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Soybean row spacing, plant densities, and N benefits to following crops

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Alberta

University of Lethbridge

Canada

Agronomy Update, January 17-18, 2017, Lethbridge, AB

Soybean in Alberta

- Acreage increasing
- Best yields at 116-121 days to maturity
- >130 days to maturity = risk of frost damage
- Threshold CHU = 2,200
- New crushing plant, Granum, AB
- Crushing capacity for 22,000 ha soybean
- Target yields of ~3,300 kg/ha (50 bu/ac)
- Replace dry bean on irrigated rotations?
- Future yields could be pushed to 4,000 kg/ha (60 bu/ac)

Soybean agronomy expt.
Experimental design
5 main effects

1				
Year				
No. 2				
2014				
2015				

Soybean agronomy expt.
Experimental design
5 main effects

1	2			
Year	Site			
No. 2	2			
2014	Bow Island			
2015	Lethbridge			

Soybean agronomy expt.
Experimental design
5 main effects

1	2	3		
Year	Site	Genotype		
No. 2	2	2		
2014	Bow Island	Co-op F045R*		
2015	Lethbridge	NSC Tilston*		

*Roundup Ready®

Soybean agronomy expt.
Experimental design
5 main effects

1	2	3	4	
Year	Site	Genotype	Row spacing, cm	
No. 2	2	2	2	
2014	Bow Island	Co-op F045R*	17.5	
2015	Lethbridge	NSC Tilston*	35	

*Roundup Ready®

Soybean agronomy expt.
Experimental design
5 main effects

1	2	3	4	5
Year	Site	Genotype	Row spacing, cm	Seeding density, seeds m^{-2}
No. 2	2	2	2	3
2014	Bow Island	Co-op F045R*	17.5	30
2015	Lethbridge	NSC Tilston*	35	50
				80

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Soybean agronomy expt.
Experimental design
5 main effects

1	2	3	4	5
Year	Site	Genotype	Row spacing, cm	Seeding density, seeds m^{-2}
No. 2	2	2	2	3
2014	Bow Island	Co-op F045R*	17.5	30
2015	Lethbridge	NSC Tilston*	35	50
				80

*Roundup Ready®

26 possible interaction effects

2 × 2 × 2 × 2 × 3 = 48 treatment combinations

What did we measure?

During growing season:

1. Plant density
2. Days to flowering
3. Plant height at flowering
4. Days to maturity
5. Plant height at maturity
6. Lowest pod height

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Yield components:

1. Pods plant^{-1}
2. Seeds plant^{-1}
3. Thousand seed weight
4. Seed (grain) yield
5. “Straw” yield
6. Harvest index

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Nitrogen parameters:

1. Grain N concentration
2. Straw N concentration
3. Grain N uptake
4. Straw N uptake
5. Total (grain + straw) N uptake

Total: 17 parameters

Significant main effects: year and site

(Not overruled by a significant interaction)
1 of 17 parameters

Year				
Seeds plant^{-1}				
2014	64b			
2015	72a			

Occurred across all sites, genotypes, row spacings, and seeding densities

Significant main effects: year and site

(Not overruled by a significant interaction)
1 of 17 parameters

Year		Site		
Seeds plant^{-1}		Plant density, plants m^{2}		
2014	64b	Bow Island	46a	
2015	72a	Lethbridge	43b	

Occurred across all sites, genotypes, row spacings, and seeding densities

Occurred across all years, genotypes, row spacings, and seeding densities

Significant main effects: year and site

(Not overruled by a significant interaction)
1 of 17 parameters

Year		Site		
Seeds plant^{-1}		Plant density, plants m^{2}		Emerg, %
2014	64b	Bow Island	46a	86%
2015	72a	Lethbridge	43b	81%

Occurred across all sites, genotypes, row spacings, and seeding densities

Occurred across all years, genotypes, row spacings, and seeding densities

Significant main effect: genotype

(Not overruled by a significant interaction)

4 of 17 parameters

	Pods plant^{-1}	Seeds plant^{-1}	Straw N conc, %	Total N uptake, kg ha^{-1}
Co-op F045R	28b	64b	0.76a	196a
NSC Tilston	30a	71a	0.64b	182b

Occurred across all years, sites, row spacings, and seeding densities

Significant main effect: row spacing

(Not overruled by a significant interaction)
3 of 17 parameters

	Lowest pod ht., cm	Seeds plant^{-1}	Harvest index
17.5 cm (narrow)	6.0b	69a	0.37b
35 cm (wide)	6.4a	66b	0.38a

Occurred across all years, sites, genotypes, and seeding densities

Significant main effect: seeding density

(Not overruled by a significant interaction)
4 of 17 parameters

	Days to maturity	Straw N conc., %	Straw N uptake, kg ha^{-1}	Total N uptake, kg ha^{-1}
30 seeds m^2	122a	0.68b	28b	163c
50 seeds m^2	122ab	0.68b	30b	185b
80 seeds m^2	121b	0.74a	40a	219a

Occurred across all years, sites, genotypes, and row spacings

Significant main effects (not overruled by interaction)

Year	1
Site	1
Genotype	4
Row spacing	3
Seeding density	4
TOTAL	13

17 parameters × 5 main effects = 85

13/85 = 15%

85% of main effects overruled by significant interaction(s)

Have to interpret all these interactions!

Let's look at significant interactions:

Days to maturity

Significant 2-way interaction: year x site
Occurred across all genotypes, row spacings and seeding densities

The behaviour of year depends on which site we are looking at:

Year	Bow Island	Lethbridge
2014	118a	127a
2015	115b	127a
Difference	3 days	0 days

Within columns, means with different letter are significantly different from each other

Let's look at significant interactions:

Days to maturity

Significant 2-way interaction: year x site

Occurred across all genotypes, row spacings and seeding densities

The behaviour of year depends on which site we are looking at:

Year	Bow Island	Lethbridge
2014	118a	127a
2015	115b	127a
Difference	3 days	0 days

The behaviour of site depends on which year we are looking at:

Site	2014	2015
Bow Island	118b	115b
Lethbridge	127a	127a
Difference	9 days	12 days

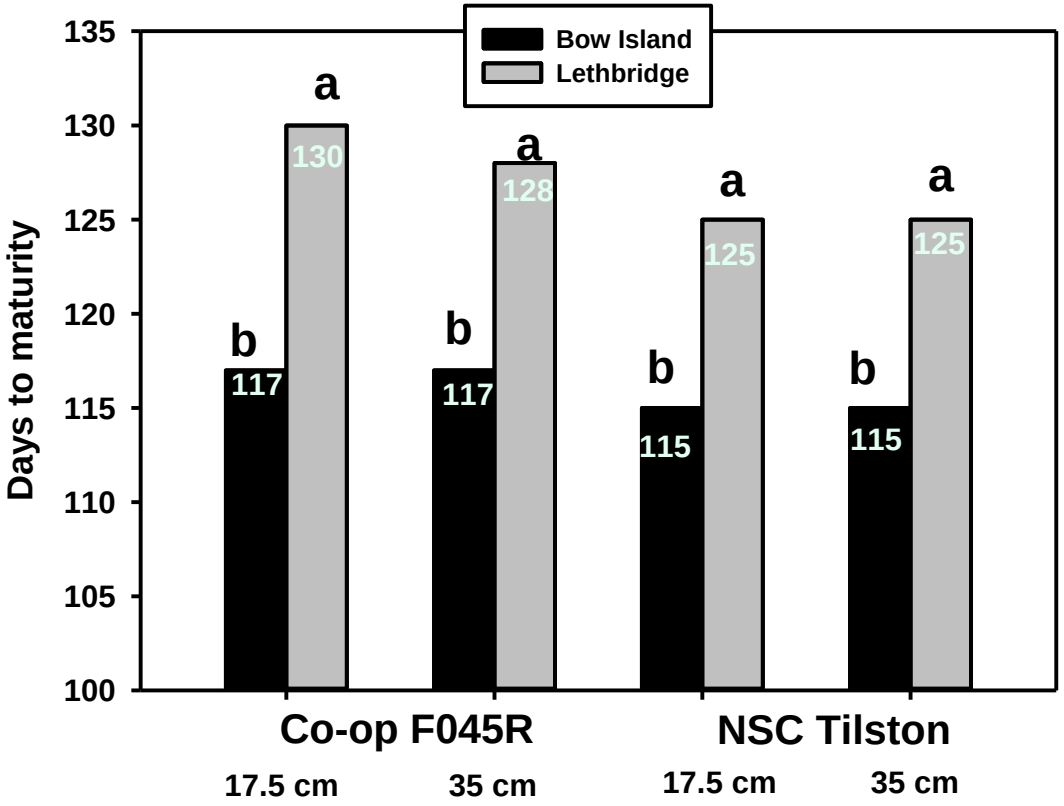
Within columns, means with different letter are significantly different from each other

Let's look at significant interactions:

Days to maturity

Significant 3-way interaction: site x genotype x row spacing occurred across all years and seeding densities

The behaviour of site depends on which genotype x row spacing combination we are looking at: While maturity was always earlier at Bow Island, widest gap occurred for Co-op F045R narrow row: 13 d vs. 10-11 d for the others

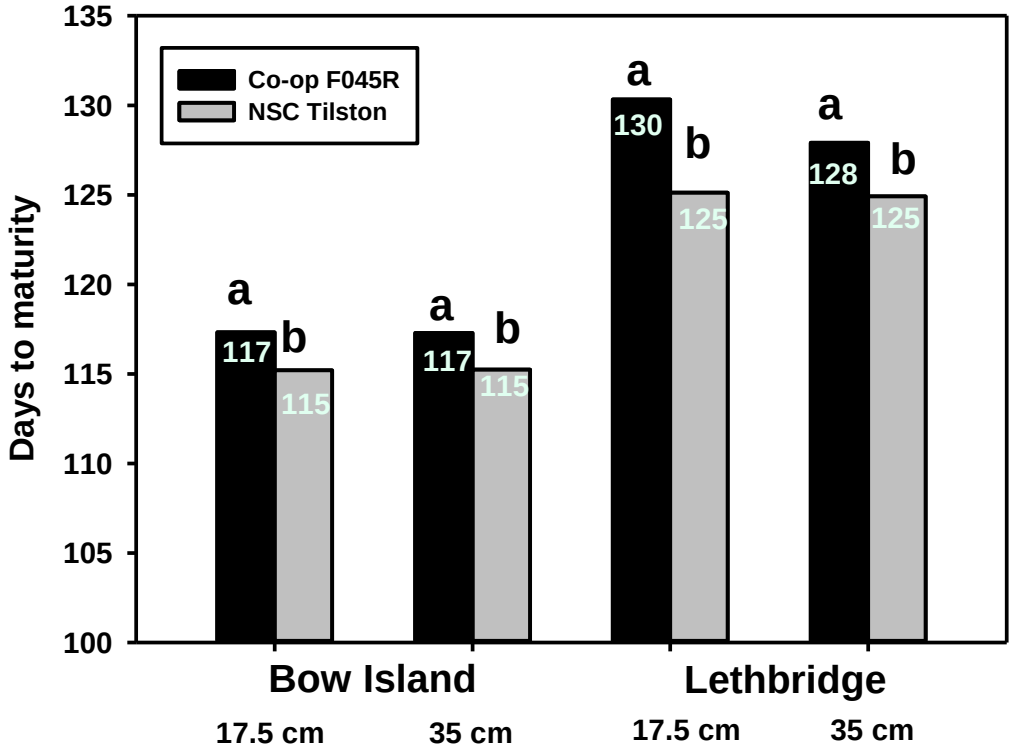


Let's look at significant interactions:

Days to maturity

Significant 3-way interaction: site x genotype x row spacing occurred across all years and seeding densities

The behaviour of genotype depends on which site x row spacing combination we are looking at: While maturity was always earlier for NSC Tilston, the widest gap occurred for narrow row spacing at Lethbridge: 5 d vs. 2-3 d for the others

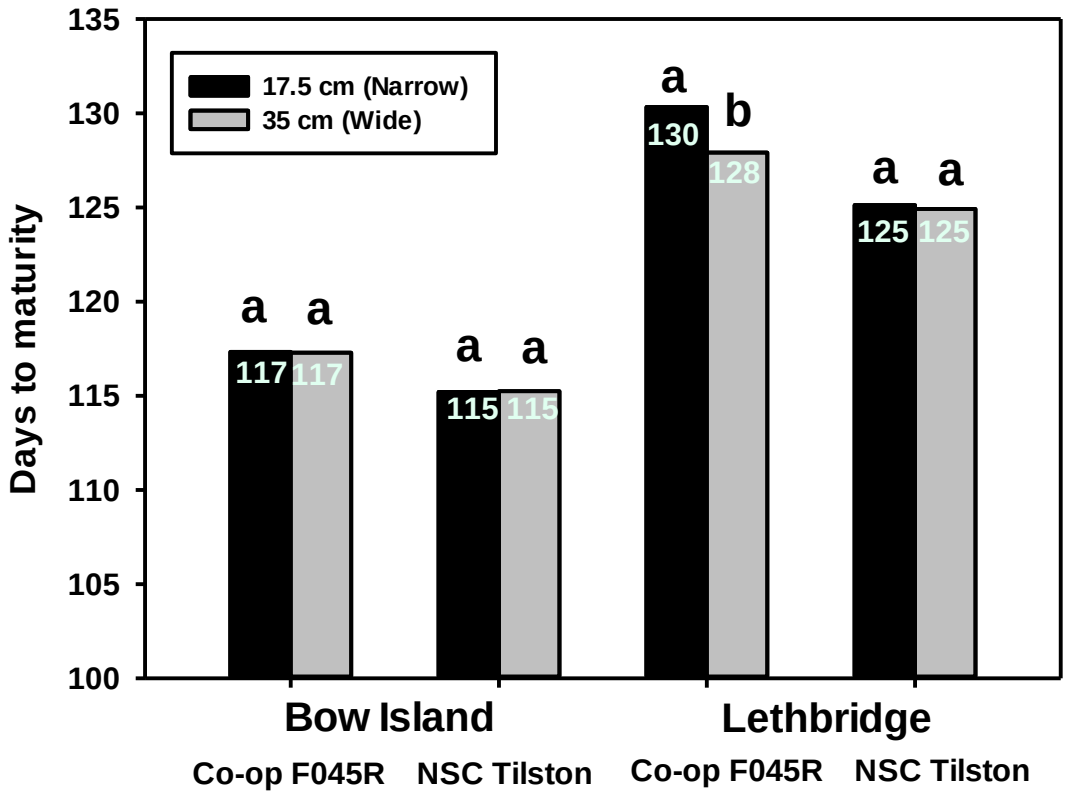


Let's look at significant interactions:

Days to maturity

Significant 3-way interaction: site x genotype x row spacing occurred across all years and seeding densities

The behaviour of row spacing depends on which site x genotype combination we are looking at: Narrow row spacing delayed maturity by 2 d for Co-op F045R at Lethbridge but had no effect on others



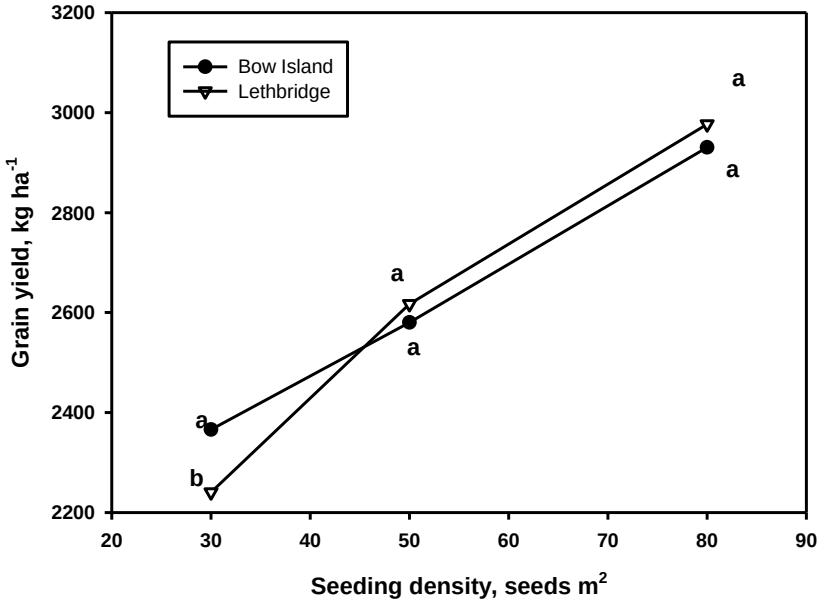
Let's look at significant interactions:

Grain yield (kg ha^{-1})

Significant 2-way interaction: site x seeding density

Occurred across all years, genotypes, and row spacings

The behaviour of site depends on which seeding density we are looking at: yields just as good at Lethbridge except at 30 seeds m^2



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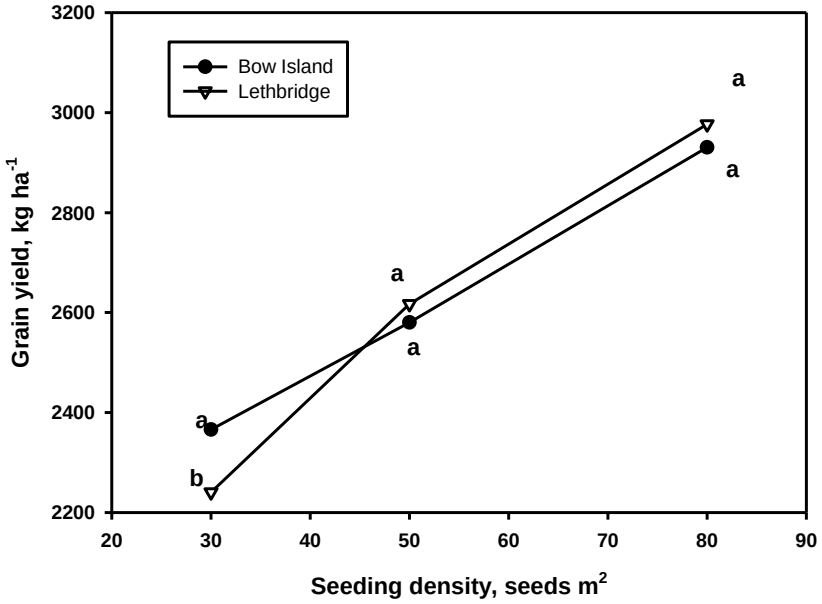
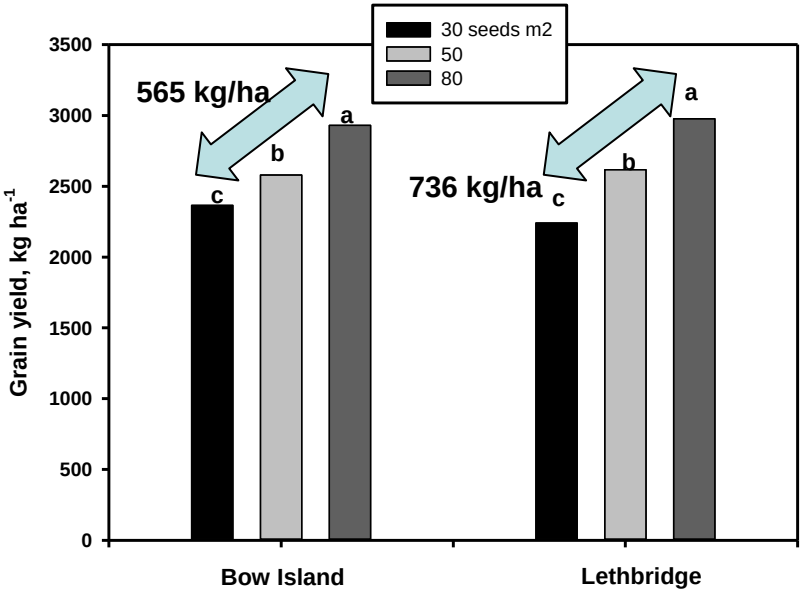
The behaviour of site depends on which seeding density we are looking at: yields just as good at Lethbridge except at 30 seeds m^2

The behaviour of seeding density depends on which site we are looking at: wider yield spread at Lethbridge





Let's look at significant interactions:

Grain yield (kg ha^{-1})

Significant 2-way interaction: genotype x seeding density
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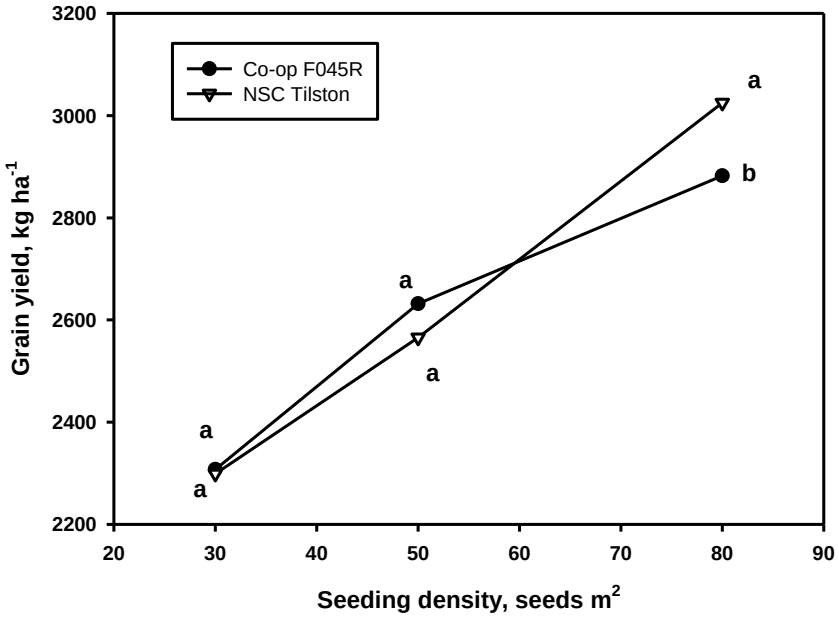
The behaviour of genotype depends on which seeding density we are looking at: NSC Tilston lower at 80 seeds m2



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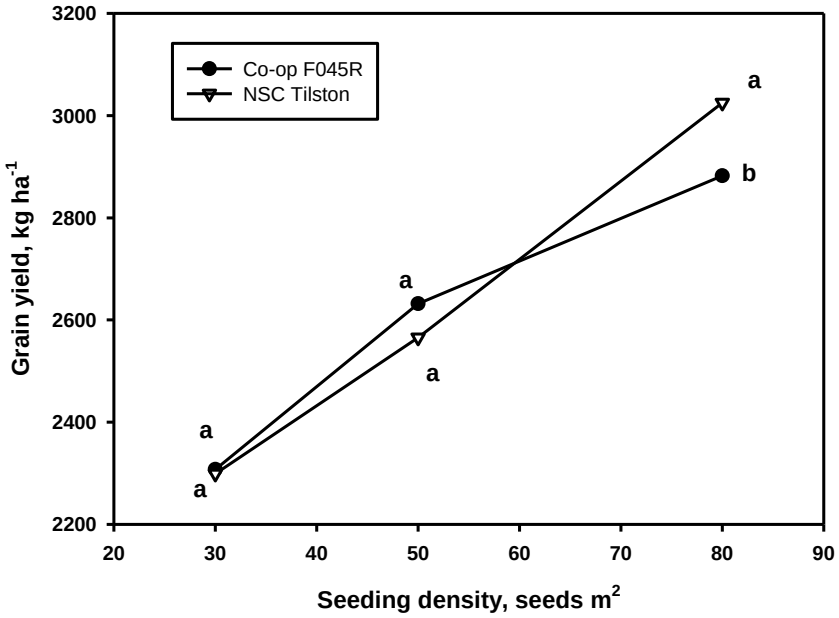
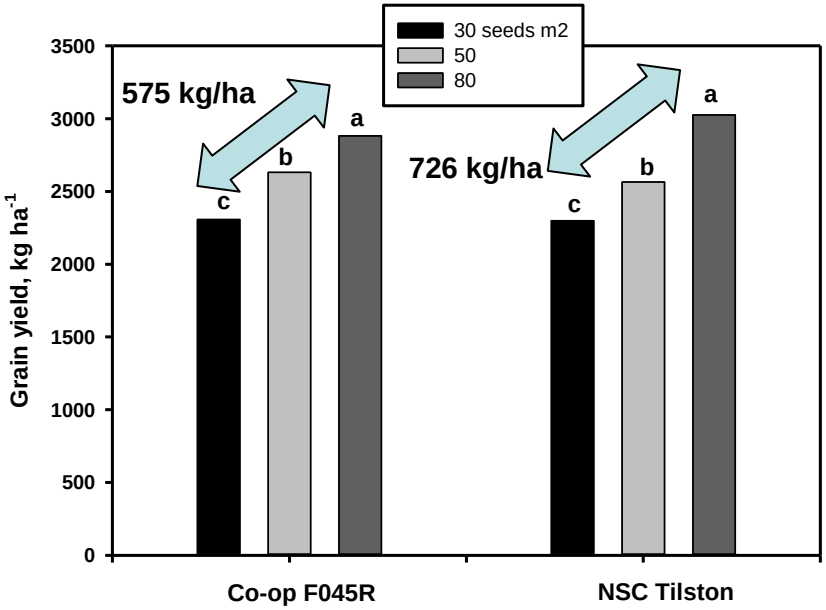
Grain yield (kg ha^{-1})

Significant 2-way interaction: genotype x seeding density
Occurred across all years, sites, and row spacings

The behaviour of genotype depends on which seeding density we are looking at: NSC Tilston lower at 80 seeds m2

The behaviour of seeding density depends on which genotype we are looking at: wider yield spread for NSC Tilston



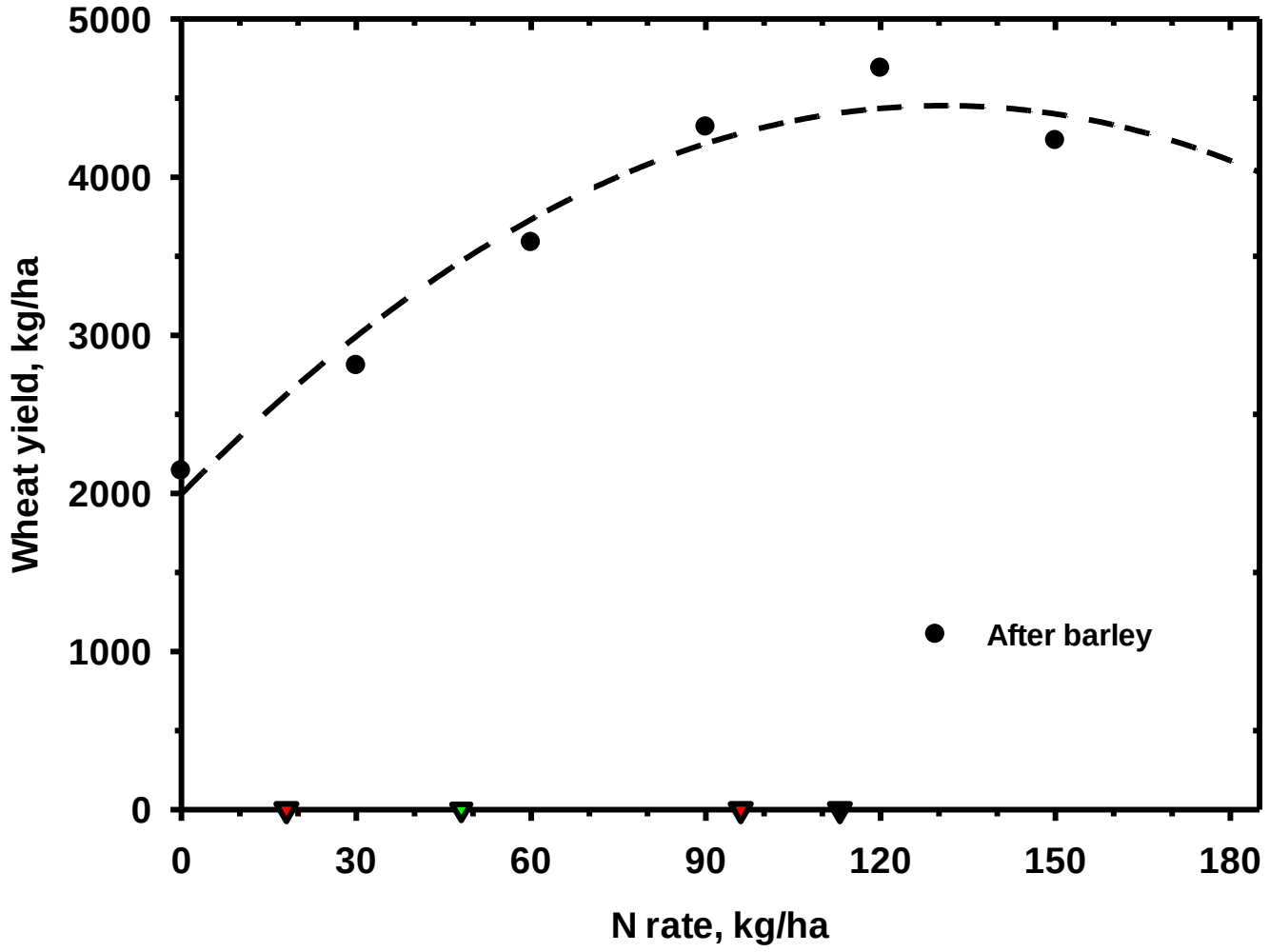


N Credit Estimates for Soybean vs. Dry Bean

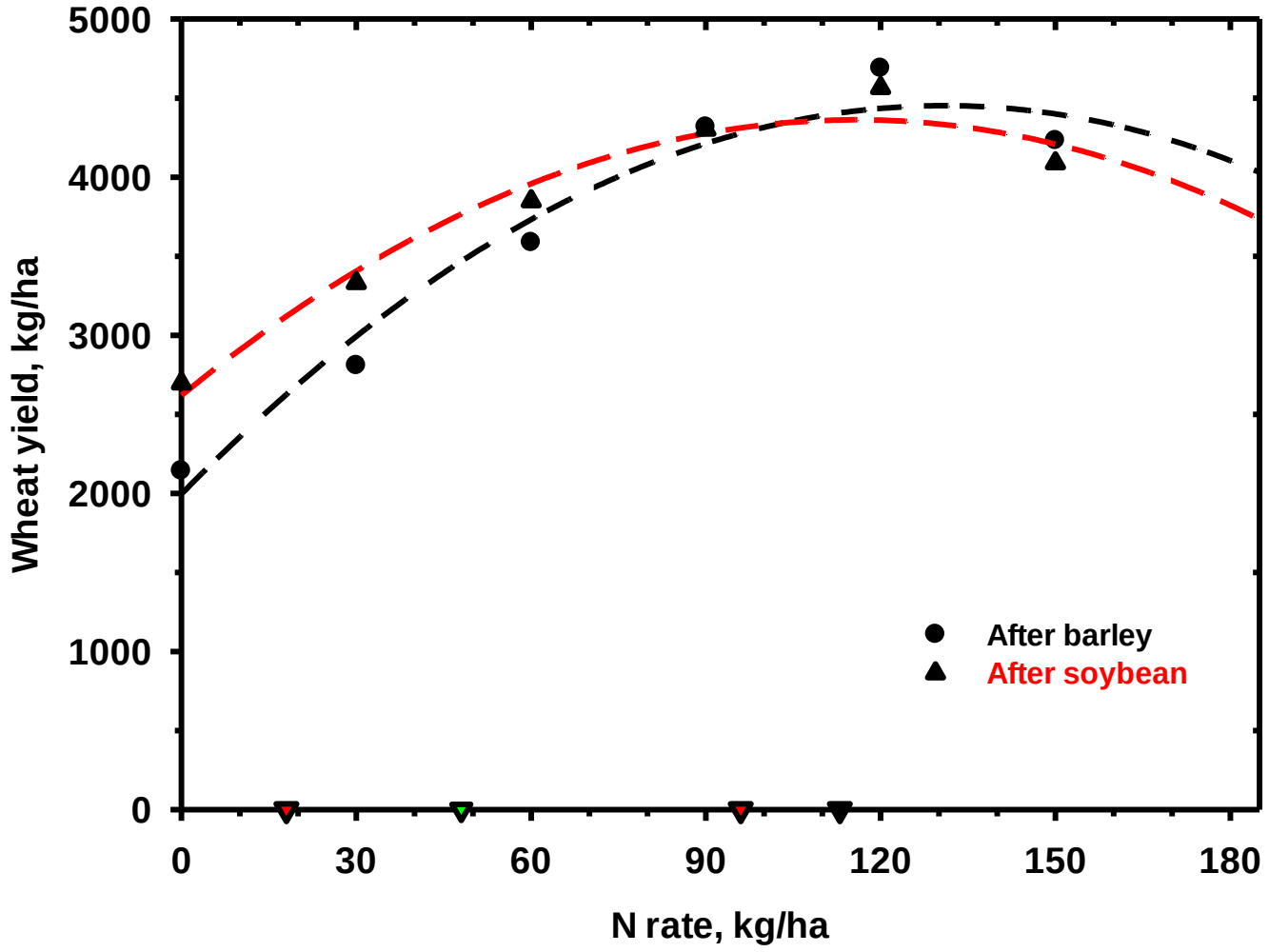
What is an N credit? Soybean and dry bean, being legumes, increase the overall supply of soil N, via biological N fixation, so that less N fertilizer should be required for following crops.

Year 1	**Year 2 (Reference crop)**
Barley (non–legume)	Wheat
Soybean (legume)	Wheat
Dry bean (legume)	Wheat
Zero N fertilizer	Six N rates: 0, 30, 60, 90, 120, 150 kg/ha

Bow Island: Wheat yield N response in Year 2



Bow Island: Wheat yield N response in Year 2



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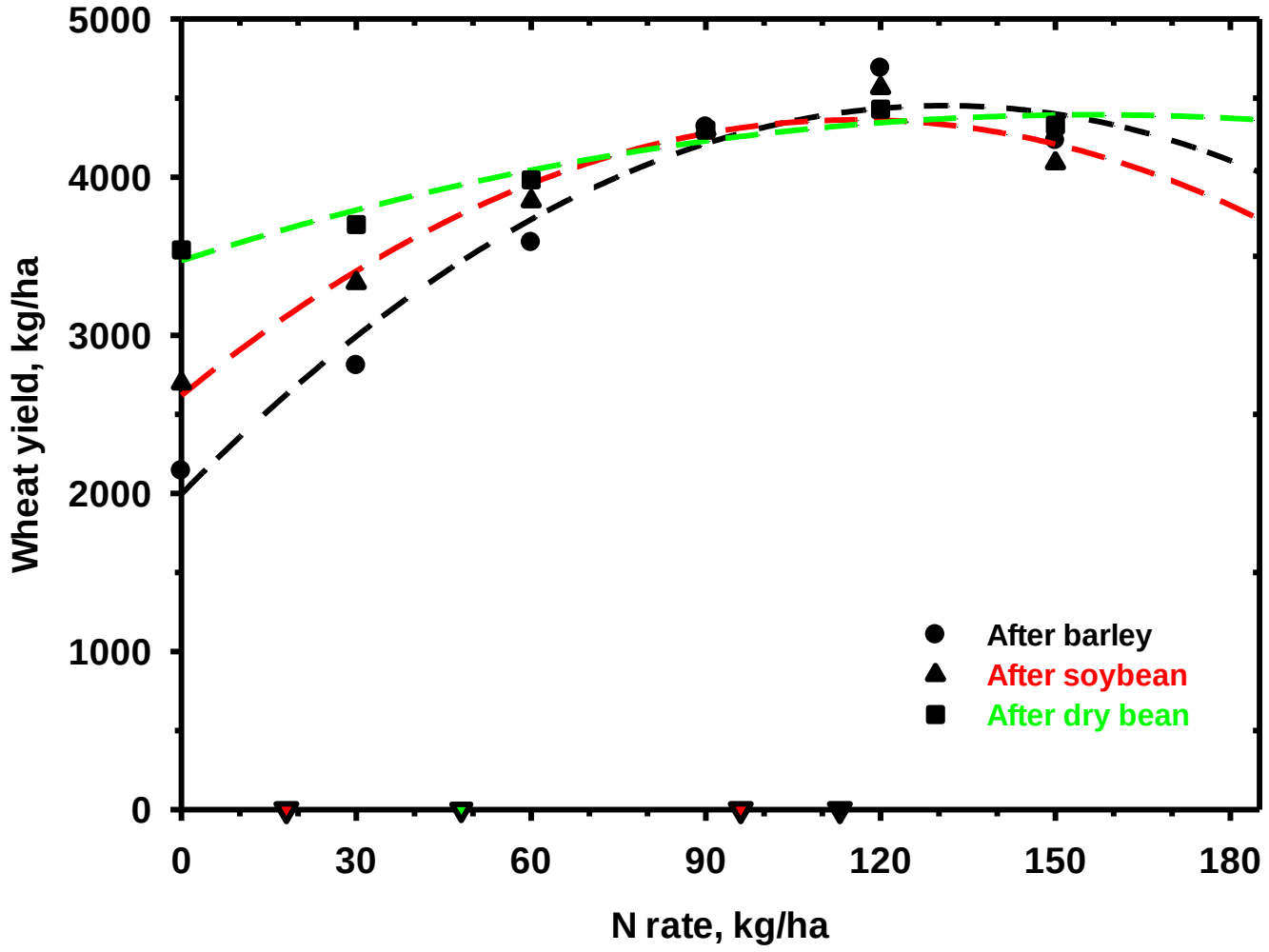
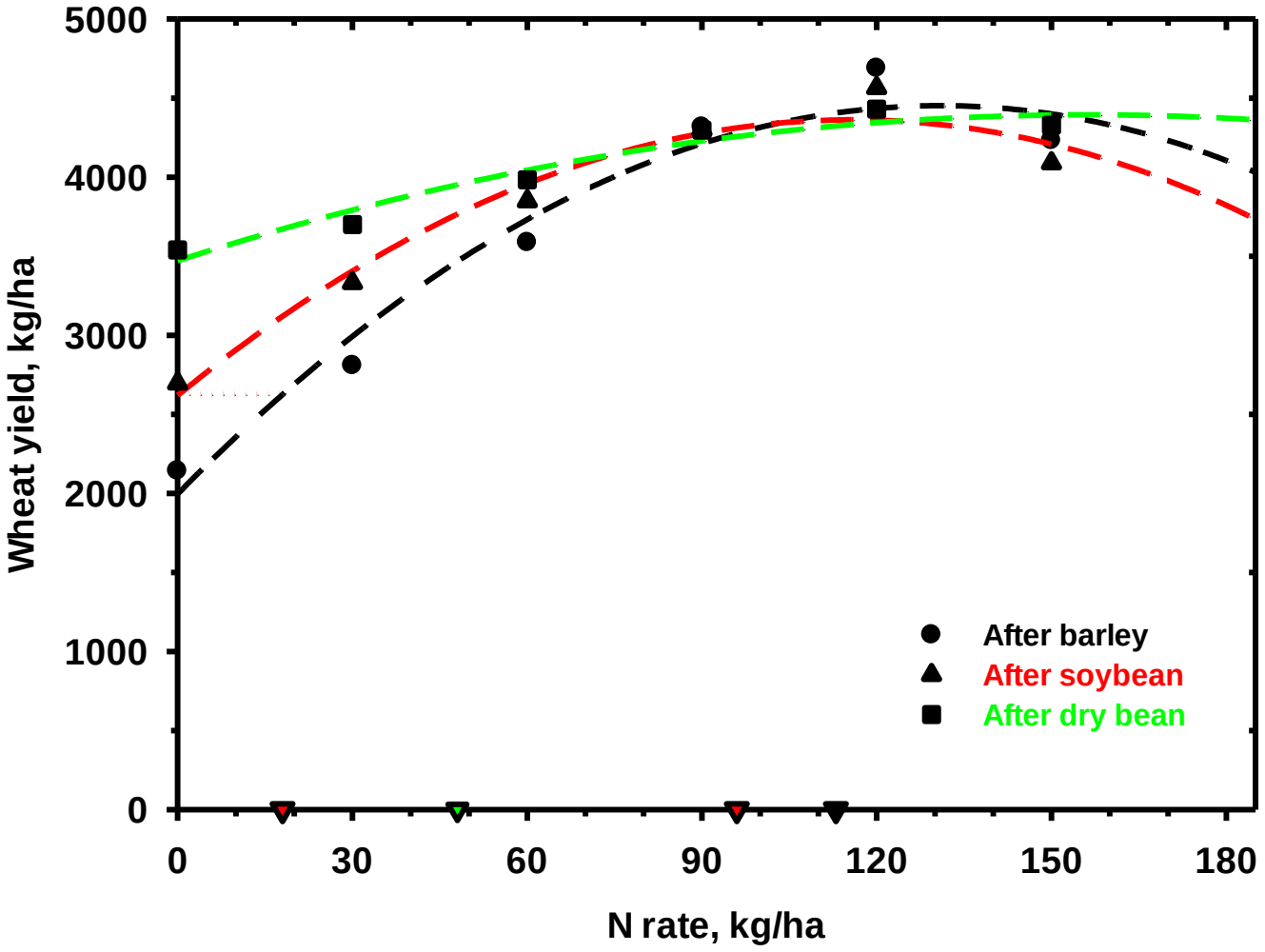


Estimating N credit – traditional method

What N rate following barley produces a yield equivalent to the unfertilized (0 N) wheat yield following soybean?



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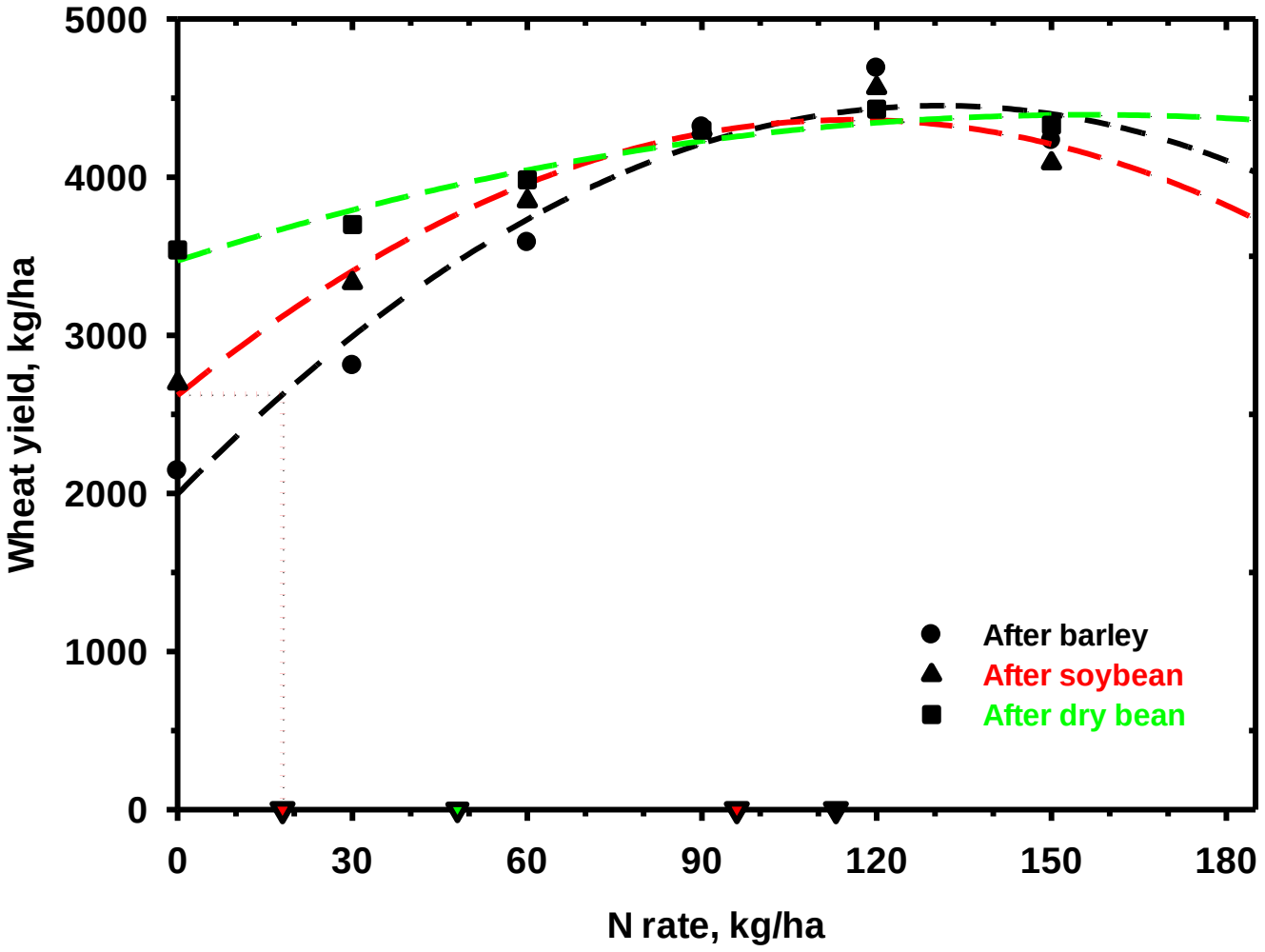
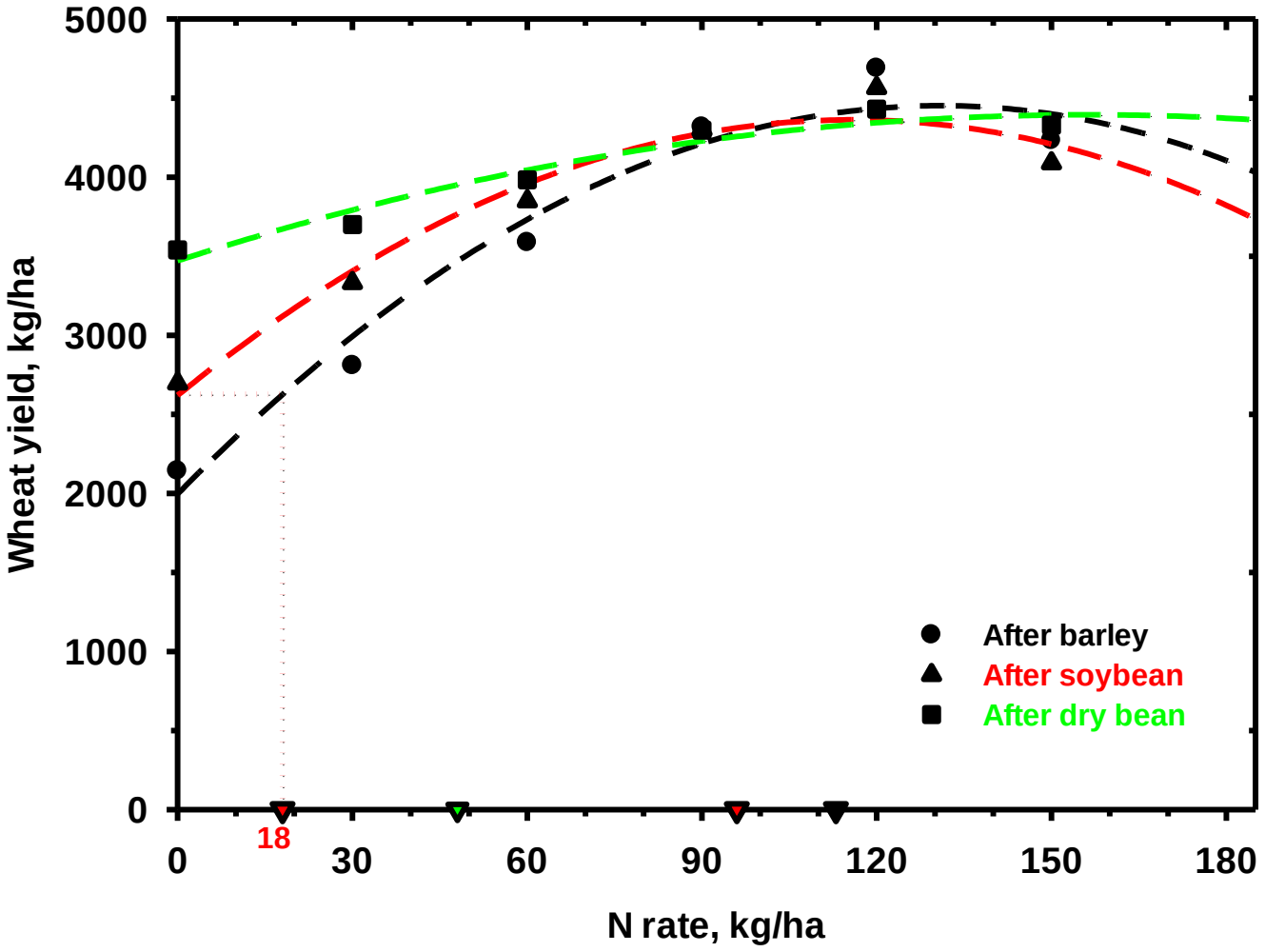


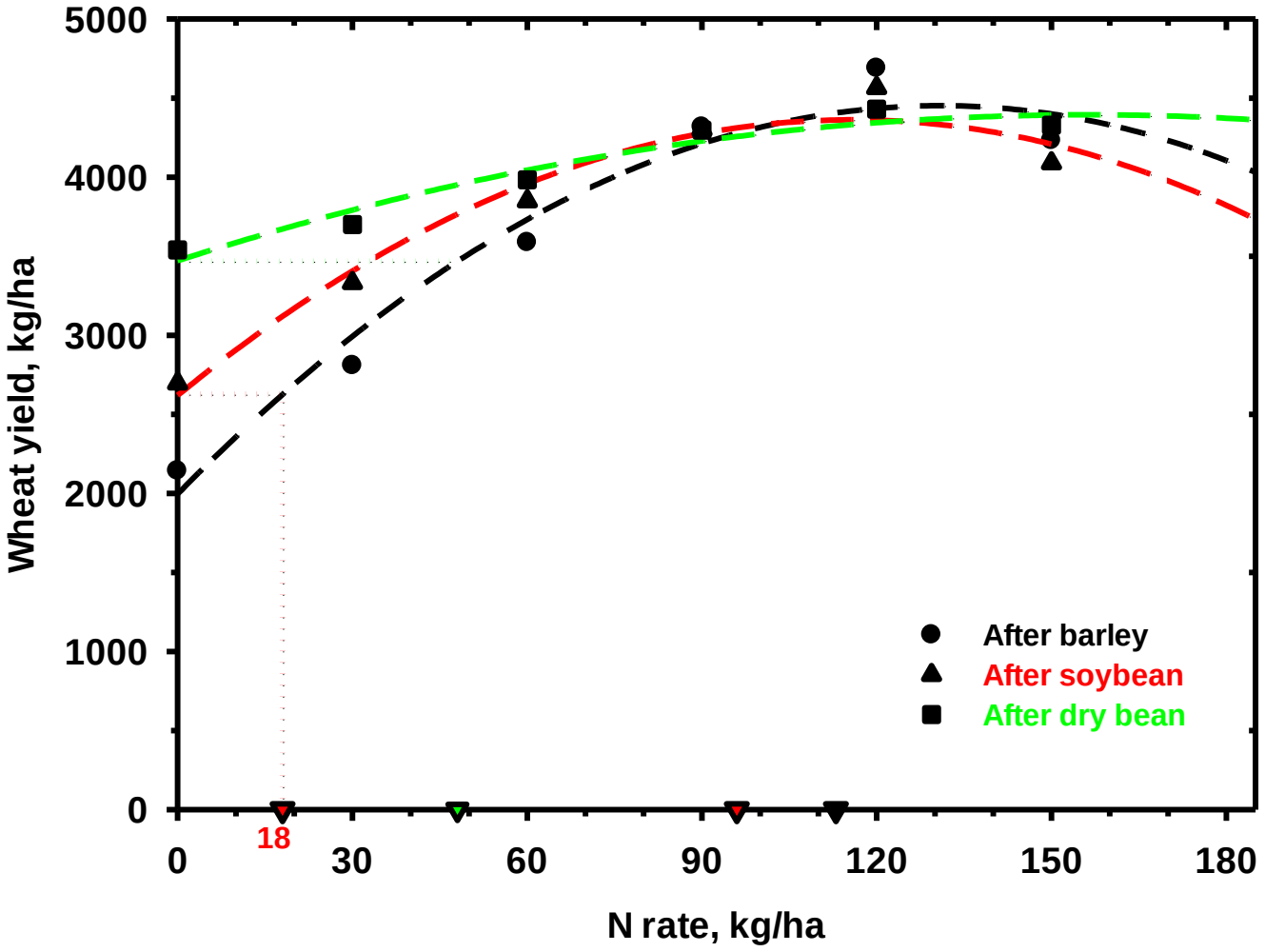
Estimating N credit – traditional method

What N rate following barley produces a yield equivalent to the unfertilized (0 N) wheat yield following soybean? Answer: 18 kg/ha



Estimating N credit – traditional method

What N rate following barley produces a yield equivalent to the unfertilized (0 N) wheat yield following dry bean?



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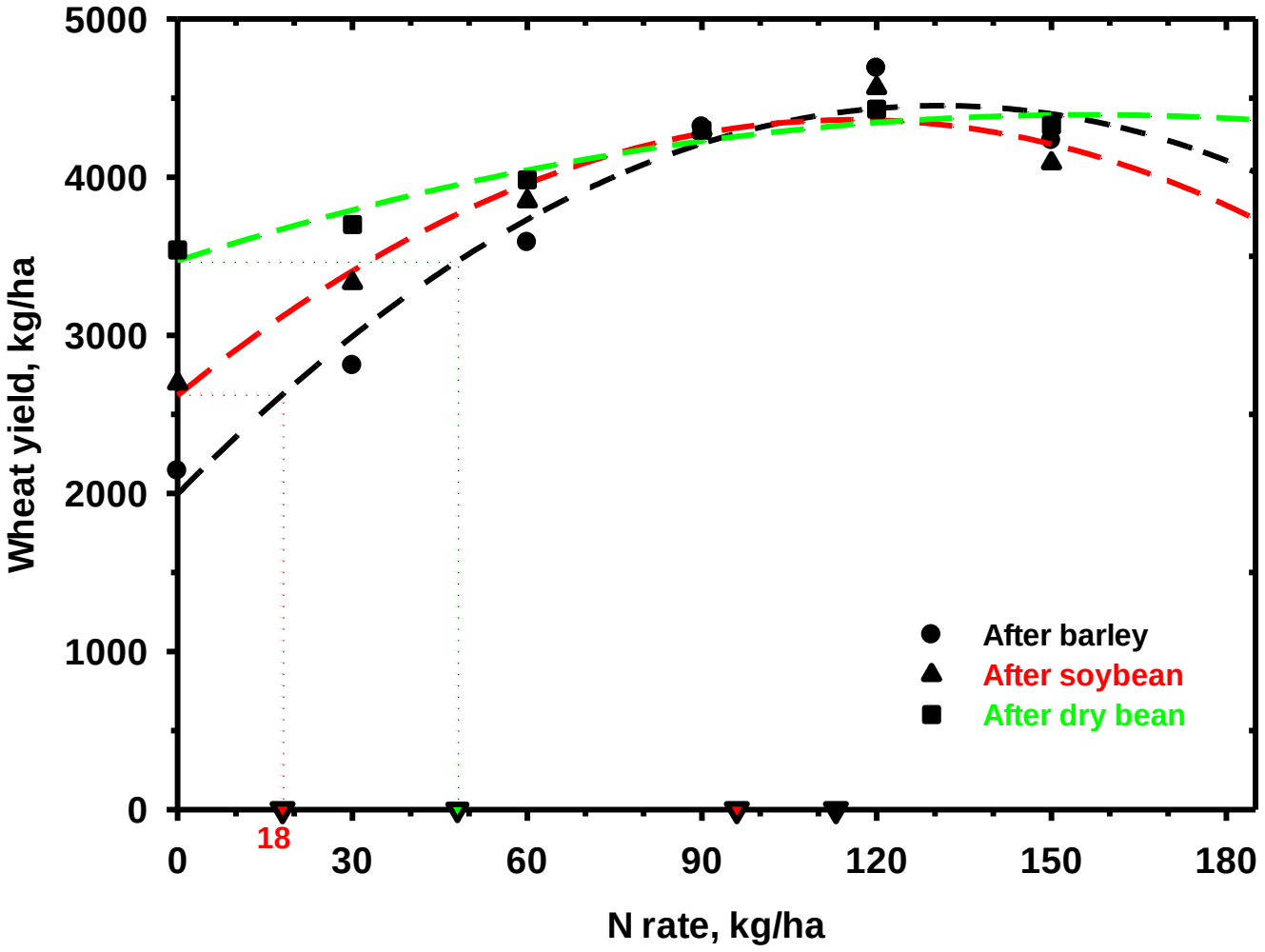
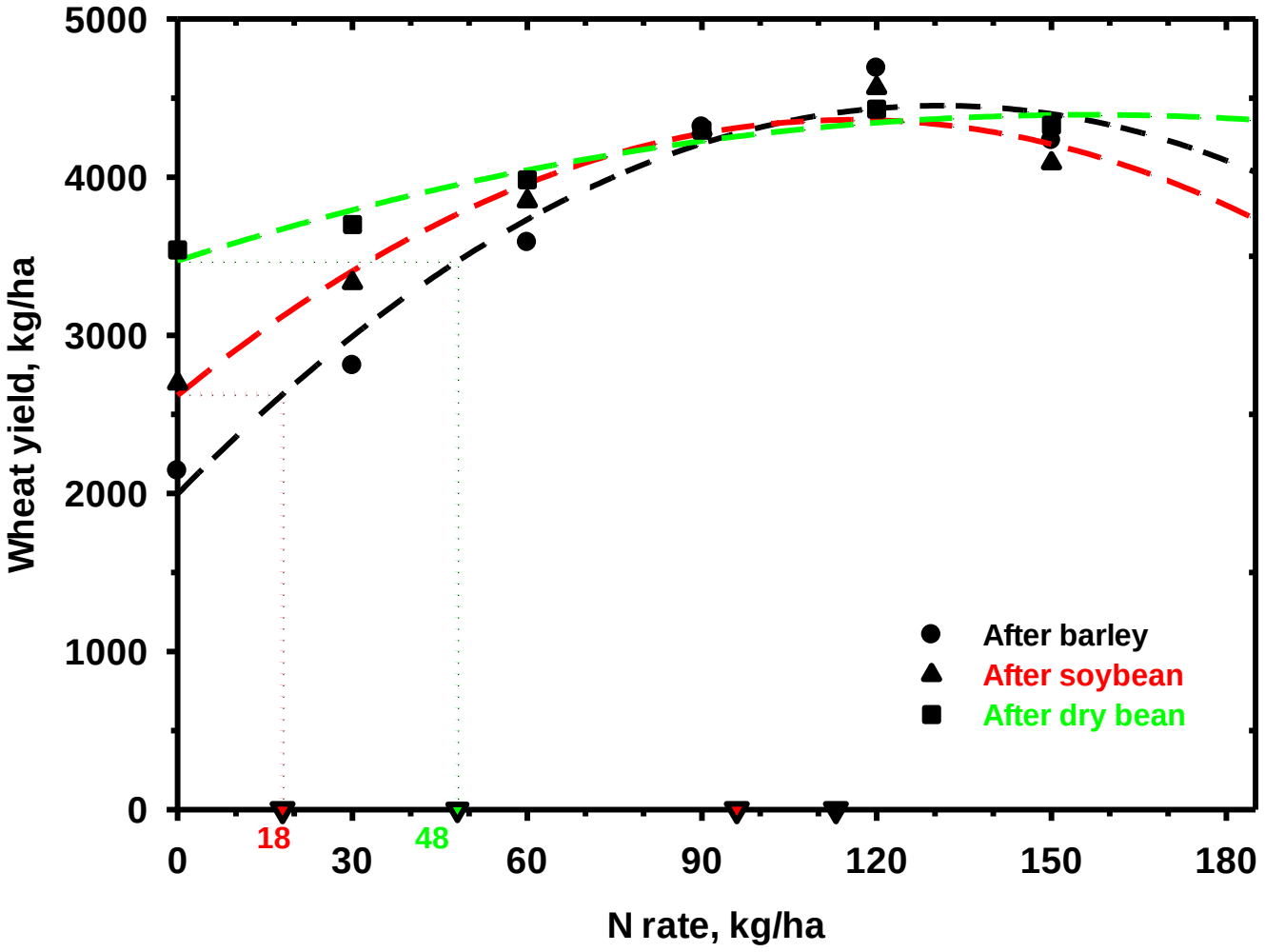


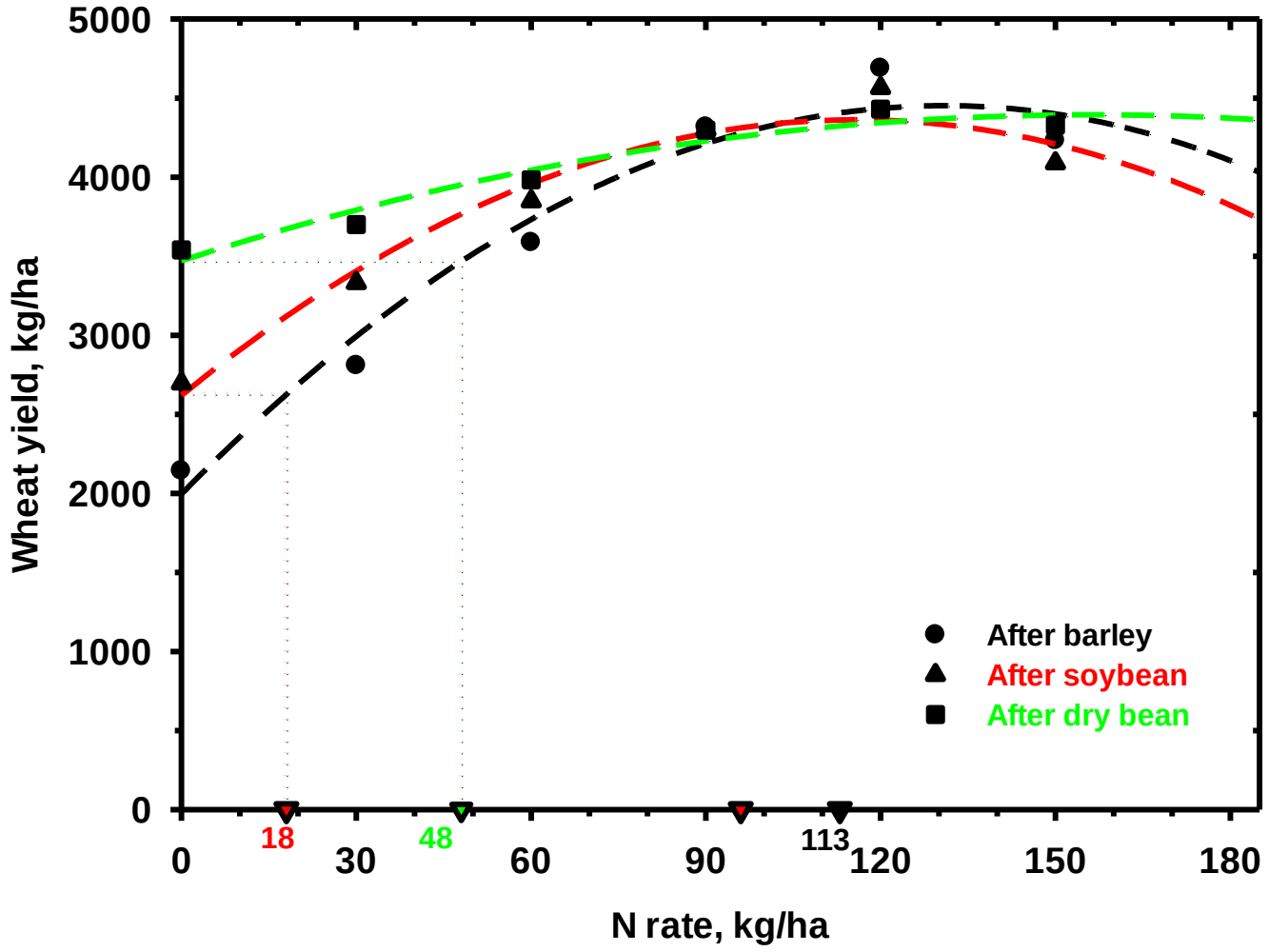
Estimating N credit – traditional method

What N rate following barley produces a yield equivalent to the unfertilized (0 N) wheat yield following dry bean? Answer: 48 kg/ha



Estimating N credit – difference method

Economic Optimum N Rate (EONR) = point where additional fertilizer N still returns a sufficient barley yield increase to cover the extra fertilizer cost



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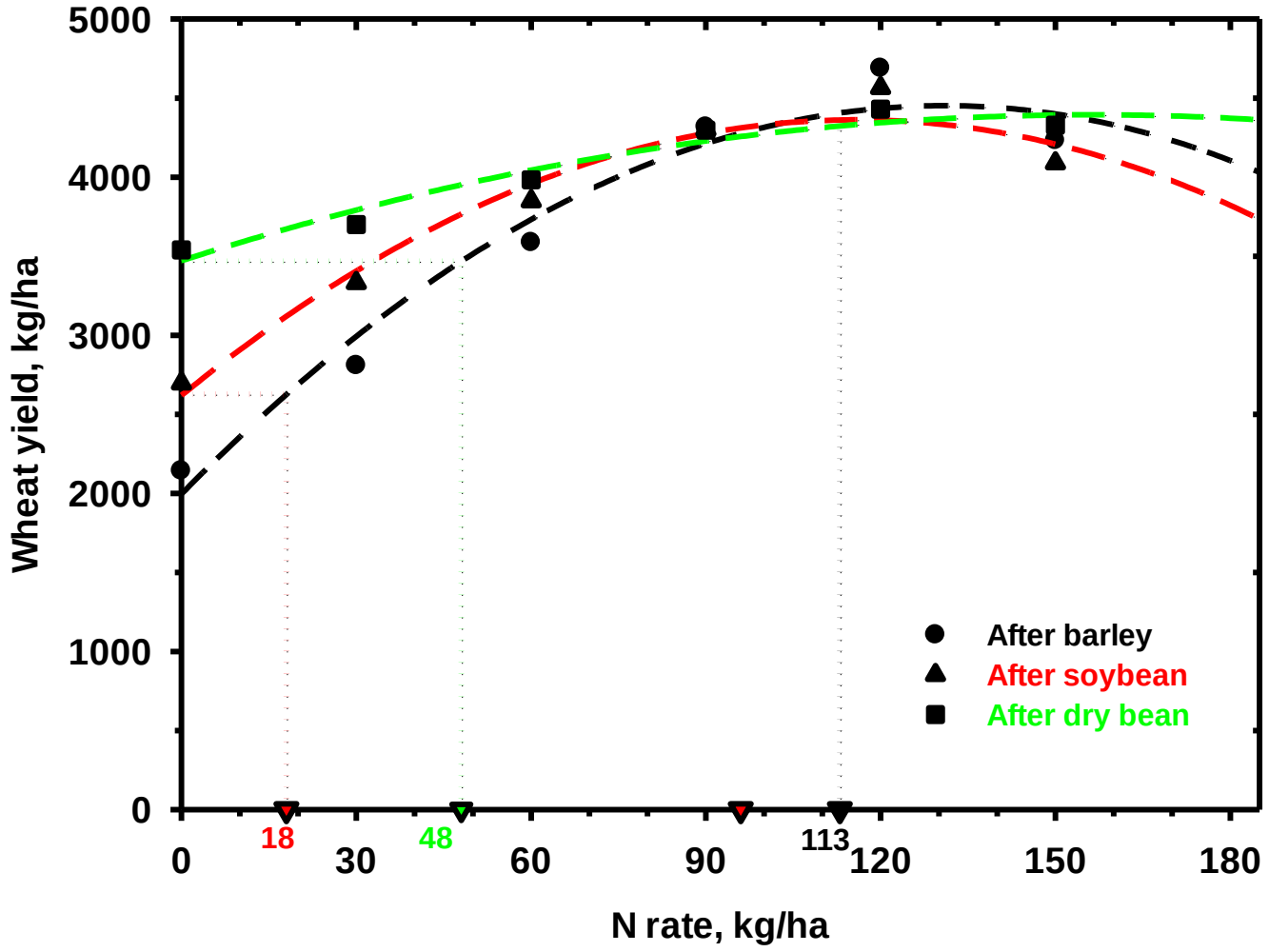

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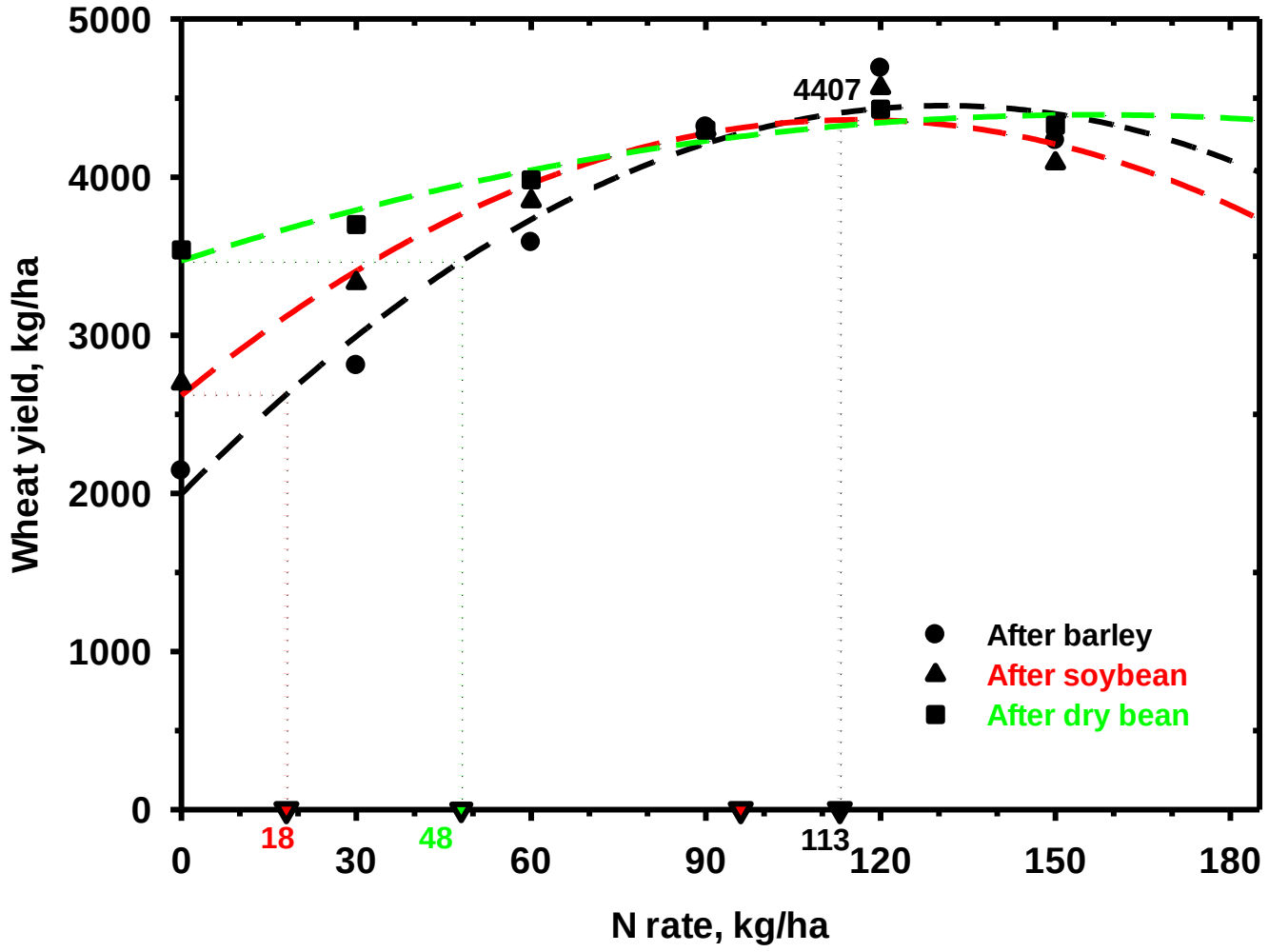

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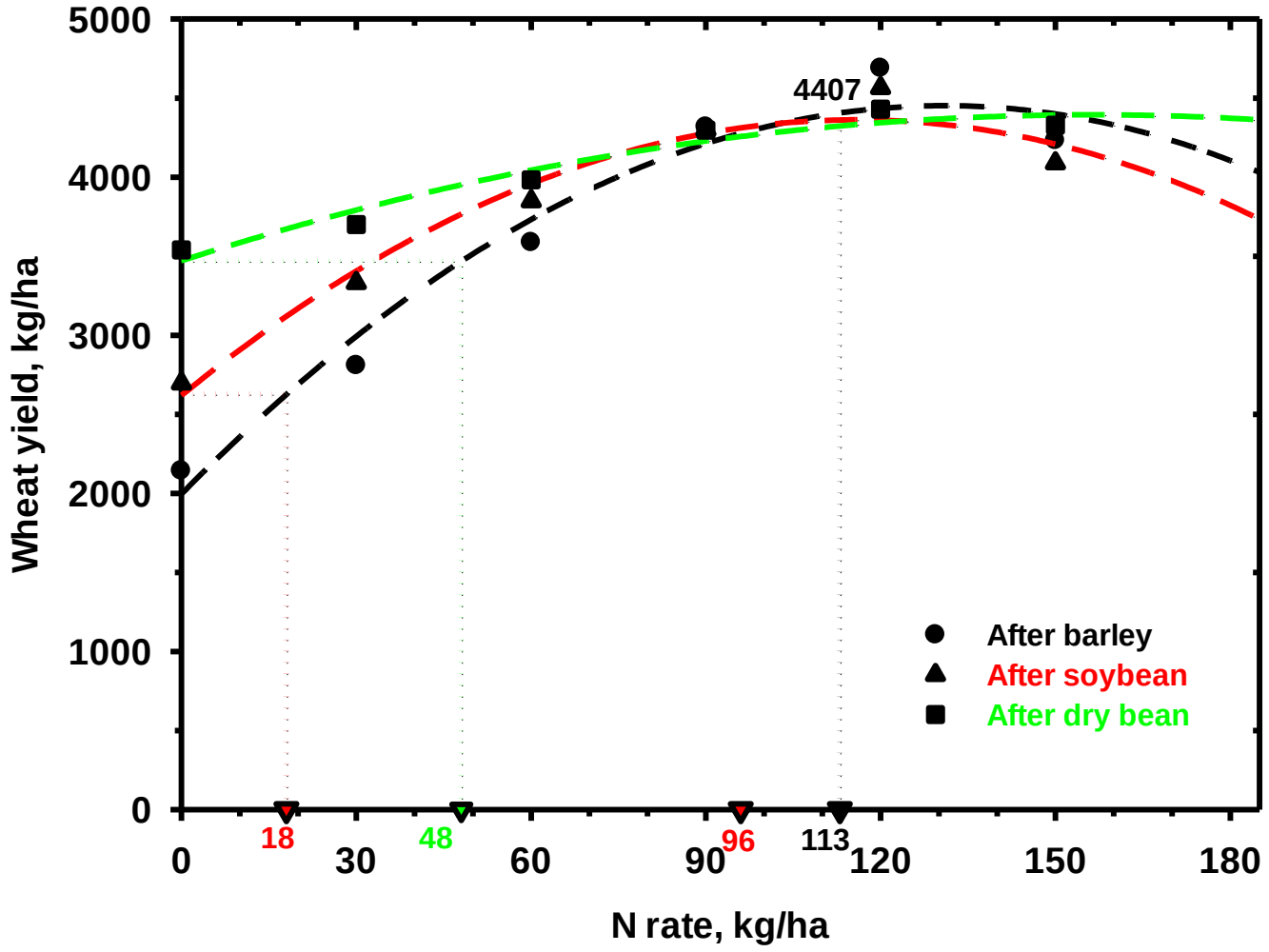

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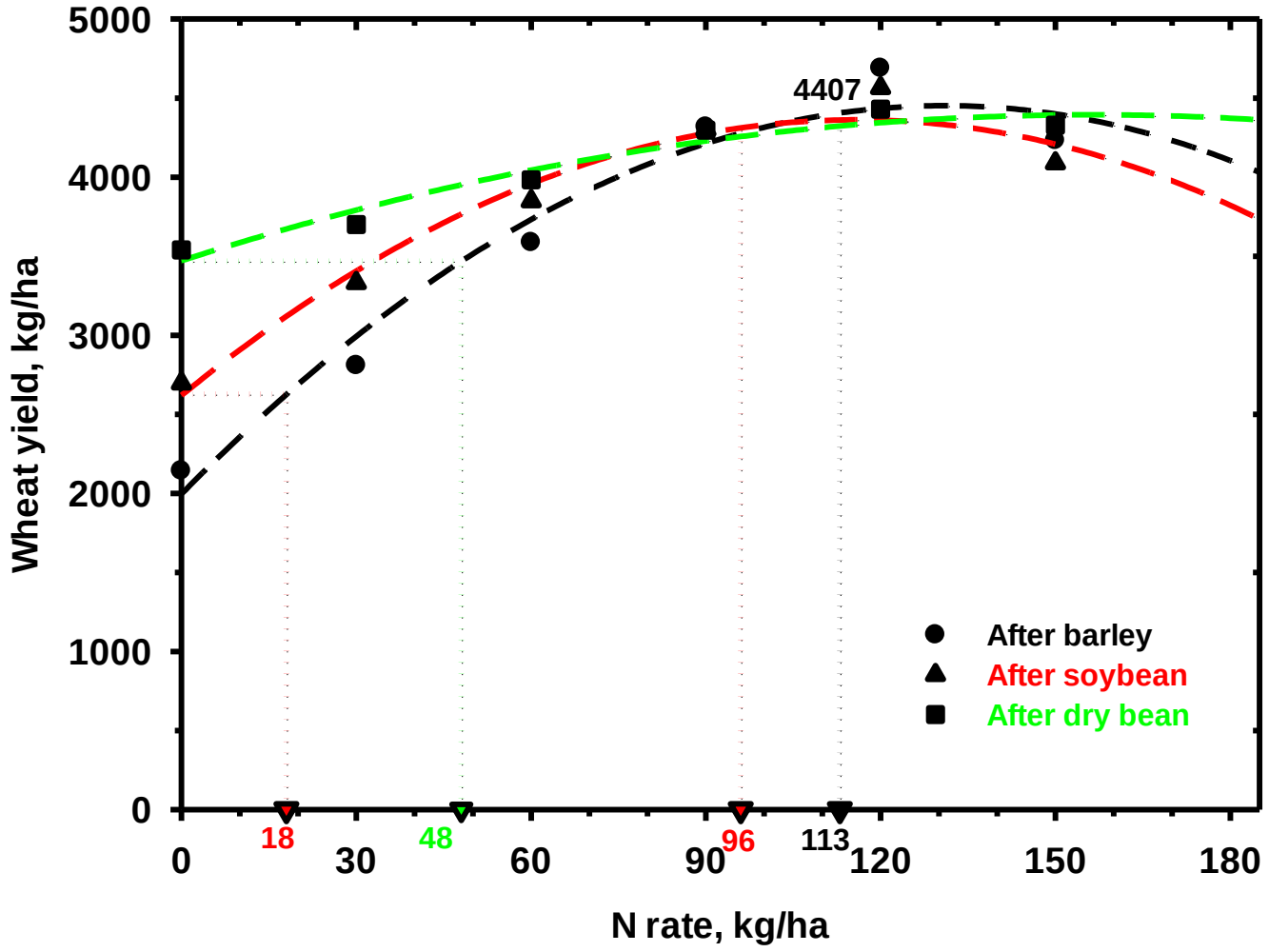

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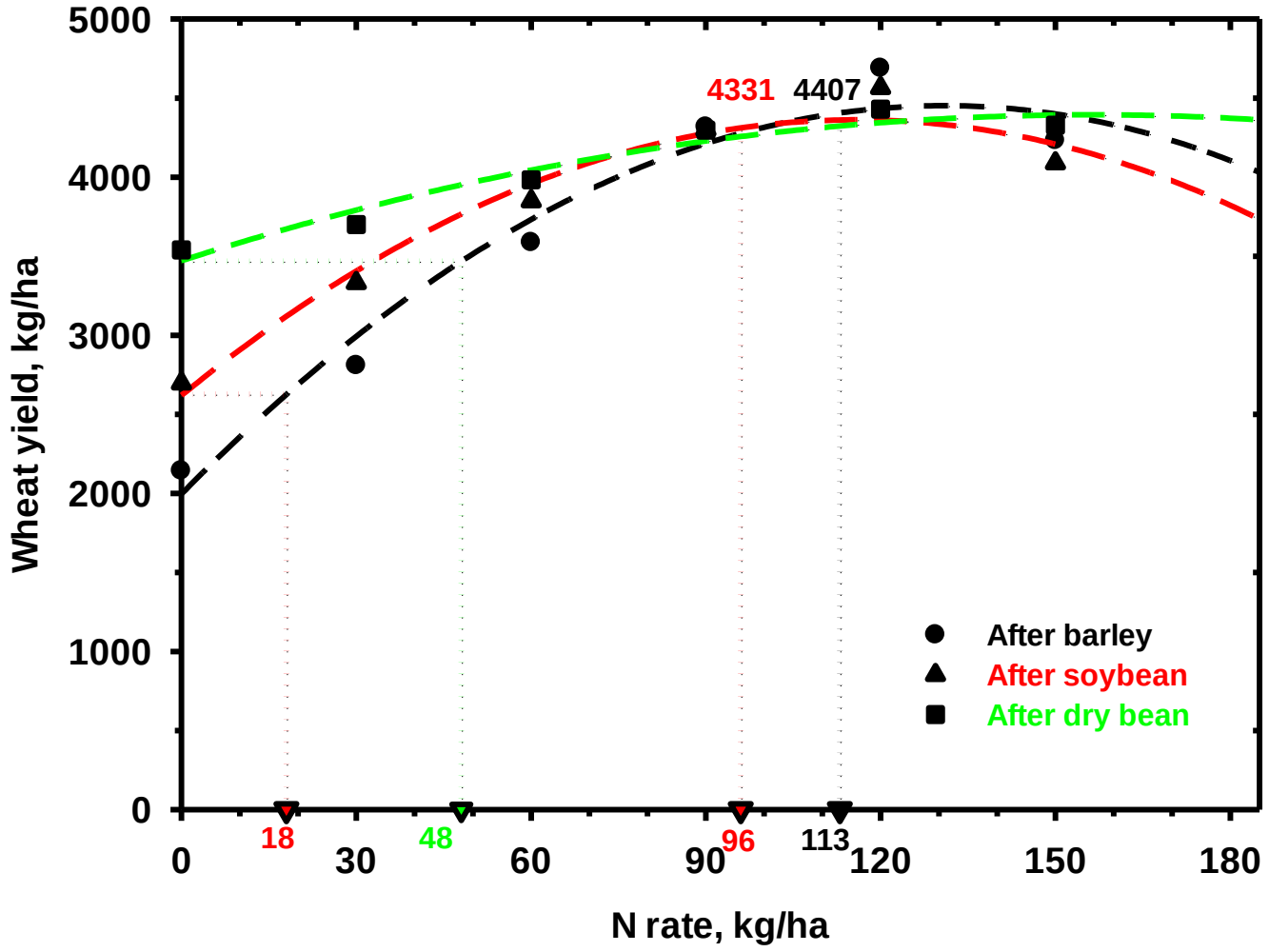

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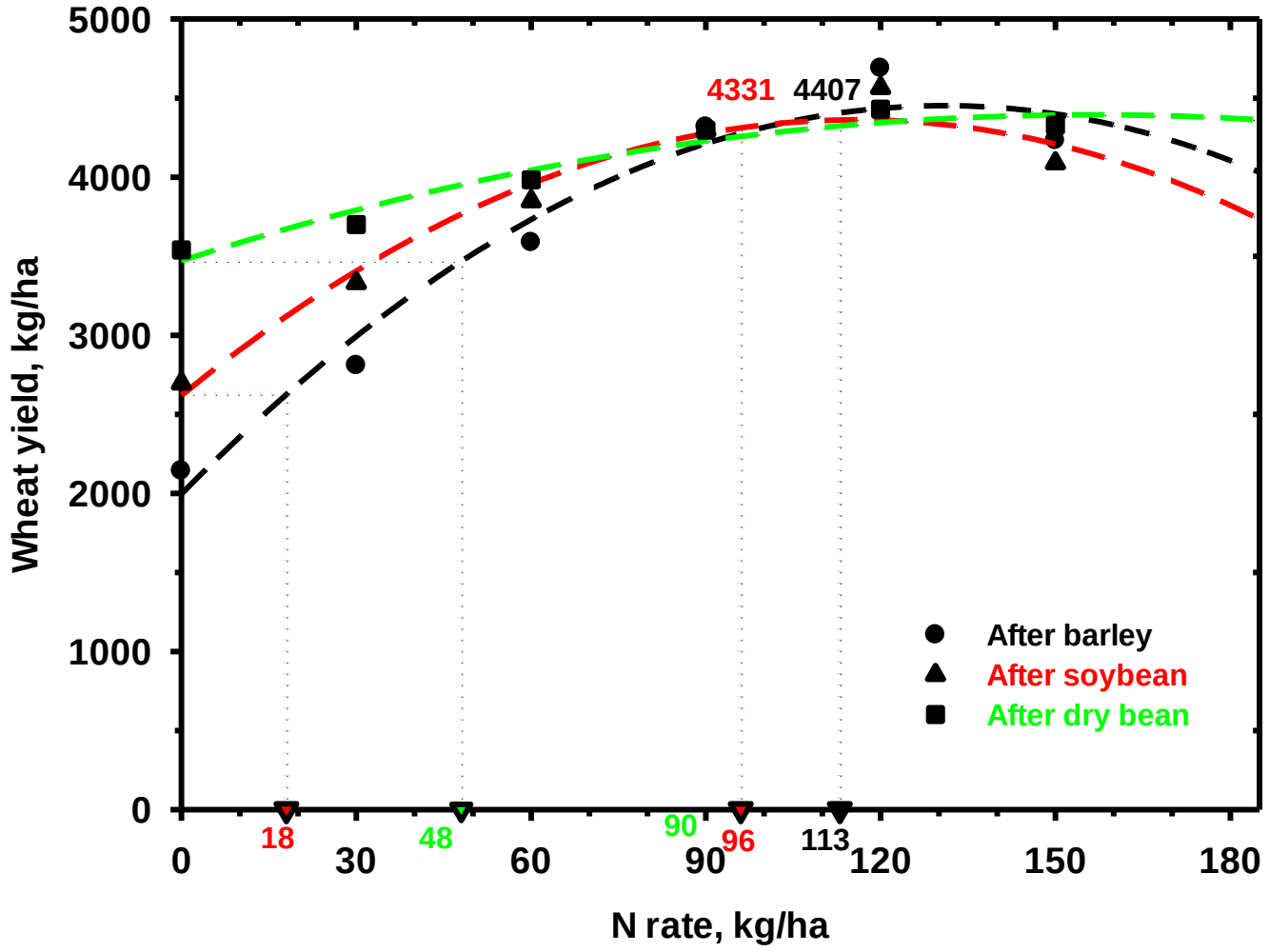

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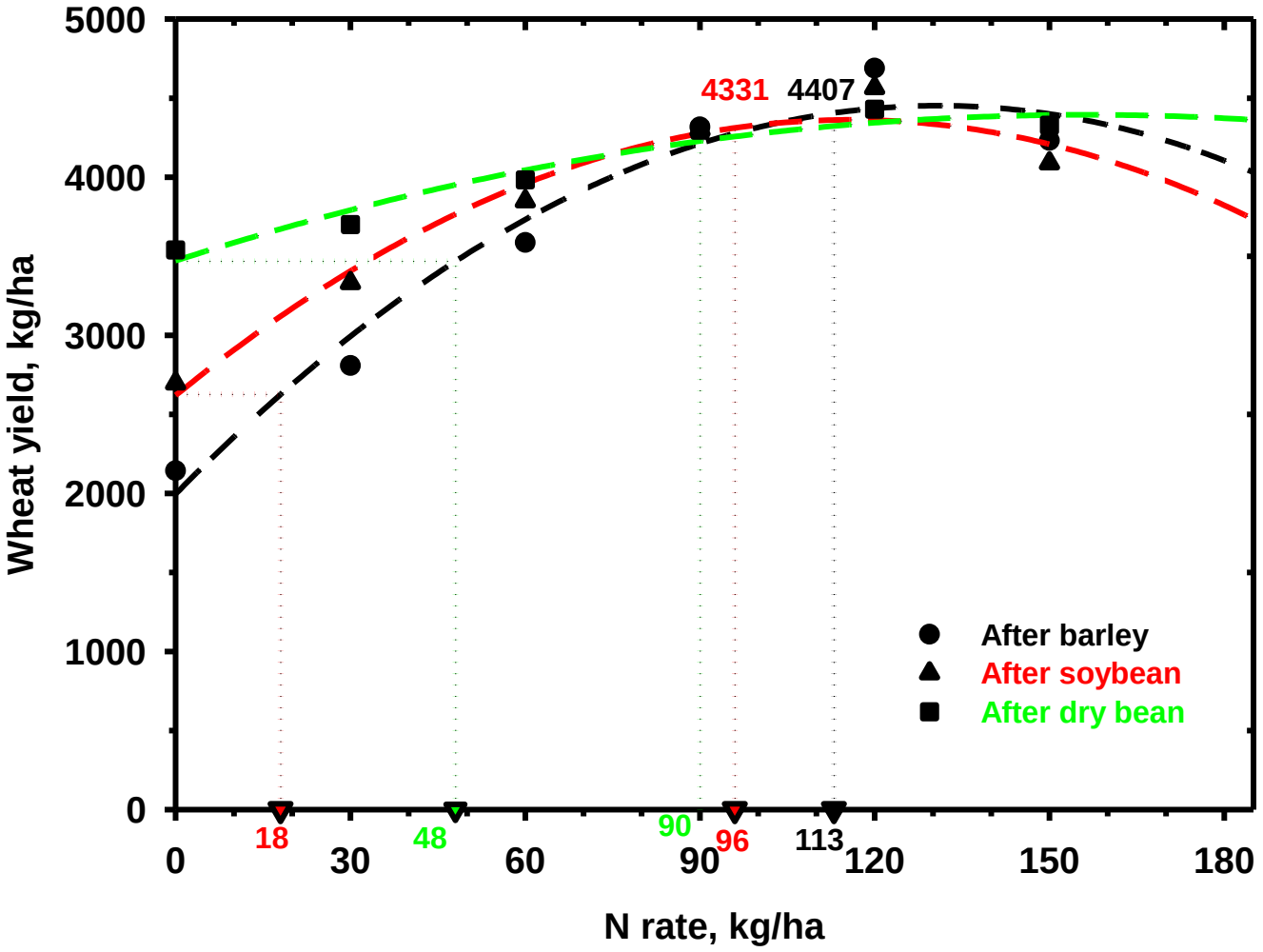

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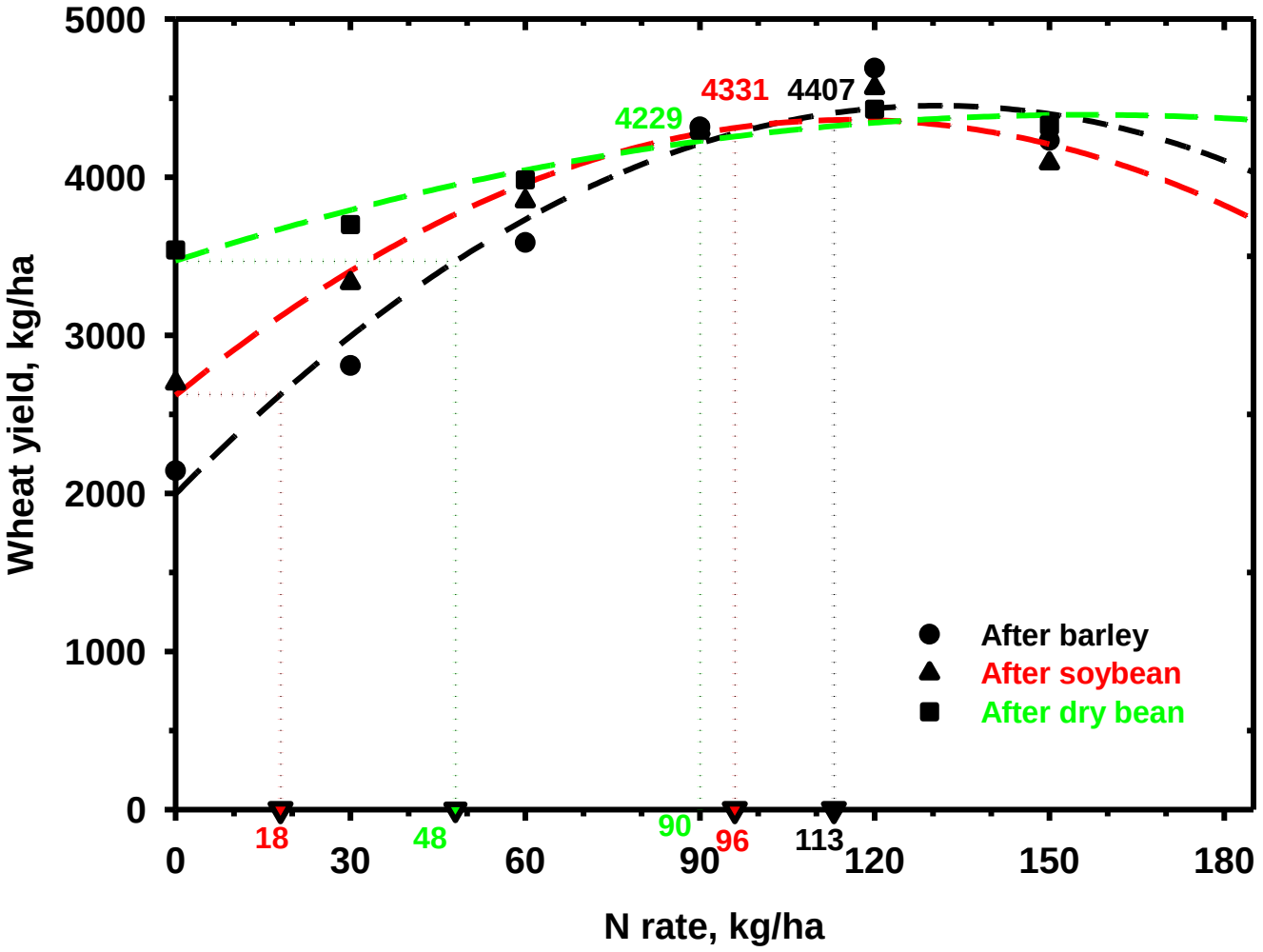
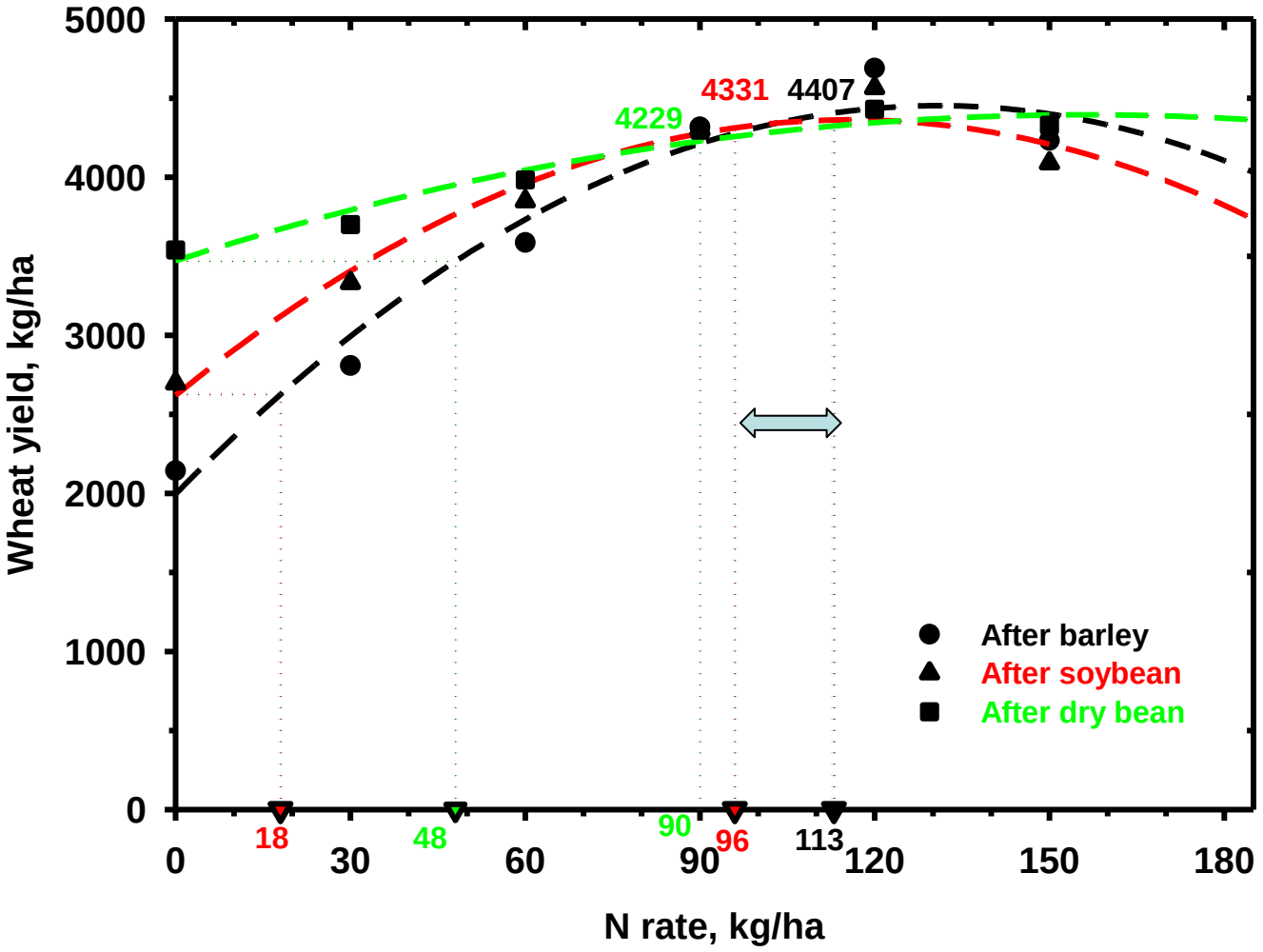


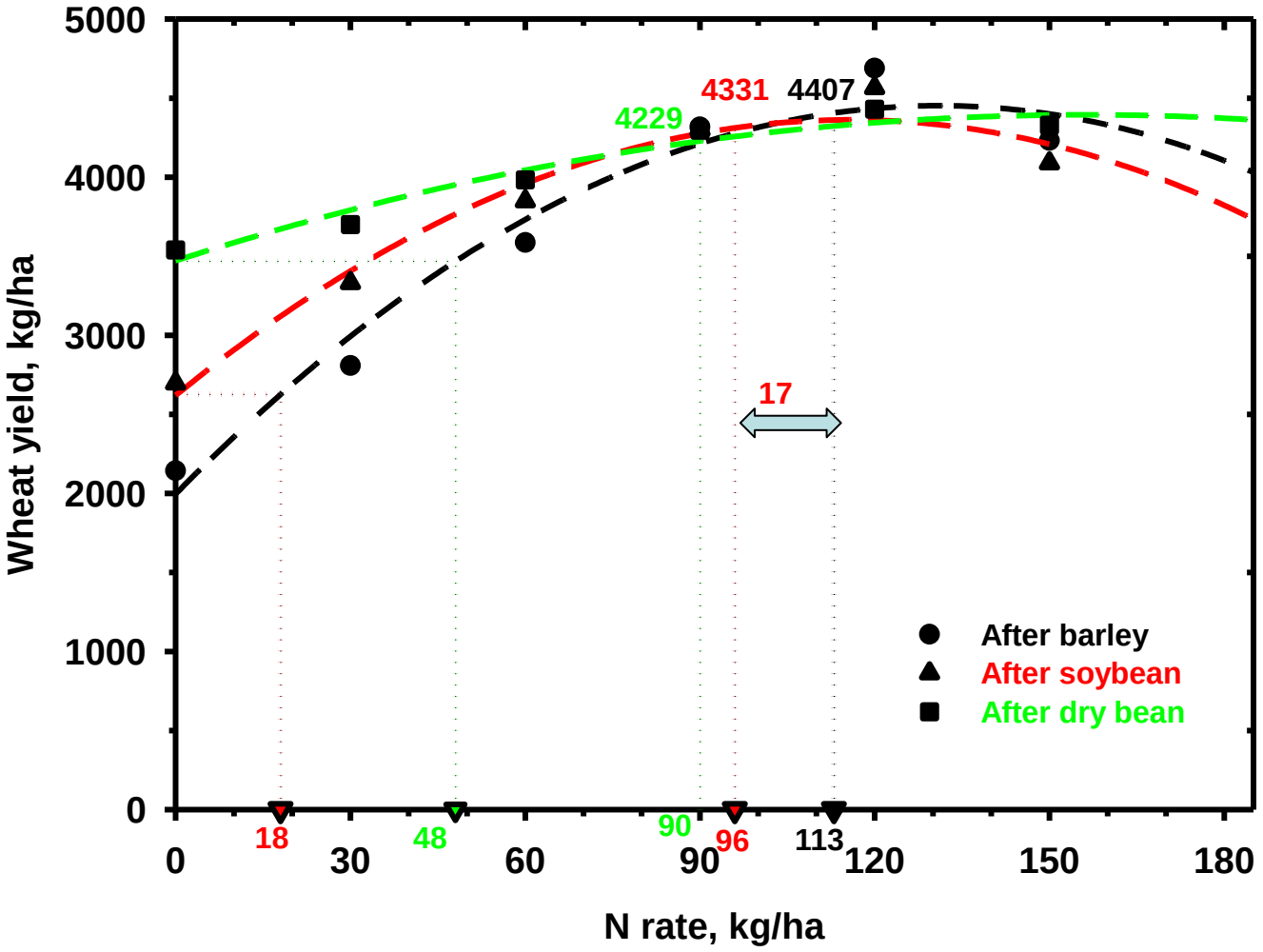
Estimating N credit – difference method

Soybean N credit = Barley minus Soybean = 113 – 96



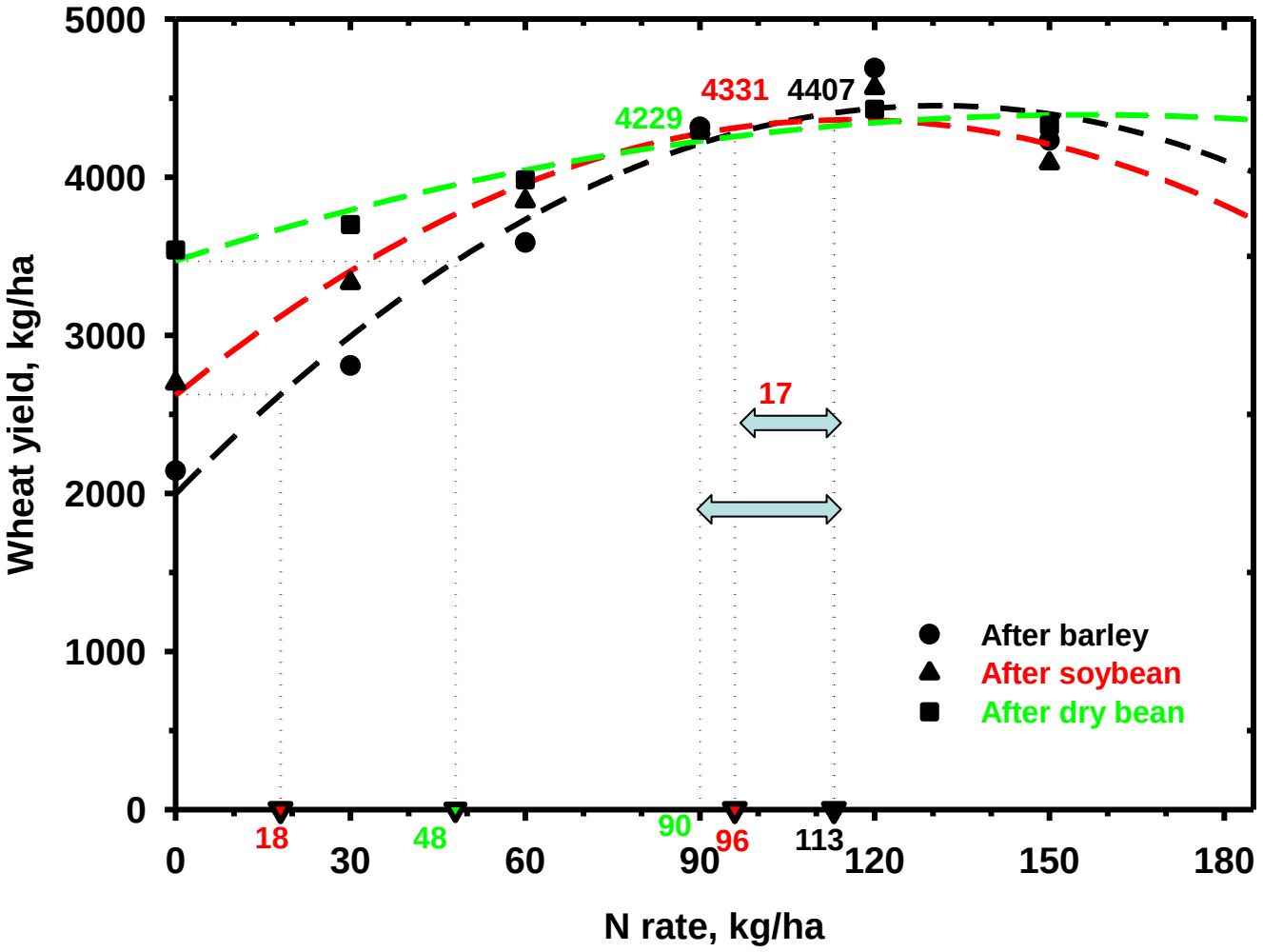
Estimating N credit – difference method

Soybean N credit = Barley minus Soybean = 113 – 96 = 17



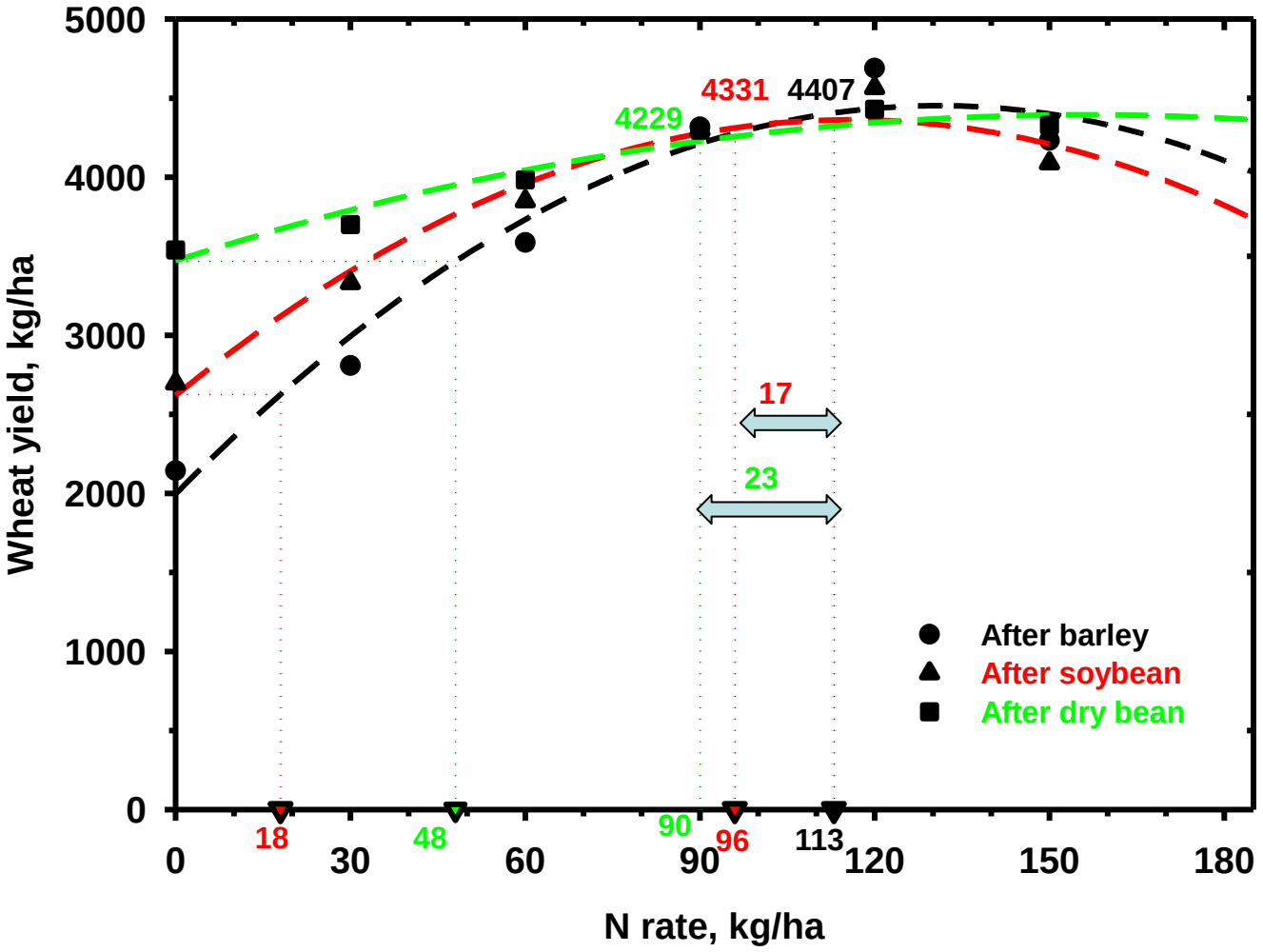
Estimating N credit – difference method

Dry bean N credit = Barley minus Dry bean = 113 – 90 =



Estimating N credit – difference method

Dry bean N credit = Barley minus Dry bean = 113 – 90 = 23



N credit (kg/ha) comparison: soybean vs. dry bean

	Soybean	Dry bean
Traditional method		
Bow Island	18	
Lethbridge	25	
Mean	**23**	

N credit (kg/ha) comparison: soybean vs. dry bean

	Soybean	Dry bean
Traditional method		
Bow Island	18	48
Lethbridge	25	48
Mean	**23**	**48**

N credit (kg/ha) comparison: soybean vs. dry bean

	Soybean	Dry bean
Traditional method		
Bow Island	18	48
Lethbridge	25	48
Mean	**23**	**48**
Difference method (Economic Optimum N Rate, EONR)		
Bow Island	17	
Lethbridge	16	
Mean	**17**	

N credit (kg/ha) comparison: soybean vs. dry bean

	Soybean	Dry bean
Traditional method		
Bow Island	18	48
Lethbridge	25	48
Mean	**23**	**48**
Difference method (Economic Optimum N Rate, EONR)		
Bow Island	17	23
Lethbridge	16	65
Mean	**17**	**44**

N credit (kg/ha) comparison: soybean vs. dry bean

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Mean	**23**	**48**
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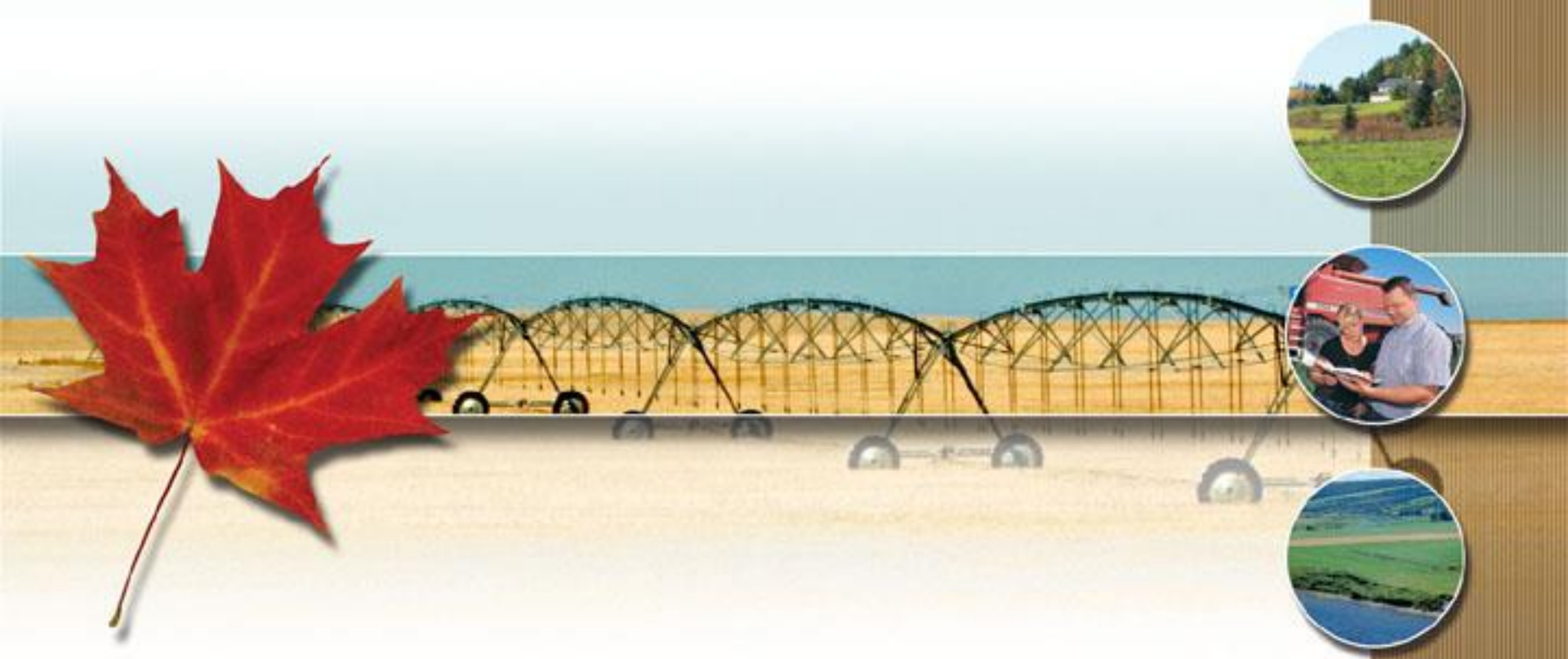
Lethbridge	16	65
Mean	**17**	**44**

Dry bean results in an N credit 2 to 2.5 times greater than soybean



Canada

ACKNOWLEDGEMENTS

AAFC-Lethbridge: Tony Curtis, Kyle Shade, Newton Lupwayi, Brett Hill

AF, Lethbridge: Allan Middleton, Pat Pfiffner, Chris Hietamaa, Colin Enns, Darryle Thiessen,

AF, Brooks: Art Kruger

Growing Forward 2
A federal-provincial-territorial initiative