Assessment of Biofumigation for Weed Control in Organic Agriculture

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Presentation Outline

- Biofumigation
- Impact on weeds
- Objectives

1: Greenhouse experiment

- Materials and methods
- Results
  - Seedling survival
  - Seeds – Reproductive effort

2: Field experiment

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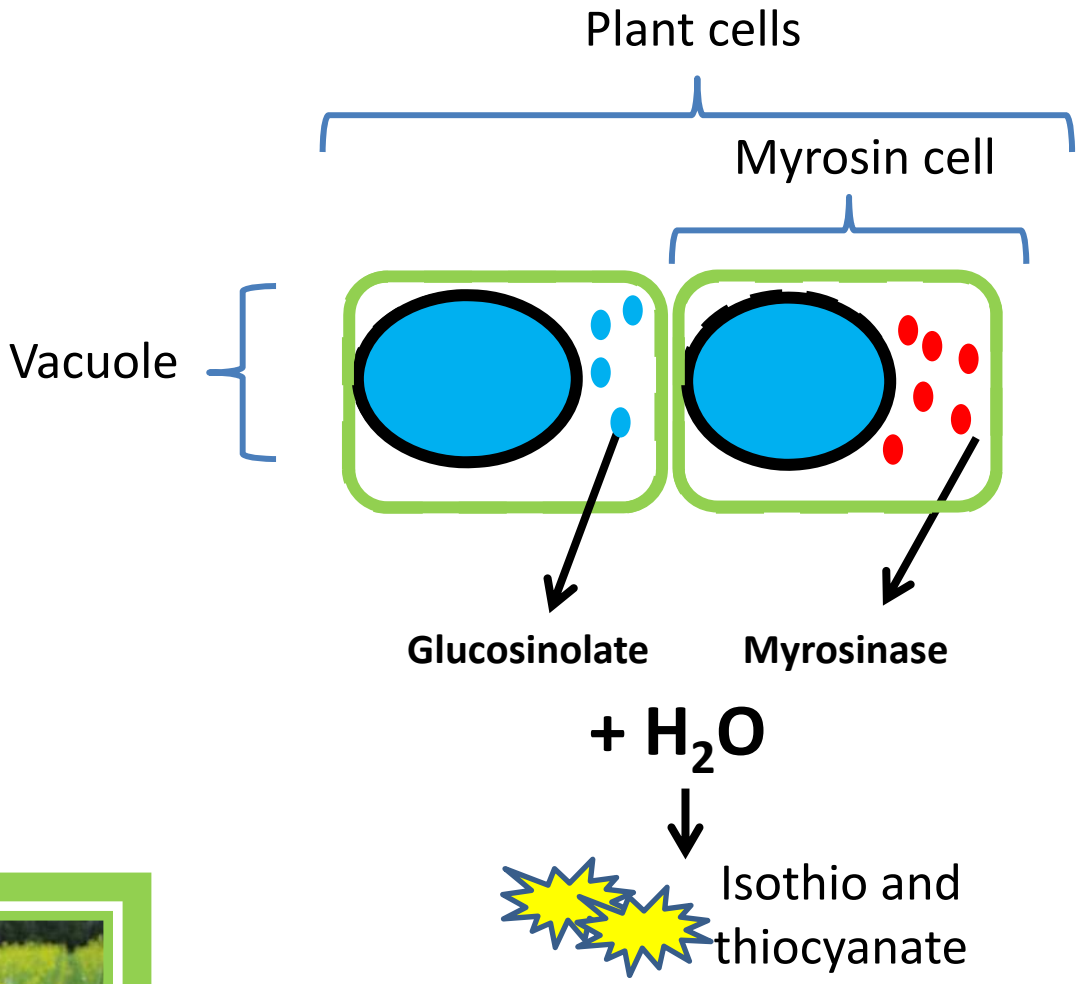
  - Biofumigant effect – ITC analyses
  - Spring emergence
  - Weed growth and establishment during green manure

- Key messages

Biofumigation



Michel, 2008. Vitic. Arboric. Hortic. 40 (2): 95-99

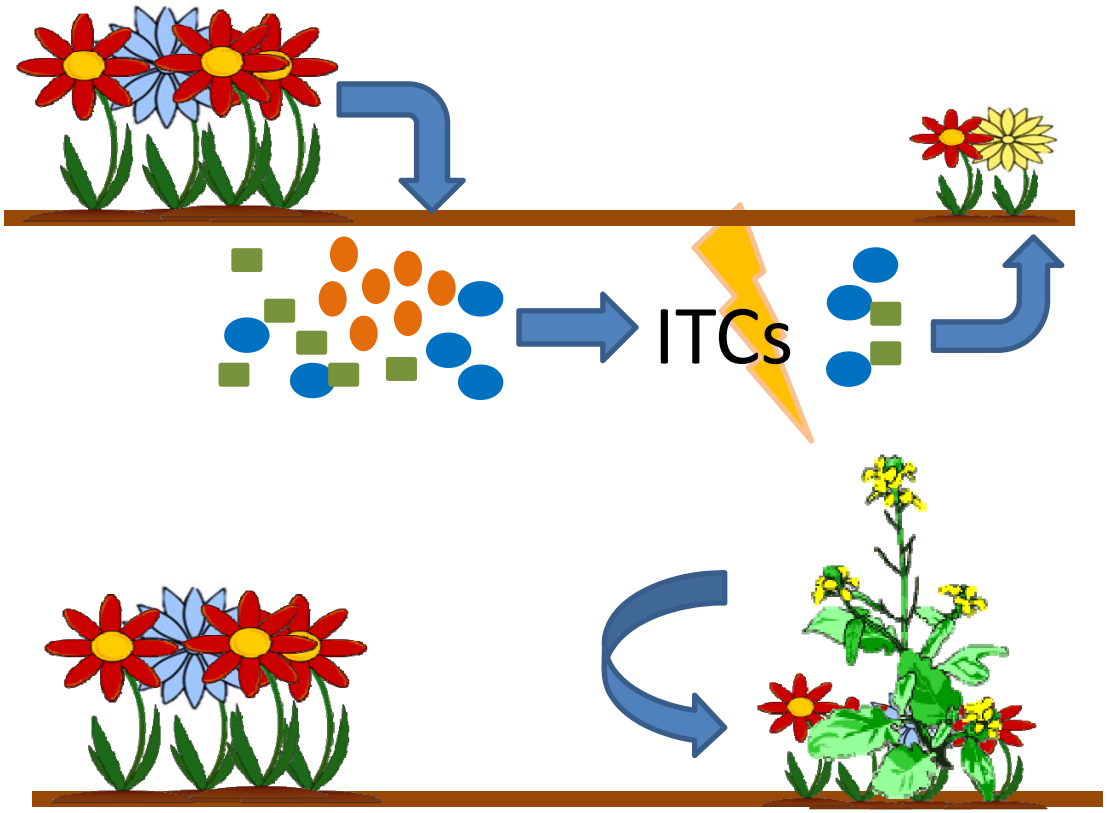
Michel et al., , 2000. Vitic. Arboric. Hortic. 39 (2): 145-150

Allelopathy current trends and future applications, Cheema, 2013.

Impact on weed population dynamics

- **Establishment** of some weed seedlings

- **Interference** during weed growth (reduce biomass)



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Biofumigation – Needs investigation

- **Establishment + Interference**
  - Is there a moment where the seedbank is more susceptible
  - Establishment by season, year after year
  - Cumulative impact or changes in weed community
- **Adaptability**
  - Impact on surviving weeds and subsequent generation
  - How biofumigation affect fitness of surviving plants
  - Adaptability to ITCs/biofumigation

Objectives

- **1 – Greenhouse experiment**
  - Determine how biofumigation acts on fitness (survival, reproduction of weeds
- **2 – Field experiment**
  - Assess the susceptibility of the weed seedbank to biofumigation through the seasons
  - Assess the effect of repeated biofumigation treatments within the same year on weed populations

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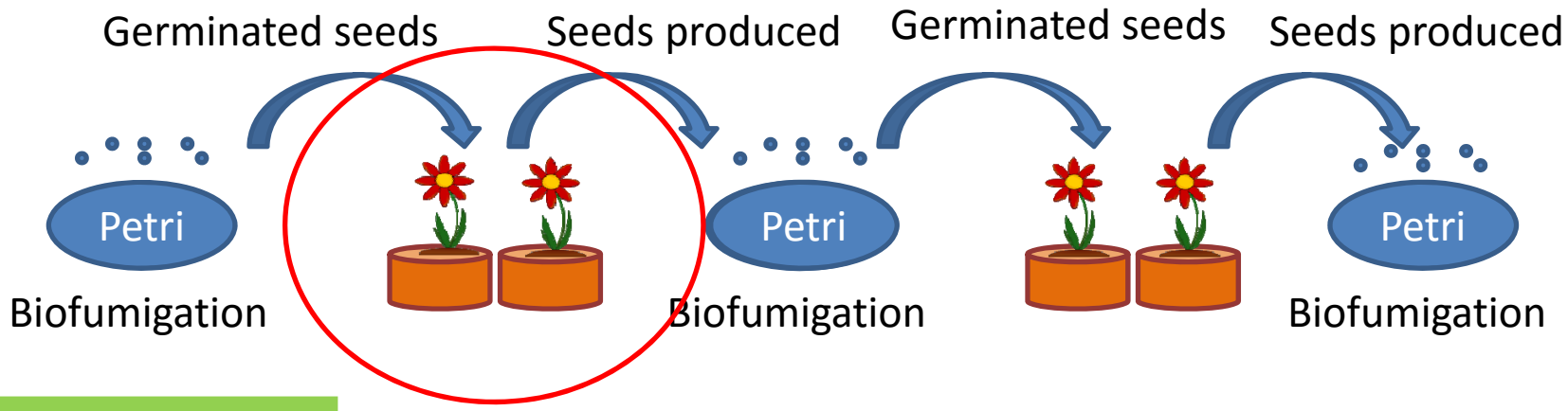
Experiment 1 - Materials and methods

- In Petri dishes and greenhouse
- 2 species: ***Ambrosia artemisiifolia*** and ***Abutilon theophrasti***
- 2 biofumigation rates + 1 control
  - For *A. artemisiifolia* (**low** = X/2 = 0.228 g/Petri; **high** = X = 0.456 g/Petri)
  - For *A. theophrasti* (**low** = X/3 = 0.152 g/Petri; **high** = X/2 = 0.228 g/Petri)
- 50 seeds/Petri, 15 Petri/treatment



Results – Seedling survival

Survival of transferred germinated seeds from Petri dishes to pots in greenhouse after biofumigation treatment.

	Treatment	Survival (% ± S.E.)
Abutilon theophrasti	Control	96.7 (1.1) a
	X/3	27.4 (4.9) b
	X/2	11.2 (5.0) c
Ambrosia artemisiifolia	Control	92.0 (1.8) a
	X/2	79.7 (2.0) b
	X	76.5 (2.4) b

ANOVAs realised on each columns by species, comparing treatments. Means comparisons by Tukey Kramer HSD, P=0.05.

Results – Seeds

Biofumigated surviving plants or untreated plants of *Abutilon theophrasti* and *Ambrosia artemisiifolia* reproduction parameters and seeds number and weight (± S.E.).

		Nb seeds plant^{-1}	Total weight of seeds plant^{-1}	Weight of 100 seeds plant^{-1}	Reproductive effort (seeds g of plant^{-1})
Abutilon theophrasti	Control	1272.9 b (33.8)	11.31 b (0.25)	0.890 a (0.008)	0.31 b (0.02)
	X/3	1536.7 a (44.1)	13.01 a (0.36)	0.847 b (0.008)	0.35 ab (0.02)
	X/2	1349.1 b (84.2)	11.51 b (0.64)	0.856 b (0.019)	0.46 a (0.05)

ANOVAs realised on each columns by species, comparing treatments. Means comparisons by Tukey Kramer HSD, P=0.05.

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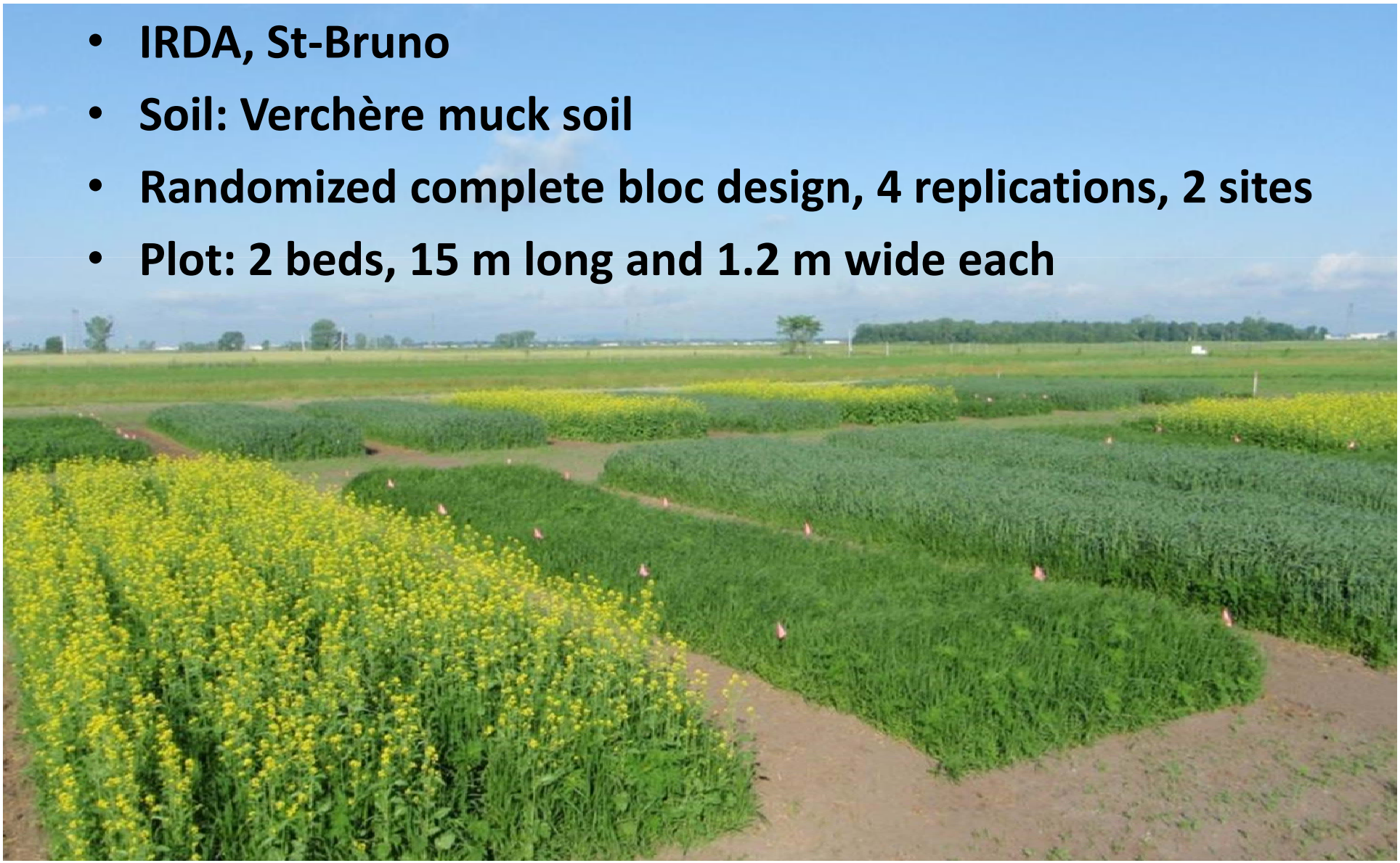
Experiment 2 - Materials and methods



- **IRDA, St-Bruno**
- **Soil: Verchère muck soil**
- **Randomized complete bloc design, 4 replications, 2 sites**
- **Plot: 2 beds, 15 m long and 1.2 m wide each**

Treatments

Treatment	Description (plot management)			
	Spring	« BIOFUMIGATION »	Summer	Fall
1) Spring biofumigation	Green manure *B. juncea*		Crop	Green manure Oat
2) Fall biofumigation	Green manure Oat		Crop	Green manure *B. juncea*
3) Spring and fall biofumigation	Green manure *B. juncea*		Crop	Green manure *B. juncea*
4) Without biofumigation (control)	Green manure Oat		Crop	Green manure Oat
5) Weedy check	No green manure		Crop without weeding	No green manure

Variables measured

- Weed abundance over time and weed biomass

- Chemical analyses of ITCs

Results – ITCs

2014	Sample	Saison	allyl ITC ug/g	butyl ITC ug/g
	Plant	Spring	69.90	43.01

2000 to 2500

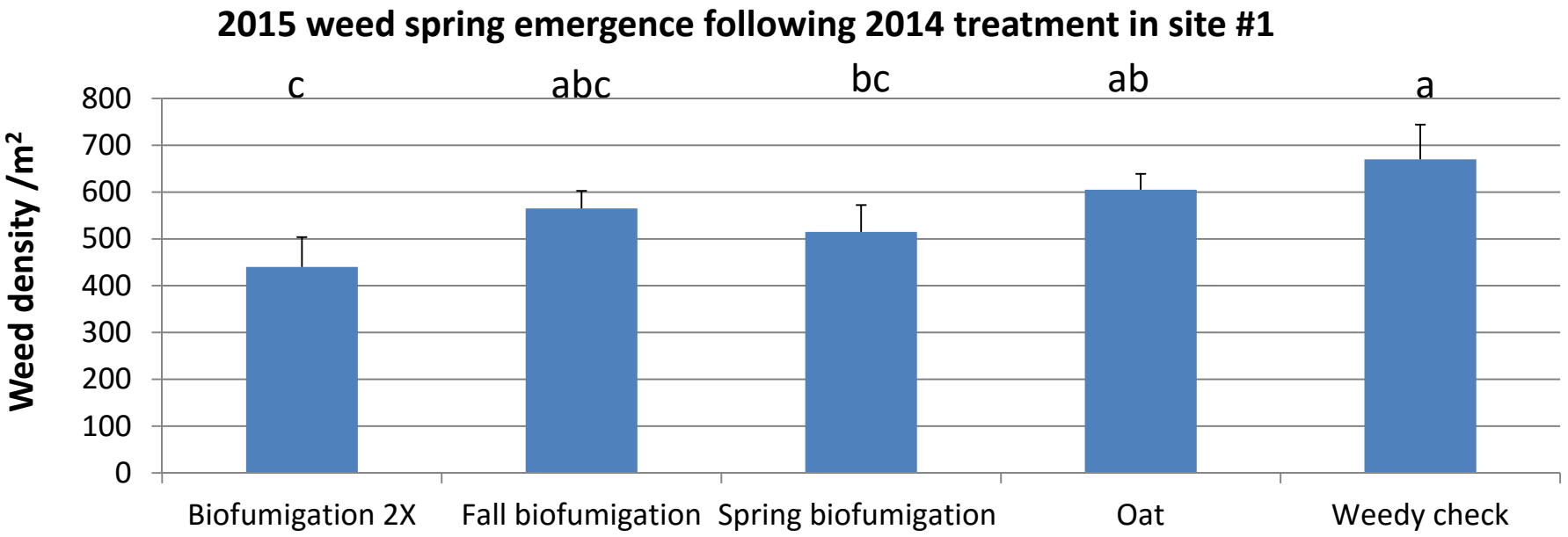
Fertilisation : Sul-po-mag (0-0-22): 278 Kg/ha, Dolomitique lime: 2000 Kg/ha

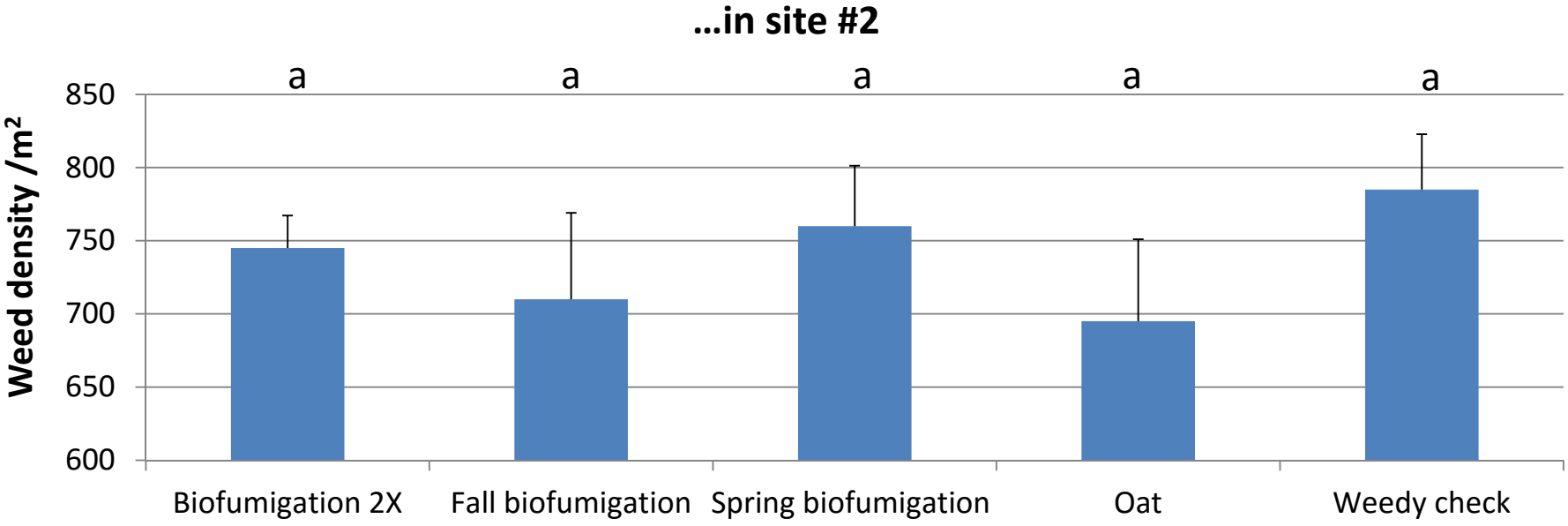
2015	Sample	Saison	allyl ITC ug/g	butyl ITC ug/g
	Plant	Spring	714.42	4.21

Fertilisation : Sul-po-mag (0-0-22): 278 Kg/ha

2016	Sample	Saison	allyl ITC ug/g	butyl ITC ug/g
	Plant	Spring	1567.50	0.00

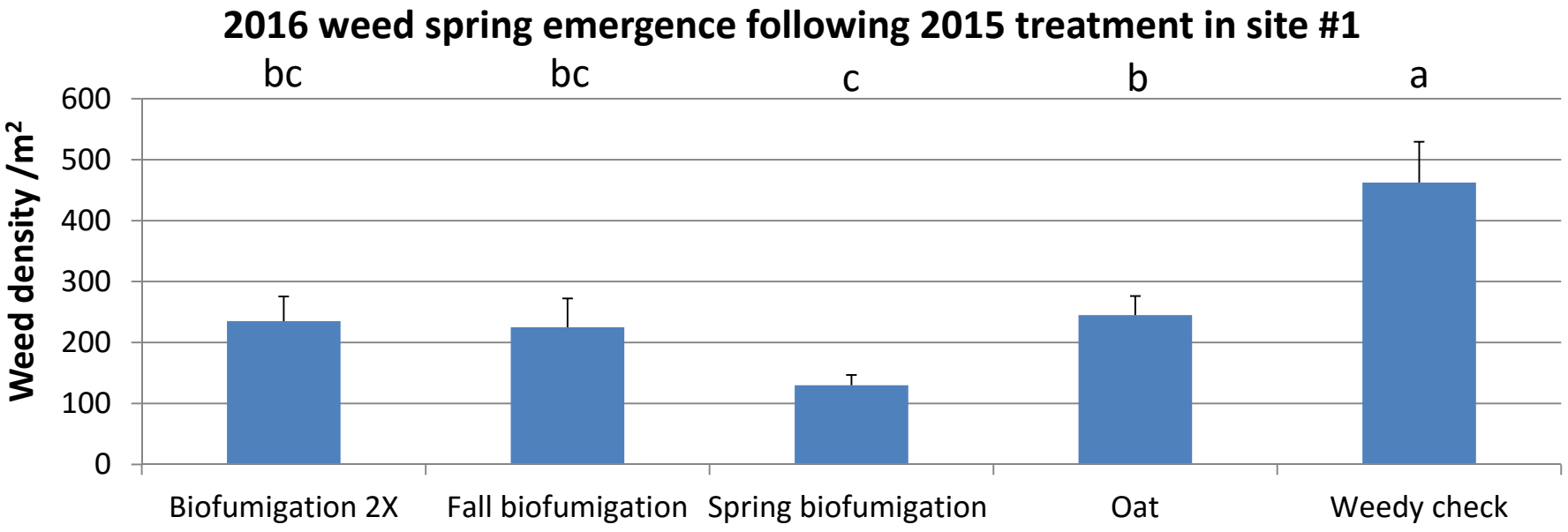
Results – Spring emergence 2015

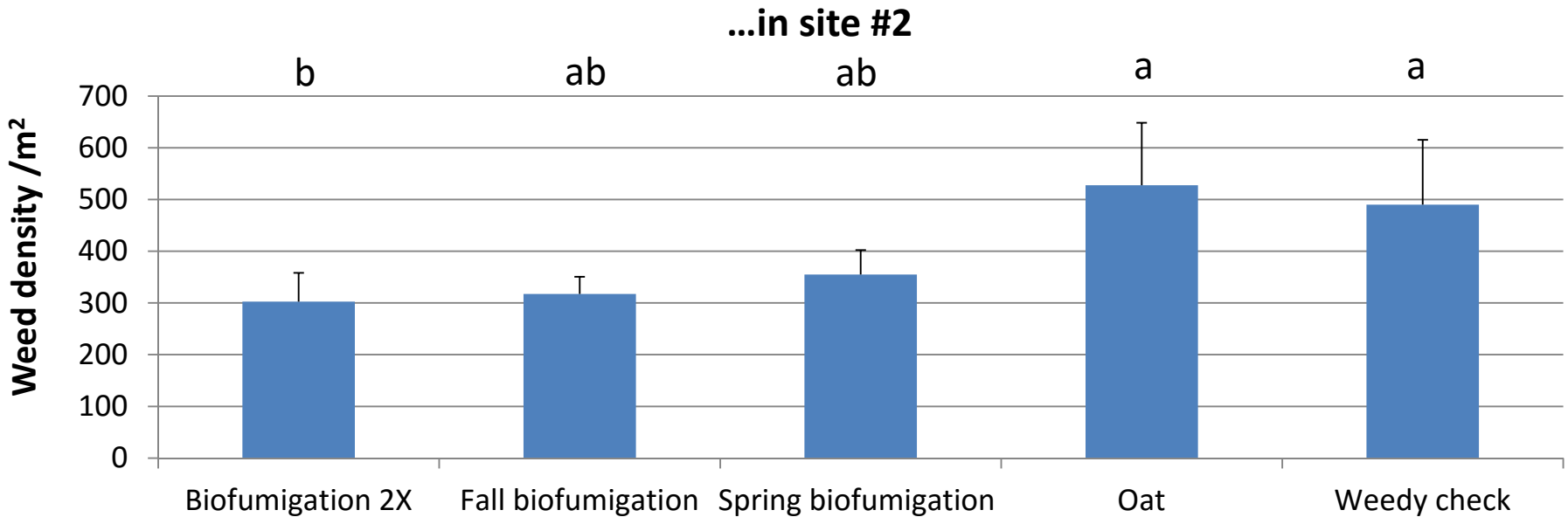




Anova by series of data and LSD test, P = 0.05

Results – Spring emergence 2016

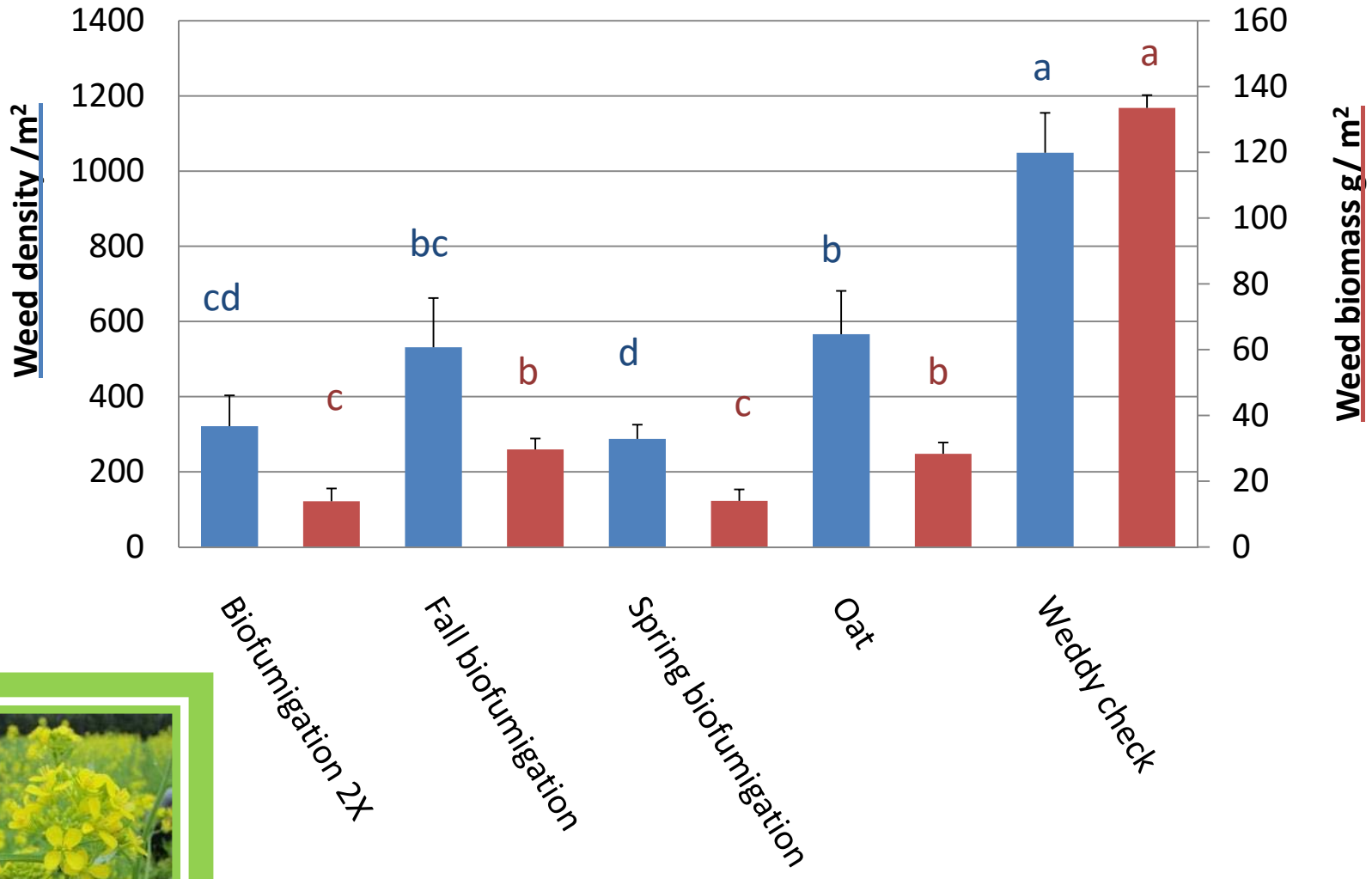




Anova by series of data and LSD test, P = 0.05

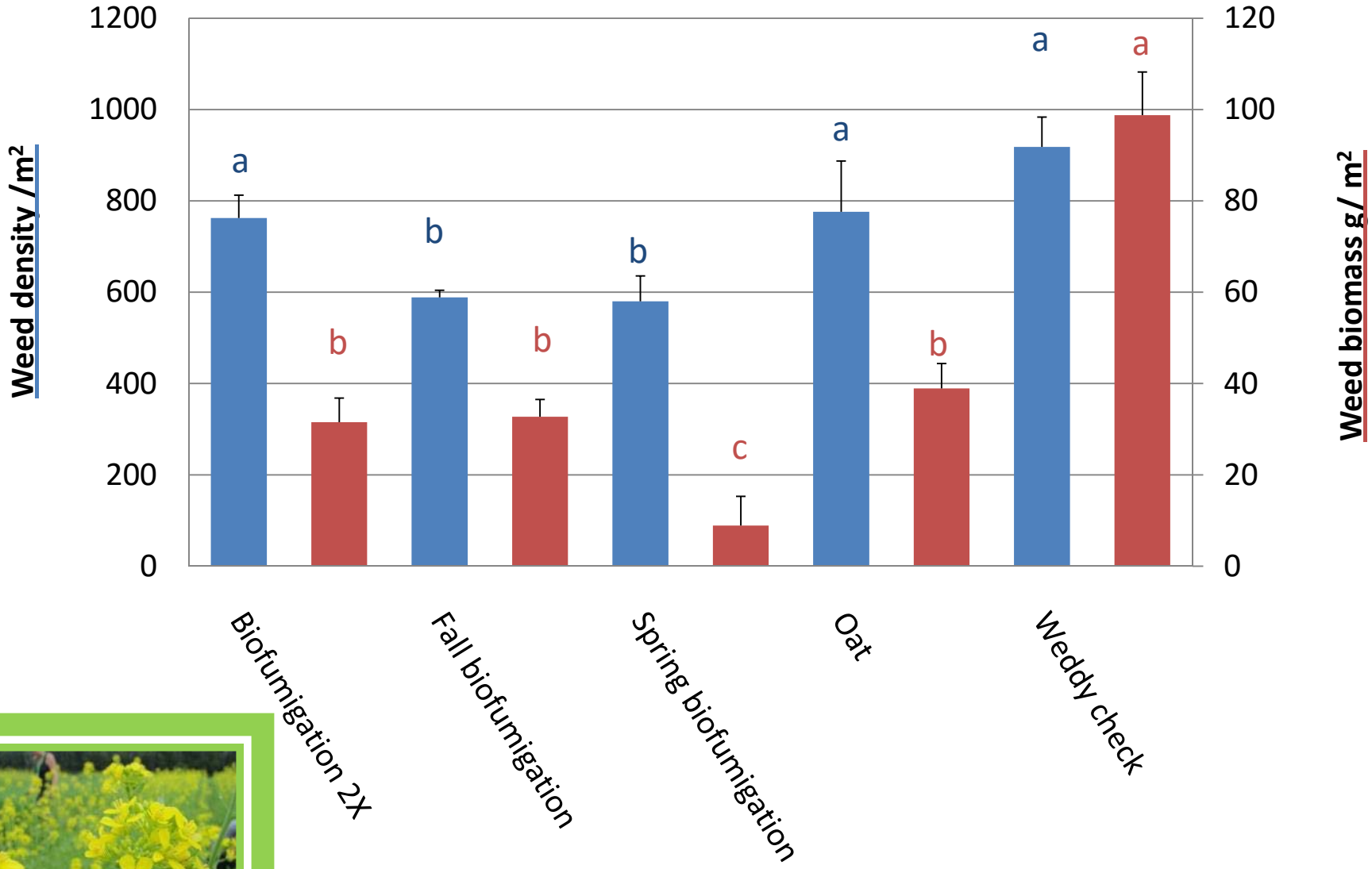
Results – During green manure growth

Weed abundance and biomass according to treatments in site #1 during green manure growth in spring 2015



Anova by series of data and LSD test, P = 0.05

Weed abundance and biomass according to treatments in site #2 during green manure growth in spring 2015



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Key messages

- Experiment 1:
  - Biofumigation acts on fitness, reproductive effort and seed production = leads to change in field population
- Experiment 2:
  - Sulfur!!!
  - Without biofumigant effect, competition similar to oat (2014)
  - Variability between sites (between species)
  - In 2015, greater impact on weed establishment and growth during green manure

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