

Effect of Iron, Phytic acid and Carotenoid Concentration on Iron Bioavailability in Pea

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Introduction

Field pea

- Source of proteins, carbohydrates, fiber, vitamins, essential amino acids and micronutrients.
- Canada is the largest global producer and exporter
- Annual production 3.1 million tonnes
- Saskatchewan (79% of the total production)



Importance of Iron

- Essential micronutrient

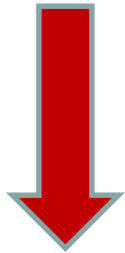
- Iron deficiency –
 - ~2 billion people
 - Highly prevalent among infants and women (during pregnancy)



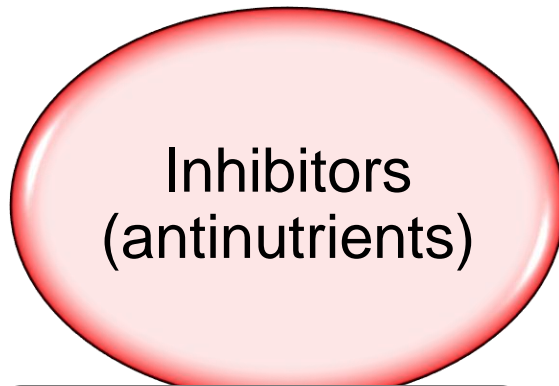
<http://zoominmedical.com/anemia-patient/>

Iron Bioavailability

Iron Absorption
in Human body

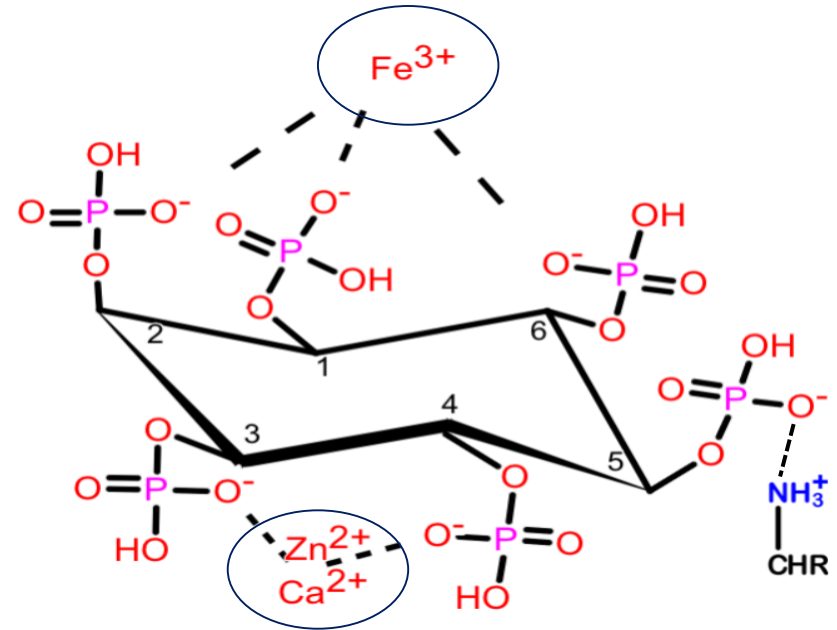
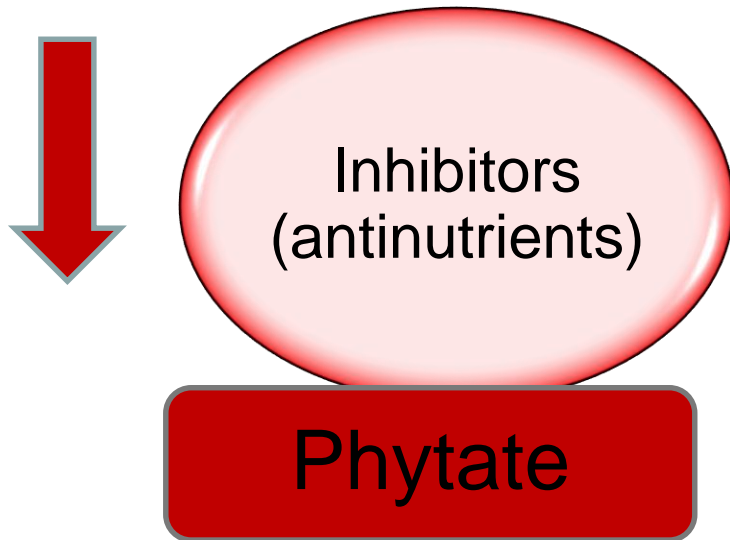


Inhibitors
(antinutrients)



Phytate





Based on Yu et al. 2012

- 60-80% of the total phosphorus
- 65% of the applied phosphorus fertilizers converted into phytate
- Strong chelator of metallic cations Fe, Zn, K, Ca, Mg, Mn
- Humans lack phytase enzyme

- Low-phytate mutants in:

- maize (*Zea mays*) - Raboy, V. et al., 2000.
- barley (*Hordeum vulgare*) - Larson, S.R. et al. 1998.
- rice (*Oryza sativa*) - Larson, S. R., et al., 2000.
- soybean (*Glycine max* L.) - Wilcox, et al., 2000.
- common bean (*Phaseolus vulgaris* L.) - Champion B. et al., 2009.
- field pea (*Pisum sativum* L.) - Warkentin, T.D. et al., 2012.

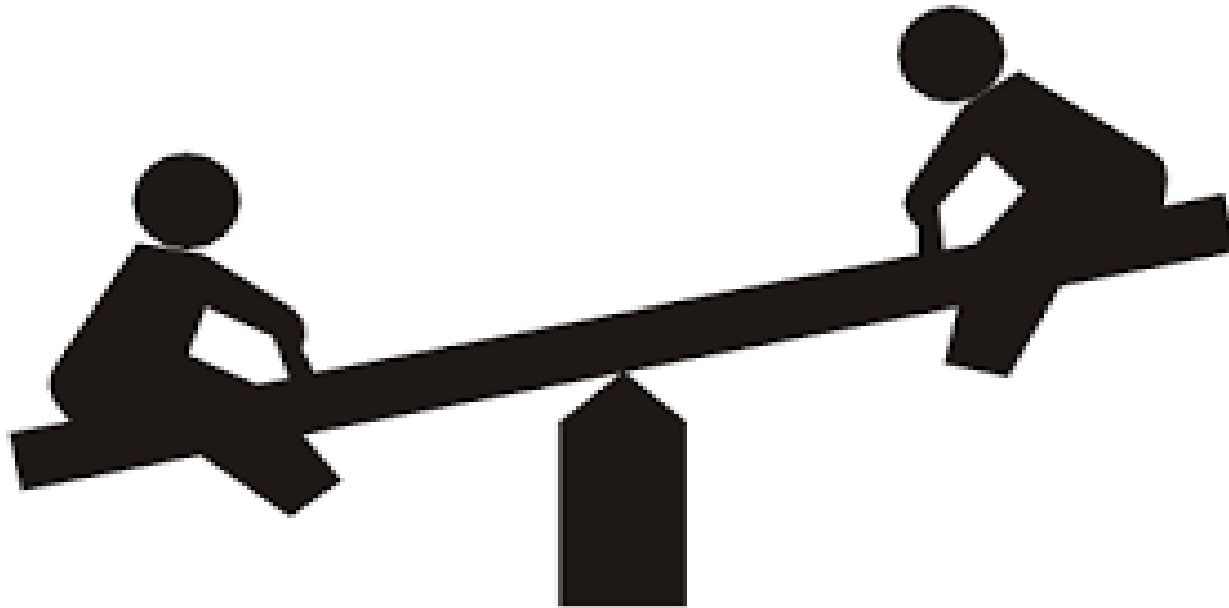


Low Phytate Pea

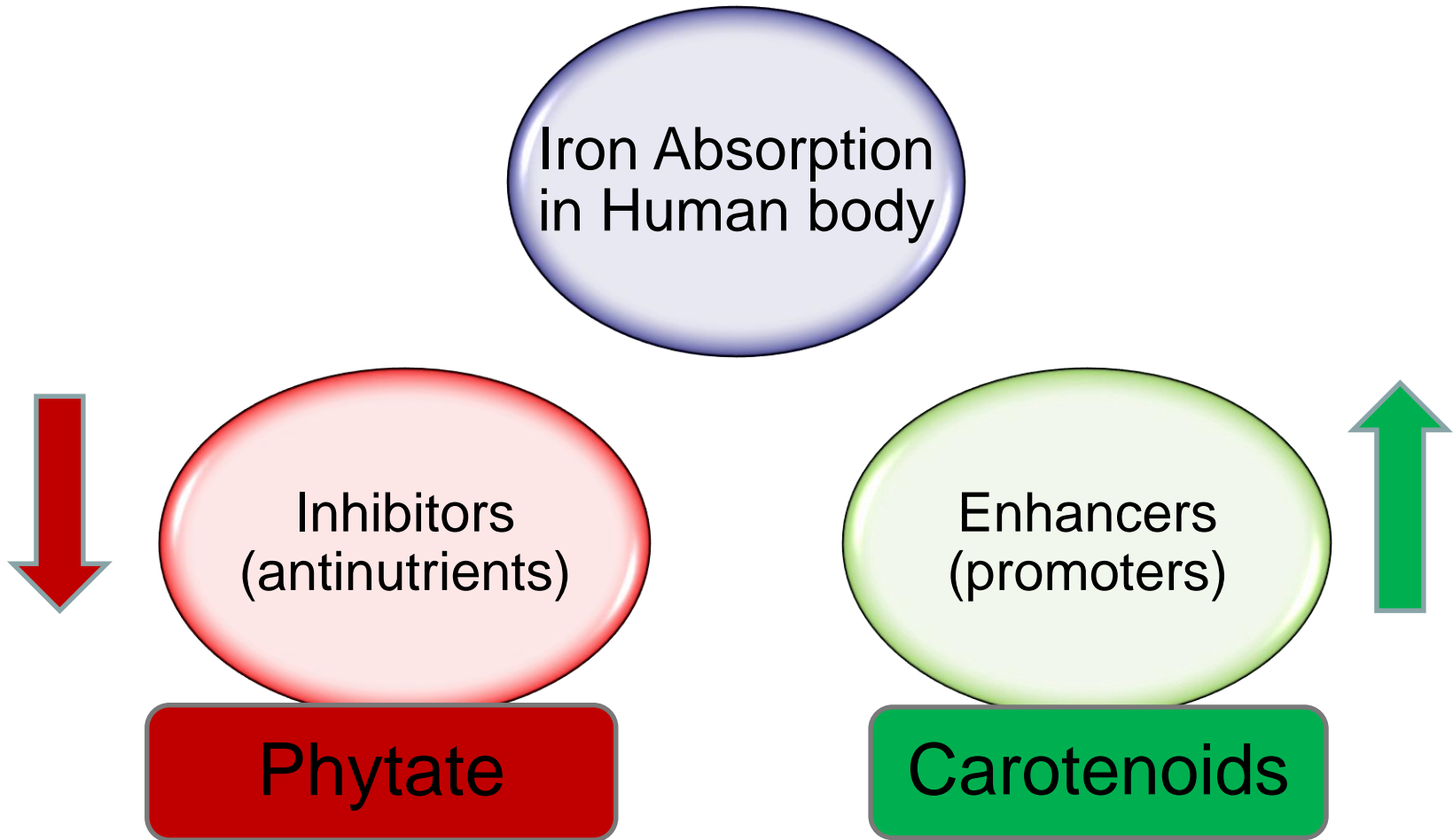
- Two *lpa* mutants (1-150-81 and 1-2347-144)
- Progenitor- CDC Bronco
- Method- Chemical mutagenesis.
- Phytate phosphorus reduced significantly:
 - 1-2347-144 (1.1 mg/g)
 - 1-150-81 (1.2 mg/g)
 - CDC Bronco (2.9 mg/g)
- Inorganic phosphorus - high
- Phytate phosphorus – low

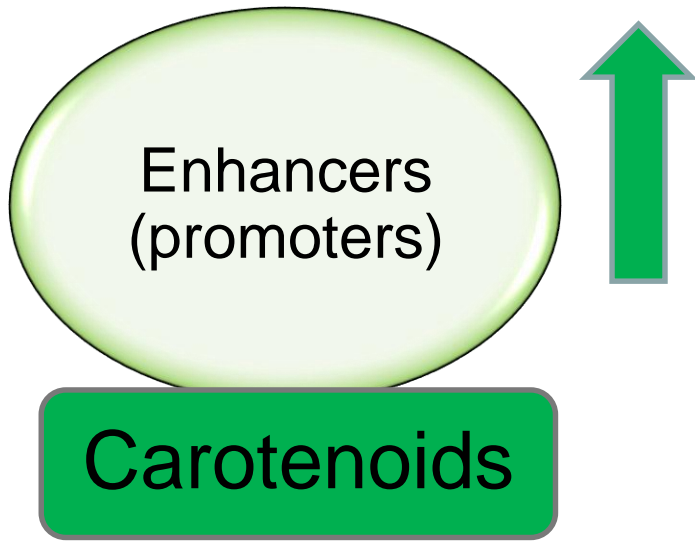
Warkentin et al., 2012


Relationship between Phytate and Inorganic phosphorus



Iron Bioavailability





- Carotenoids increased iron bioavailability in cereal-based foods (Gracia-Casal, 2006)
- Green cotyledon  yellow cotyledon (Kaliyaperumal et al, 2013)

Hypotheses

- Low phytate and high carotenoid concentration have additive benefits for iron bioavailability in pea.

Objectives

To compare iron bioavailability in pea lines contrasting in

- a. iron concentration
- b. phytate concentration
- c. carotenoid concentration

Objective # 1

To compare iron bioavailability in pea lines contrasting in

- a. iron concentration

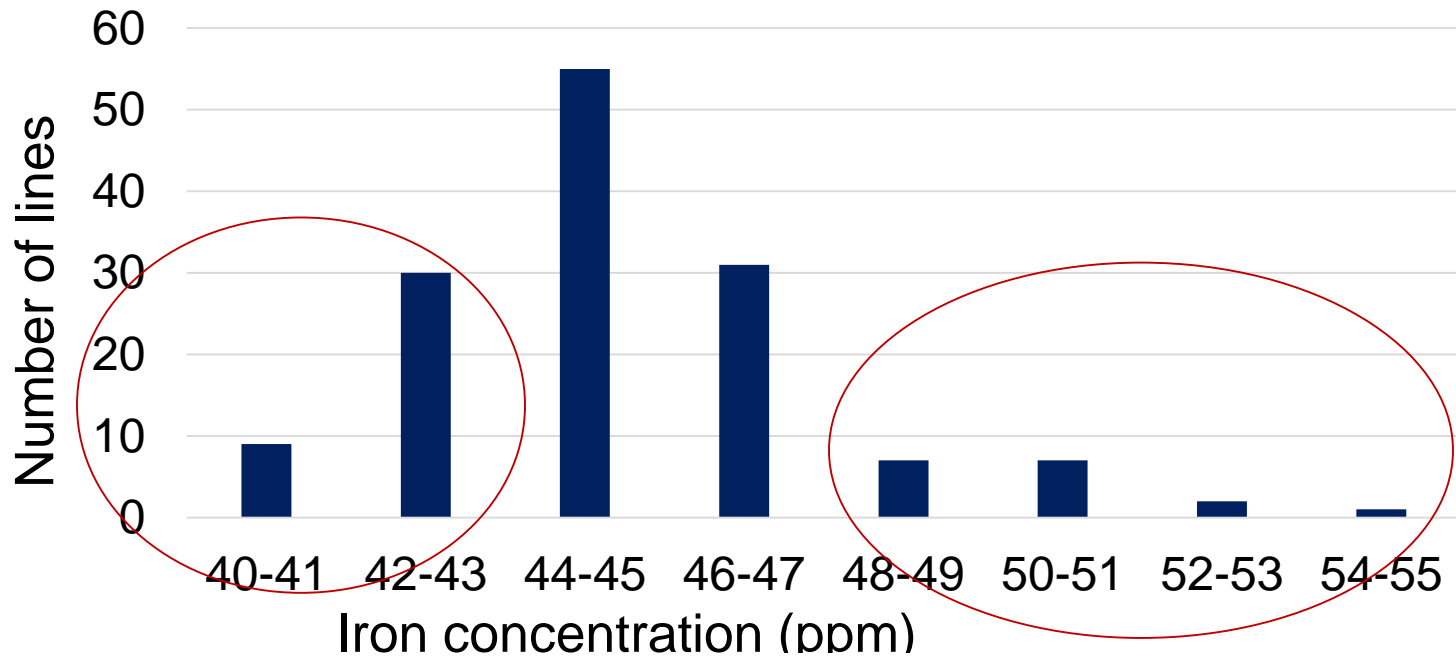
Plant Material



Yellow cotyledon
High Iron

Green cotyledon
Low Iron

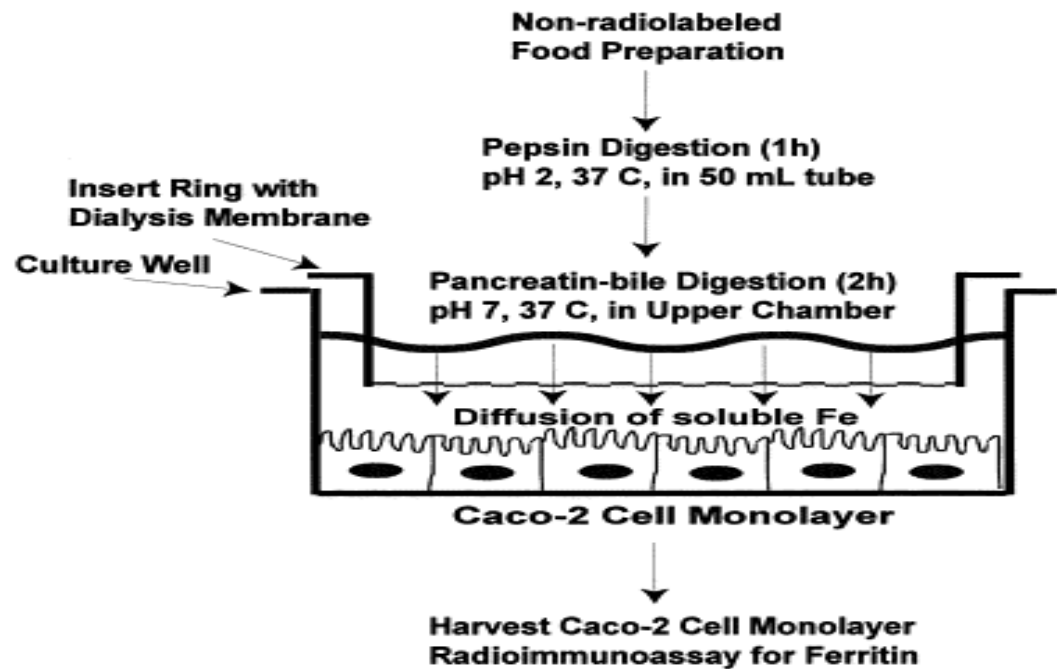
PR-07 RILs



Next step...

- Iron Bioavailability using Caco-2 cell culture assay

Developed by
Glahn et al. (1998)



Source: <http://www.atc-pharma.be/en/node/151>

Objective # 2

To compare iron bioavailability in pea lines contrasting in

- a. phytate concentration
- b. carotenoid concentration

Plant Material

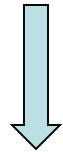
1-2347-144



CDC Raezer

Yellow cotyledon
Low phytate

Green cotyledon
Normal phytate



Cross-4802

F1

F2

F3

F4

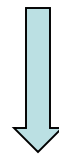
1-150-81



CDC Limerick

Yellow cotyledon
Low phytate

Green cotyledon
Normal phytate



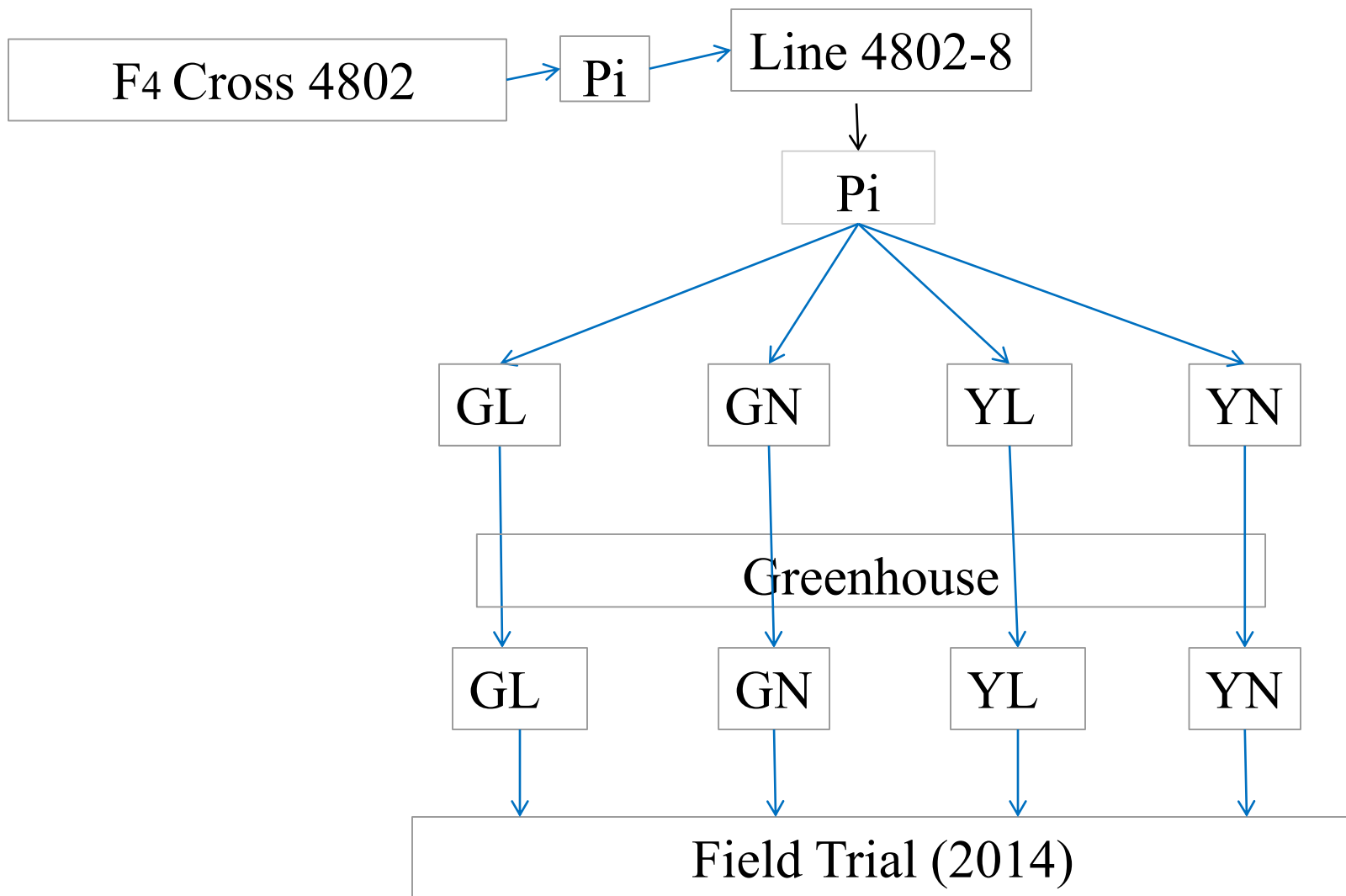
Cross-4803

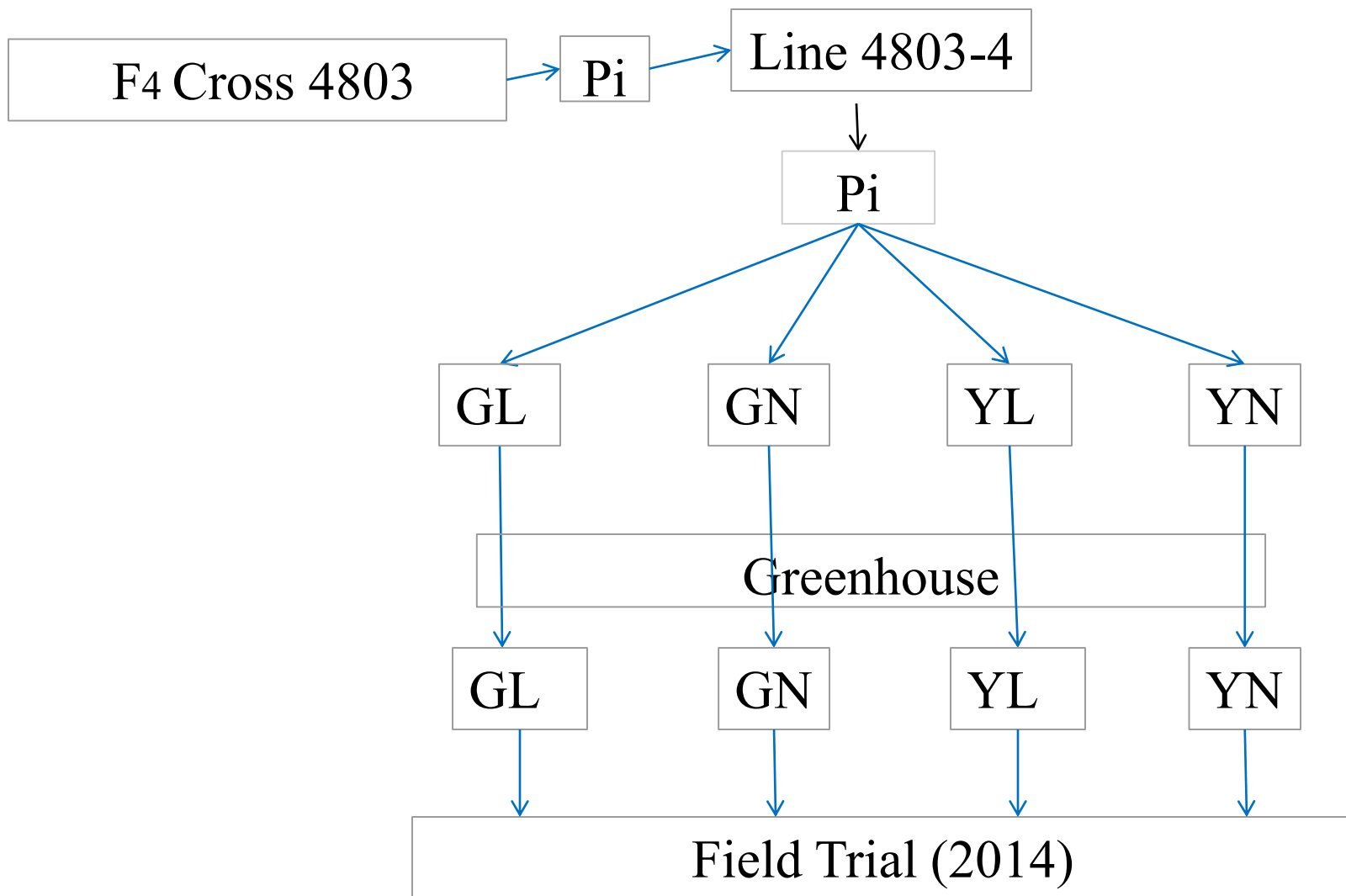
F1

F2

F3

F4





Techniques:

Atomic Absorption Spectroscopy

- Iron concentration

- Modified colorimetric (Wade's reagent) method (Gao et al., 2007)

- phytate-phosphorus

- Modified Chen's reagent method (Chen et al., 1956)

- Inorganic-phosphorus

HPLC

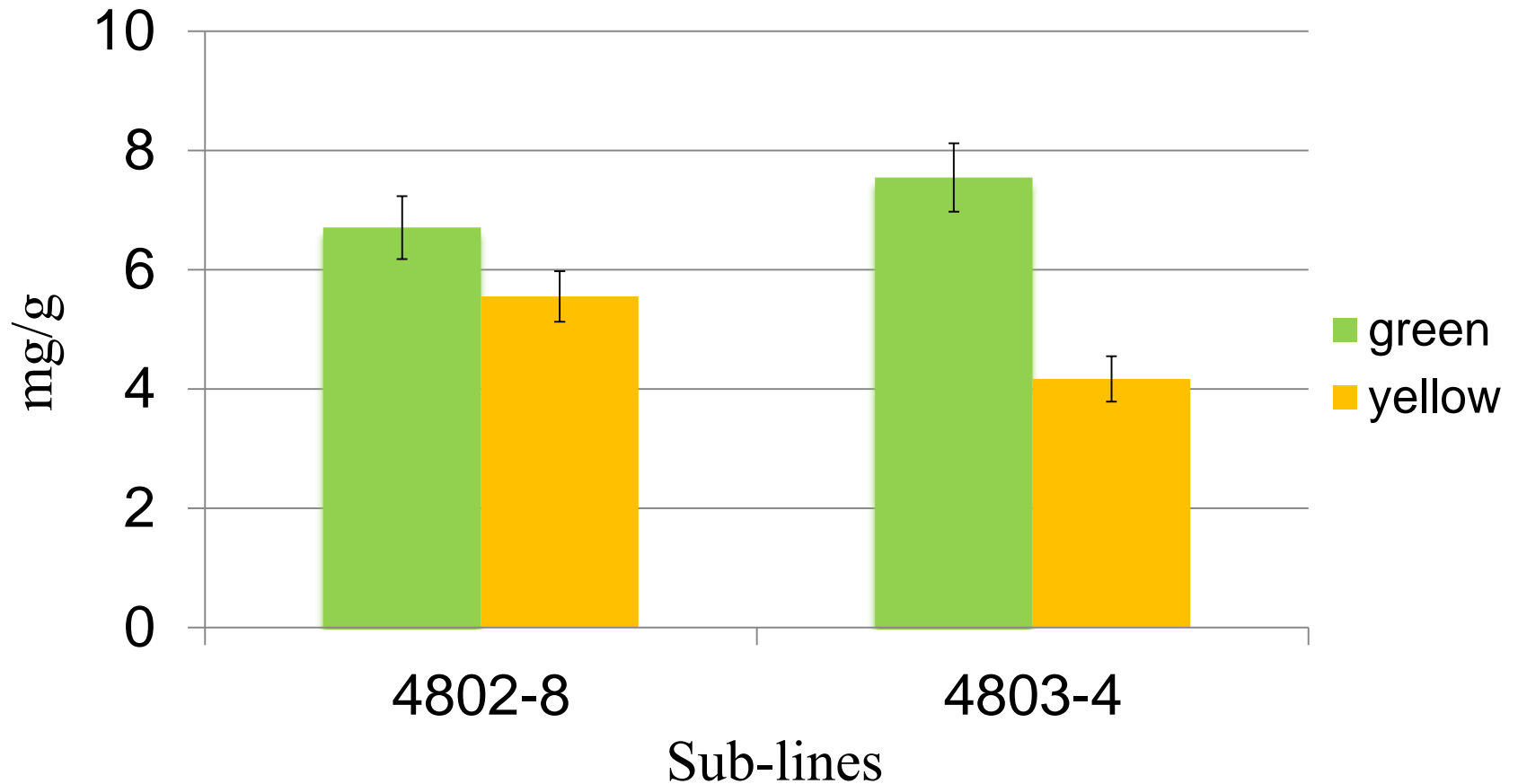
- Carotenoid Concentration

Lines	Color/phytate	Inorganic phosphorus(mg/g)	Phytate (mg/g)
4802-8	GL		
	GN		
	YL		
	YN		
4803-4	GL		
	GN		
	YL		
	YN		
1-150-81	YL	95	4
1-2347-144	YL	90	5
CDC Bronco	YN	24	11
CDC Limerick	GN	25	12
CDC Raezer	GN	28	13

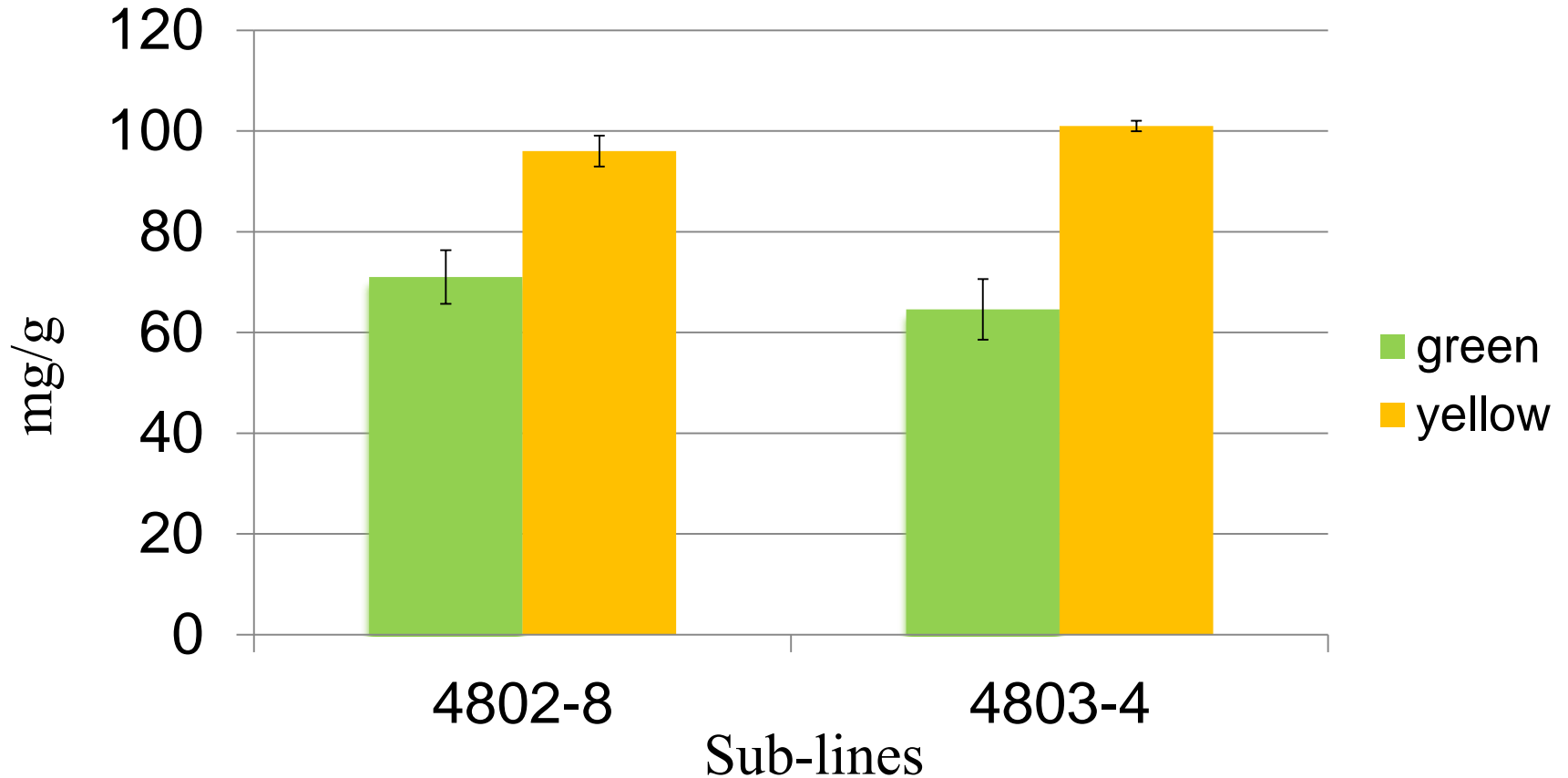
Lines	Color/phytate	Inorganic phosphorus(mg/g)	Phytate (mg/g)
4802-8	GL	97	5
	GN		
	YL	104	5
	YN		
4803-4	GL	101	5
	GN		
	YL	101	4
	YN		
1-150-81	YL	95	4
1-2347-144	YL	90	5
CDC Bronco	YN	24	11
CDC Limerick	GN	25	12
CDC Raezer	GN	28	13

Lines	Color/phytate	Inorganic phosphorus (mg/g)	Phytate(mg/g)
4802-8	GN	35	9
	YN	49	9
4803-4	GN	25	10
	YN		
1-150-81	YL	95	4
1-2347-144	YL	90	5
CDC Bronco	YN	24	11
CDC Limerick	GN	25	12
CDC Raezer	GN	28	13

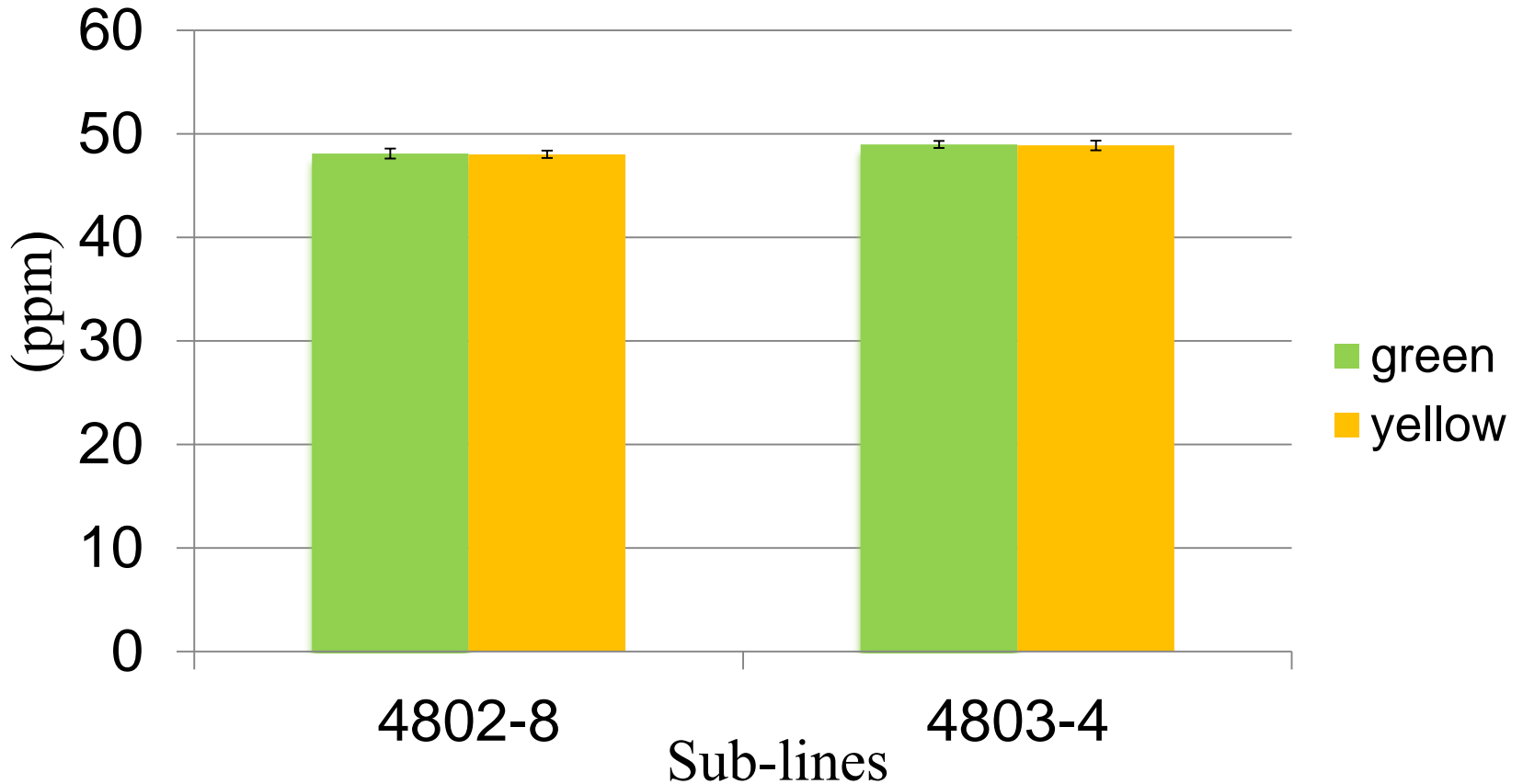
Phytate



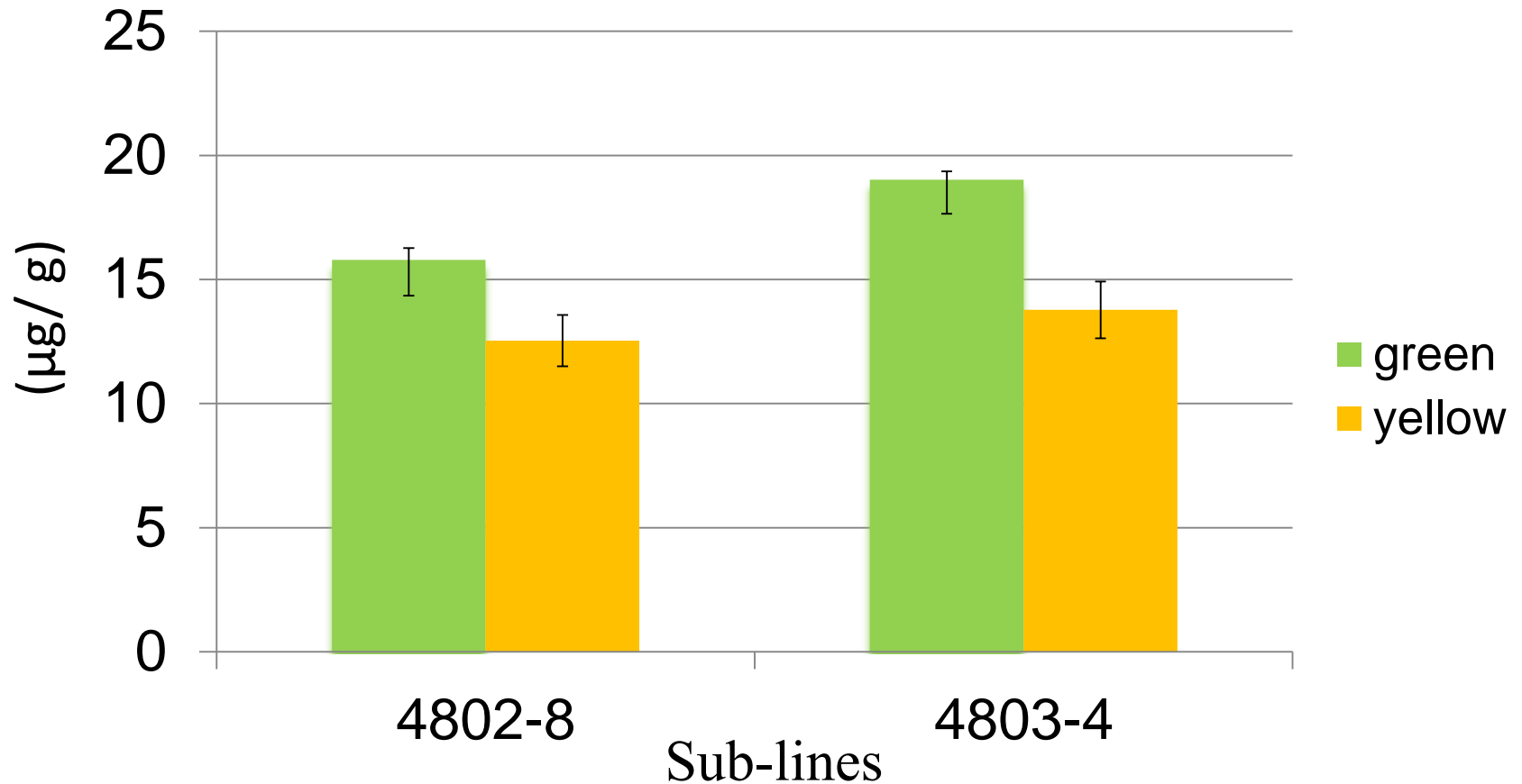
Inorganic phosphorus



Iron Concentration



Carotenoid concentration



Next step...

- Iron Bioavailability from lines contrasting in
 - Phytate concentration
 - Carotenoid concentration

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**Saskatchewan
Ministry of
Agriculture**

Thank You!