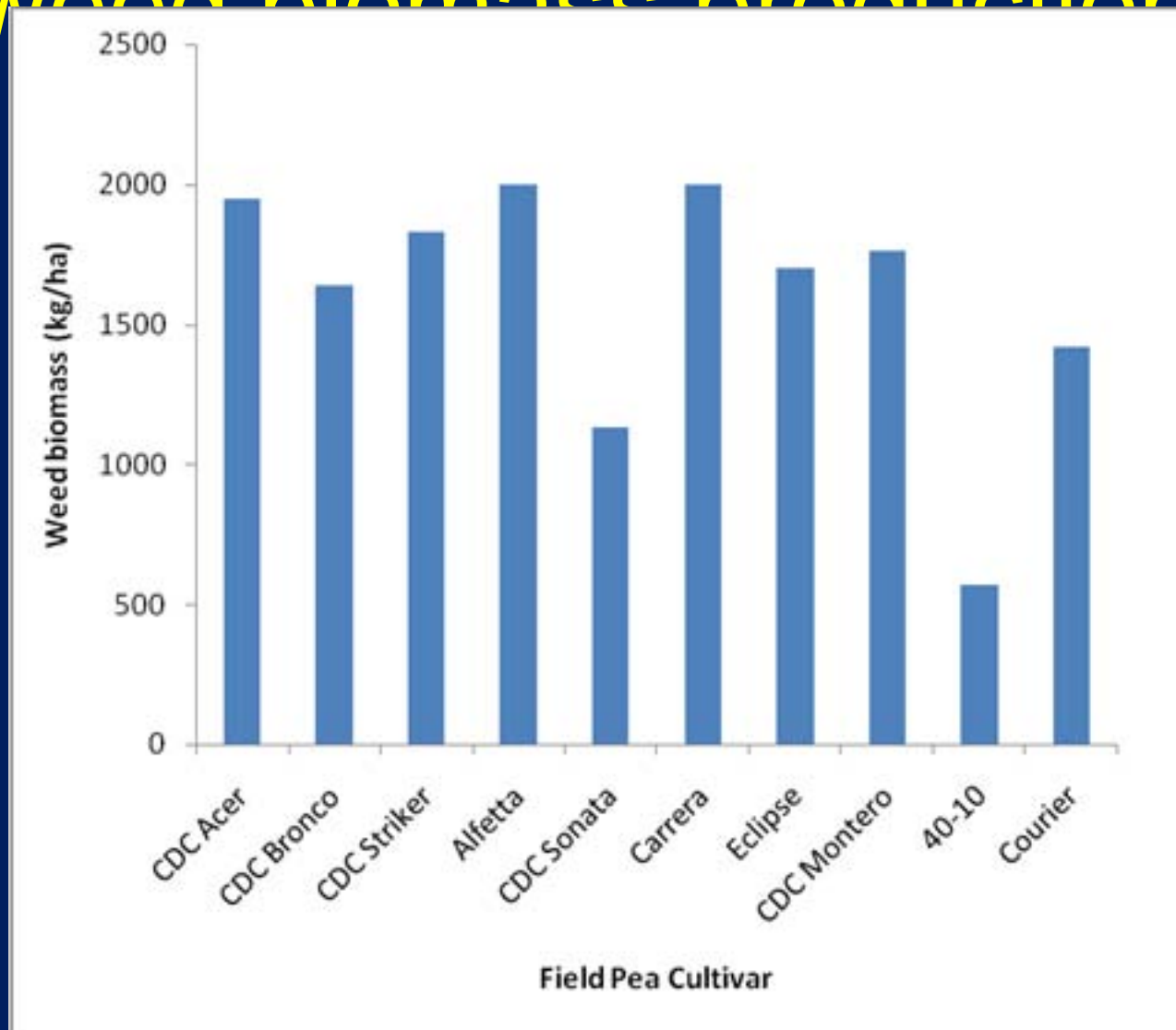
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Effect of weeds on field pea variety biomass production



Effect of field pea variety on weed biomass production



Oat seeding rate recommendations

- use a minimum of 250 seeds /m² (25 seeds /ft²)
- for seed wt. of 35g/1000 seeds ~80 lbs./ac.
- for organic conditions increase rate
- 120 lbs./ac not unreasonable

2) Crop seeding rate

- The effect of crop seeding rate on crop yield is proportional
- imagine a crop and weed of equal competitiveness
- If you seed the crop at 100 plants / m² and the weeds are present at 100 plants / m²
- 50% yield goes to the weeds

2) Crop seeding rate

- If you increase the seeding rate of the crop to 200 plants / m² and the weeds are present at 100 plants / m²
- Now on 33% of the yield goes to the weeds
 - 33% yield loss instead of 50%
- Crop yield is now 67% of the total instead of just 50%

The effect of weed density on yield at different crop seeding rates

