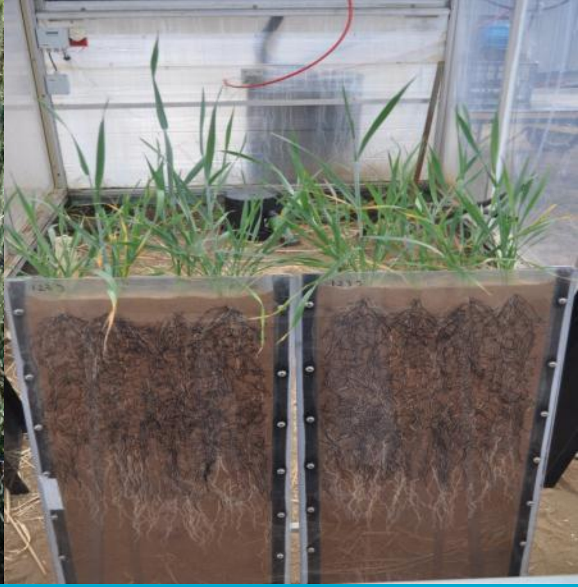

How to improve N uptake efficiency in wheat: vigorous root system versus root affinity for NO_3^-?

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Crop Science Workshop, Melbourne 21-22 May 2014

GRDC Grains Research & Development Corporation

Australian Government
Department of Agriculture, Fisheries and Forestry

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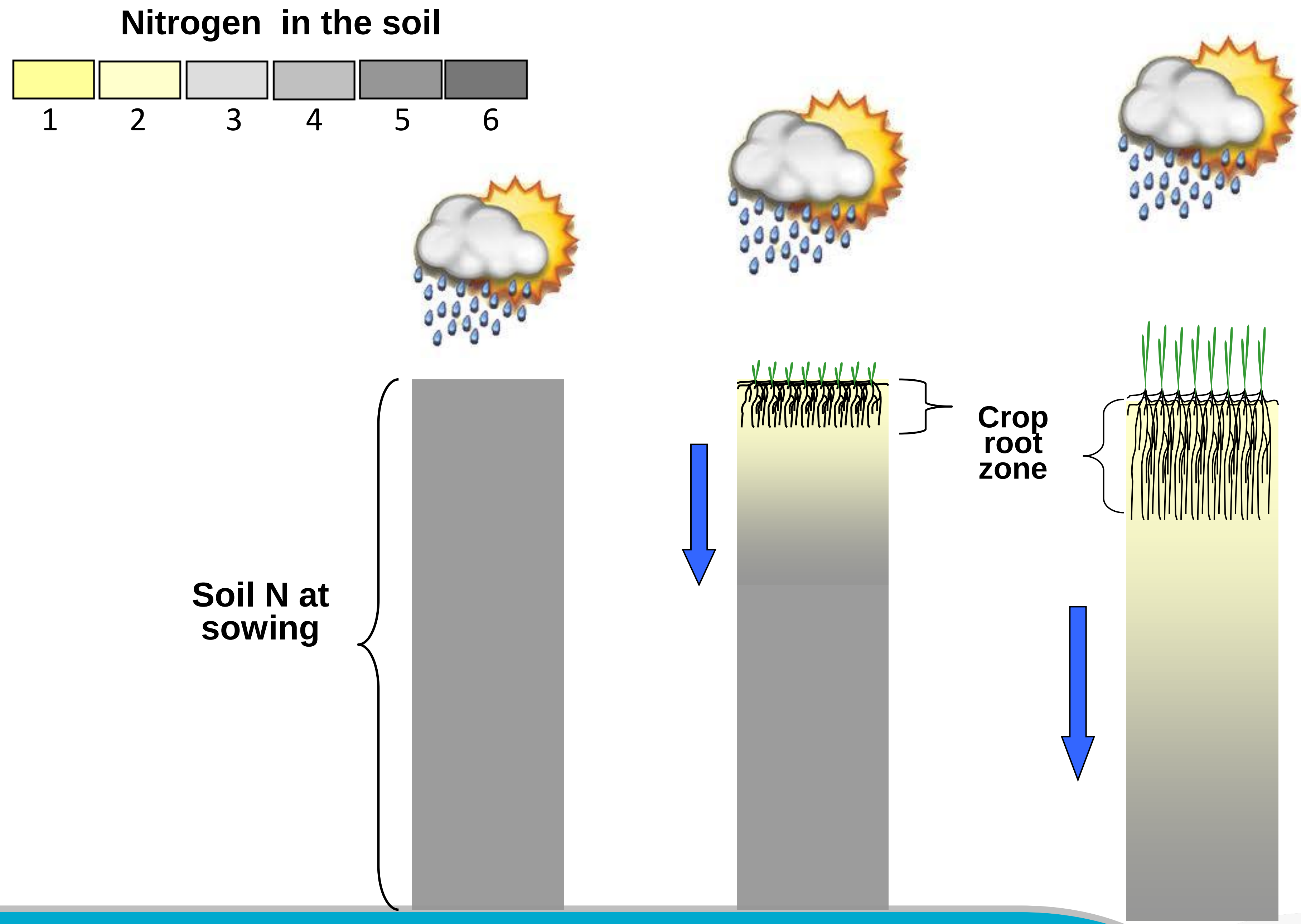
Background: challenges and opportunities

- Wheat crops in most of the agricultural regions of Australia are inefficient users of the N available in the soil profile at the break of the season as well as the N applied as fertilizer (McDonald 1989; Fillery & McIness 1992; Angus & Van Herwaarden 2001; Sadras & Angus 2006)

- Poor synchronization between the availability of NO_3^- in the soil profile and the demand for NO_3^- by the crop. (Angus 2001; Liao et al., 2004)

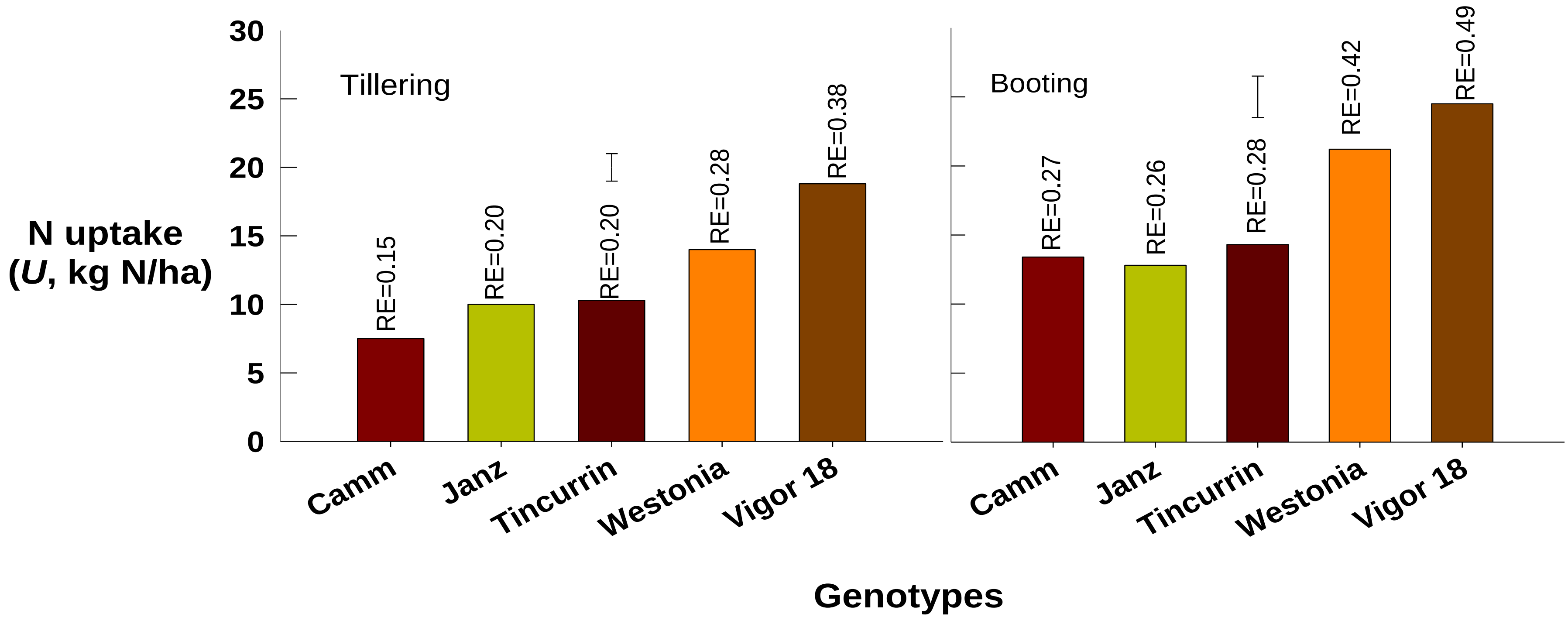

Nitrogen in the soil
1
2
3
4
5
6
Soil N at sowing
Crop root zone

Approaches to break the poor synchronization

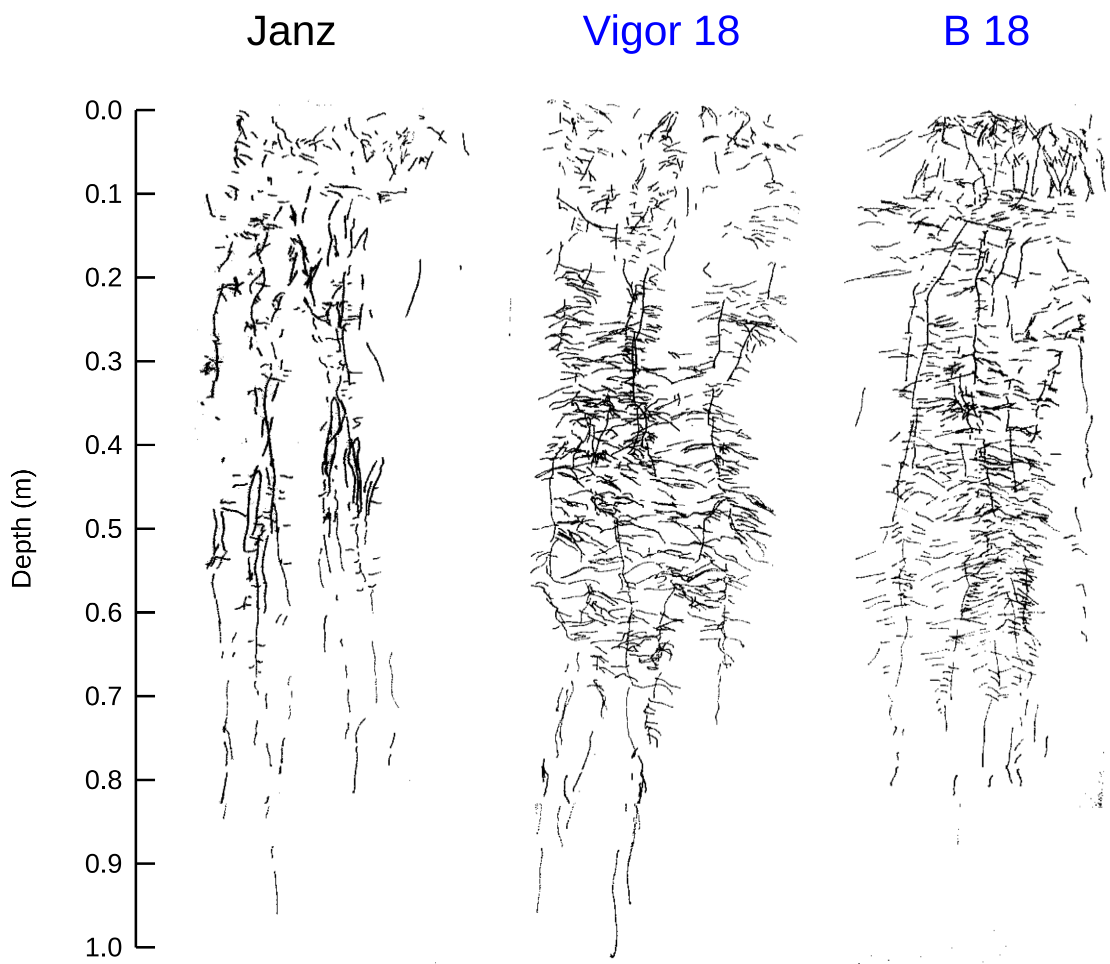
- Changing the time of supply of N fertiliser to match the availability of N in the soil with the demand by the crop (Di Tomaso 1995; Raun & Johnson 1999)

- Using genotypes with roots that grow faster and proliferate earlier to intercept and capture the $NO3^-$ before it moves below the rooting depth (Liao et al., 2004; 2006; Palta et al., 2007)

N-fertiliser uptake by wheat at tillering and booting stage



Non-vigorous and vigorous root systems in wheat

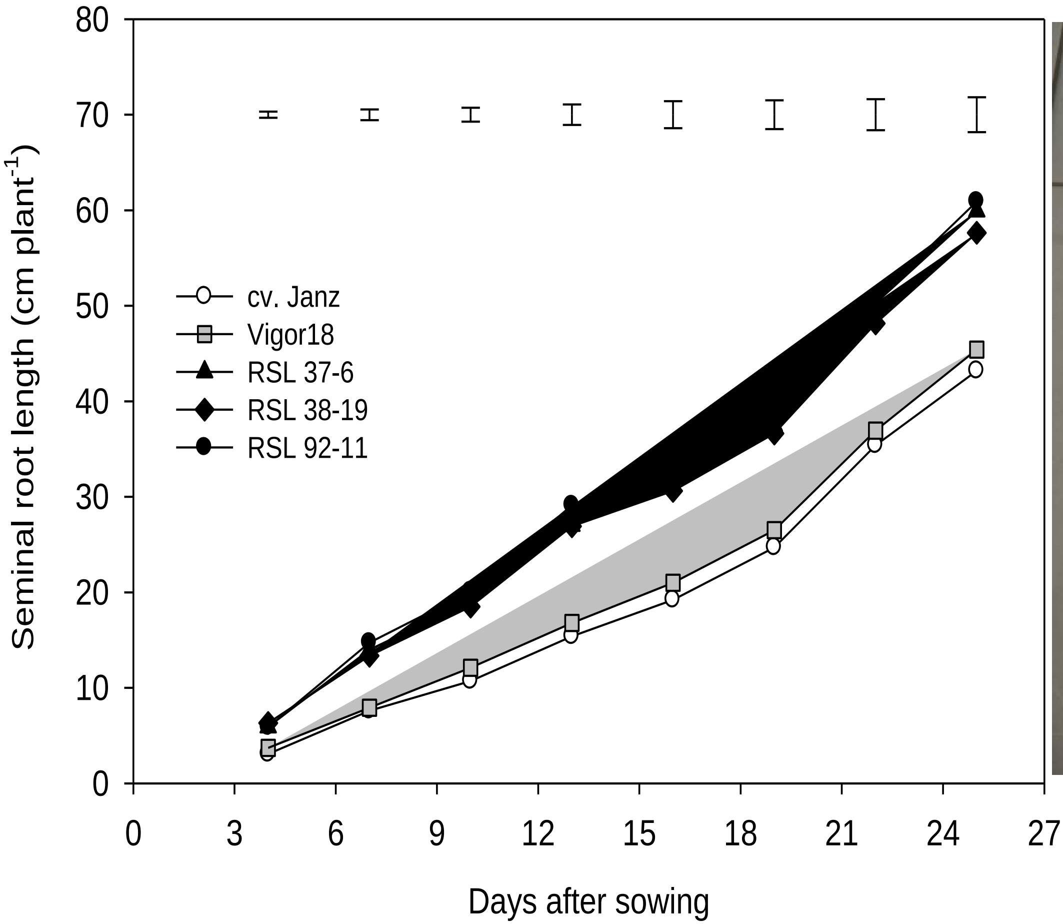


1.77 g N m^{-2} **2.52 g N m^{-2}** **2.81 g N m^{-2}**

38-45% more root biomass

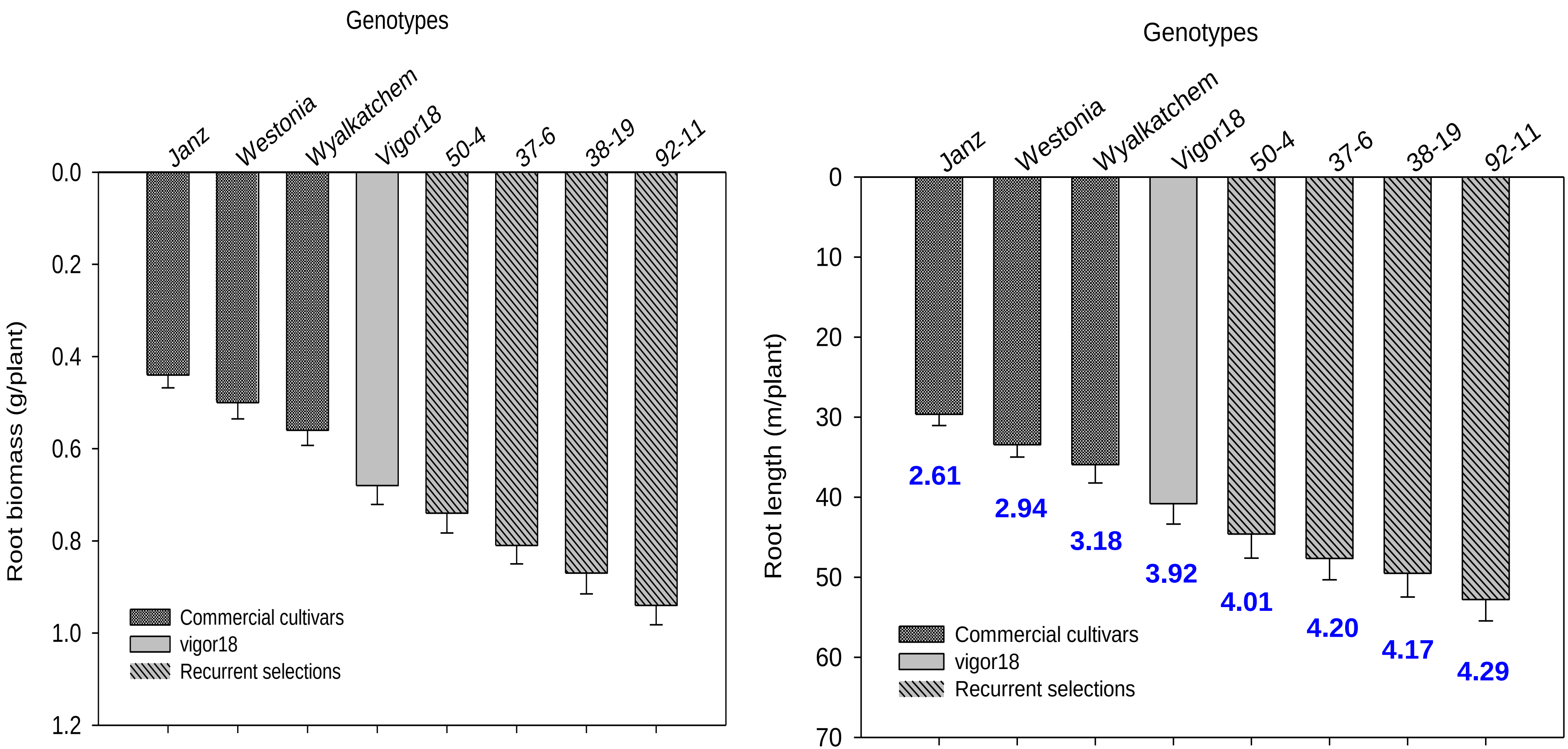
42-59% more N uptake

Differences in mean axis length of the seminal roots



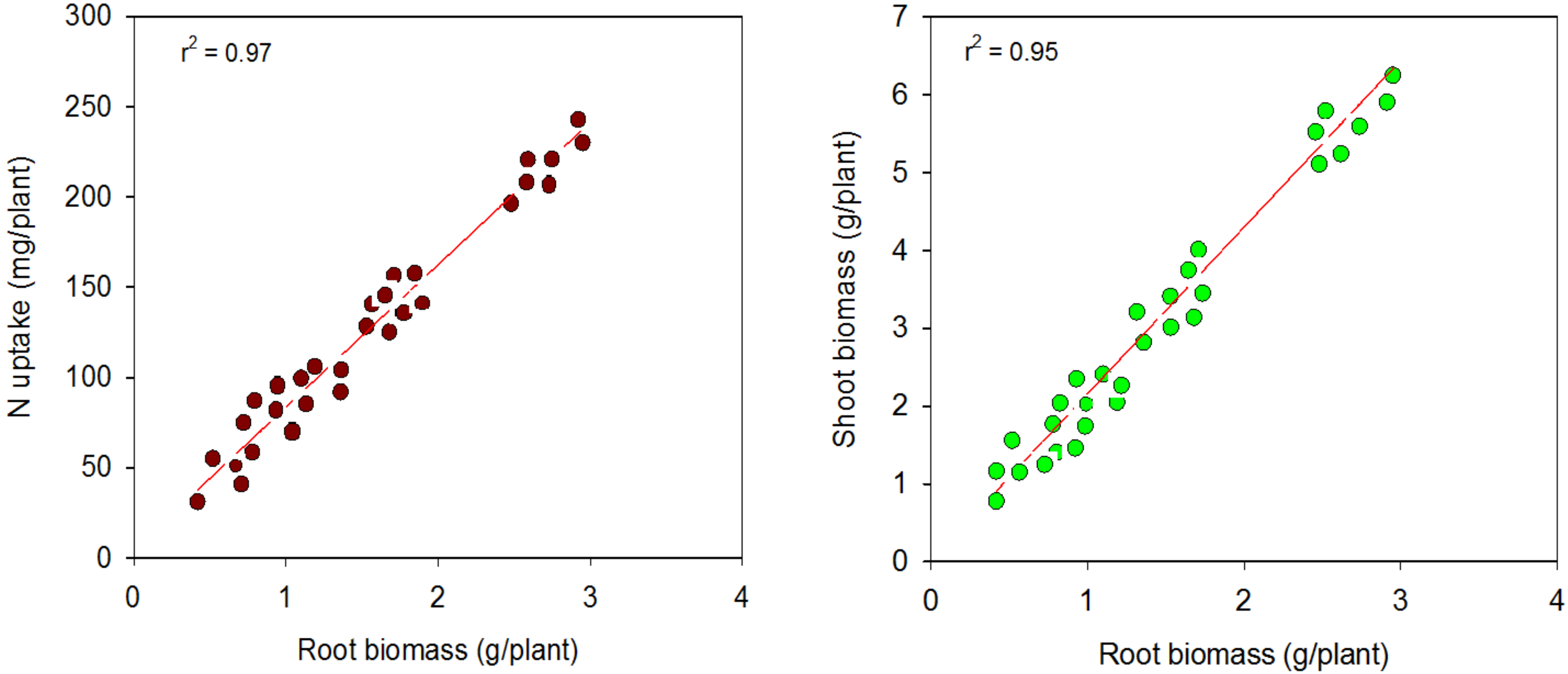
(Palta et al., 2011)

Differences in root biomass and total root length among wheat genotypes



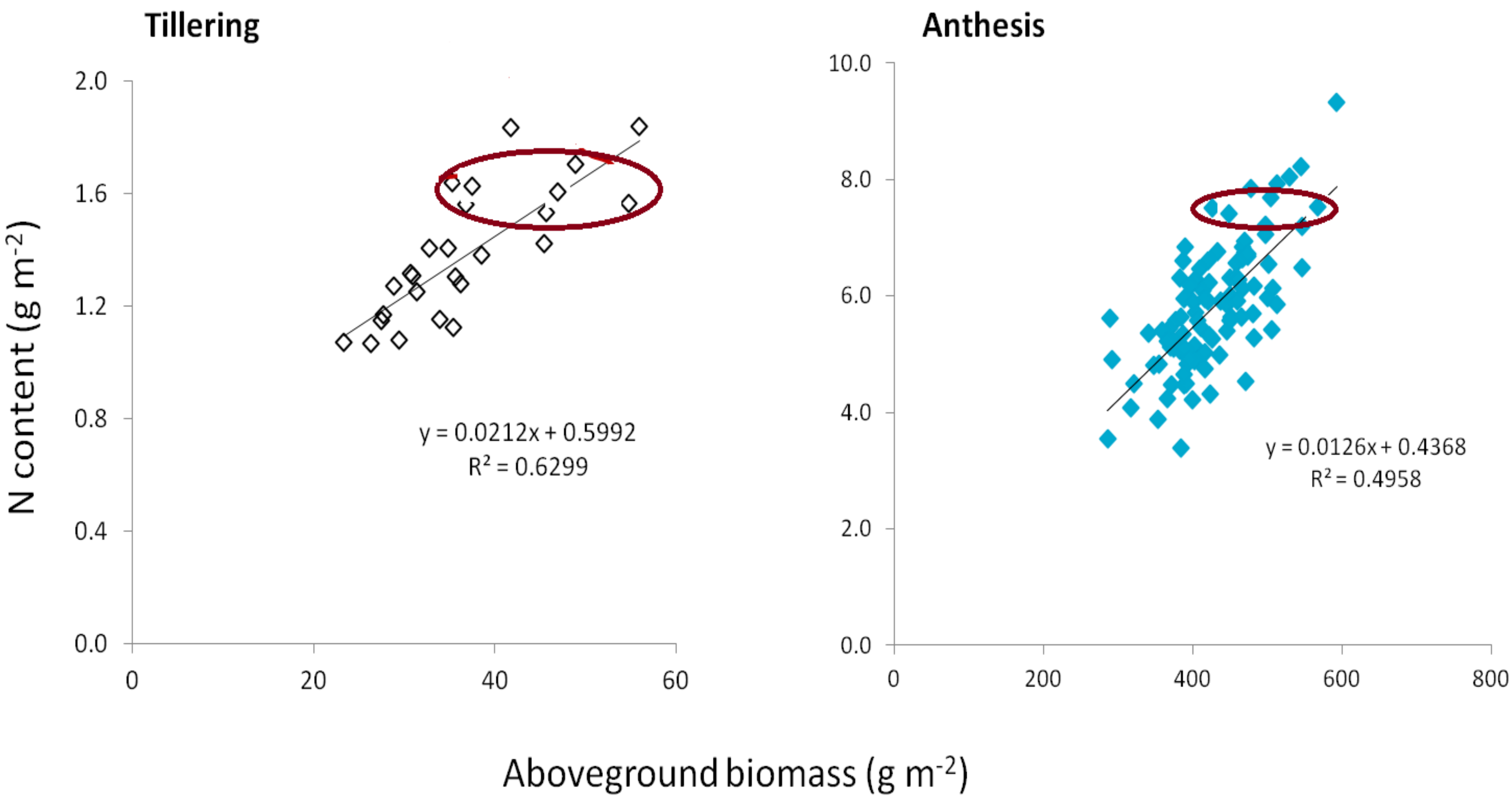
(Palta et al., 2011)

Characteristics correlated to N uptake



(Palta et al)

Relationship between N uptake and biomass in the field



(Palta et al)

Kinetics parameters for high-affinity NO_3^- transport system (HATS) in either non-induced or induced seedlings

Genotype	I_{max} (µmol g^{-1} root DW hr^{-1})		K_m (mM)	
	-N	+N	-N	+N
38-19	17.5 ± 0.6	70.4 ± 7.1	0.0171 ± 0.0021	0.0422 ± 0.0031
92-11	15.0 ± 0.7	70.4 ± 7.4	0.0237 ± 0.0022	0.0351 ± 0.0036
CV97	18.0 ± 2.1	71.3 ± 3.8	0.0094 ± 0.0011	0.0286 ± 0.0021
Janz	27.5 ± 2.1	86.1 ± 5.8	0.0102 ± 0.0010	0.0278 ± 0.0023
$LSD_{0.05}$	4.7	12.6	0.006	0.006

(Pang et al.,2014)

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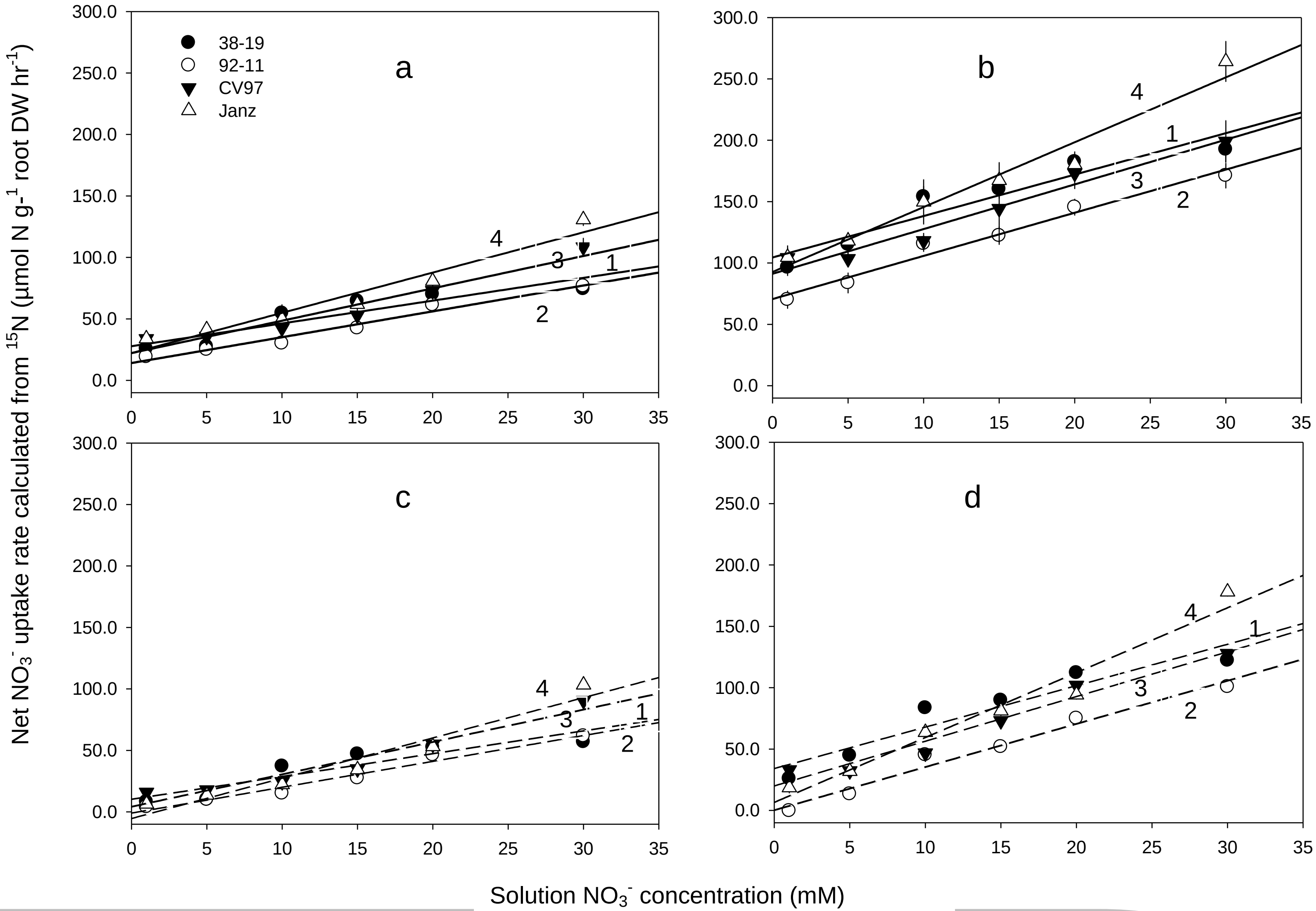
Low-affinity transporters (LATS)

Fig. 5



(Benlloch-Gonzalez et al.,2014)

How to improve N uptake efficiency in wheat: vigorous root system versus root affinity for NO_3^-?

- Seek genetic variation in root system affinity for NO_3^-
- Evaluate vigorous root systems versus root affinity systems in diverse soils for N uptake
- Evaluate the photosynthetic carbon costs of vigorous root systems versus root affinity systems.
- Evaluate the impact of future climates on vigorous root systems and root affinity systems.

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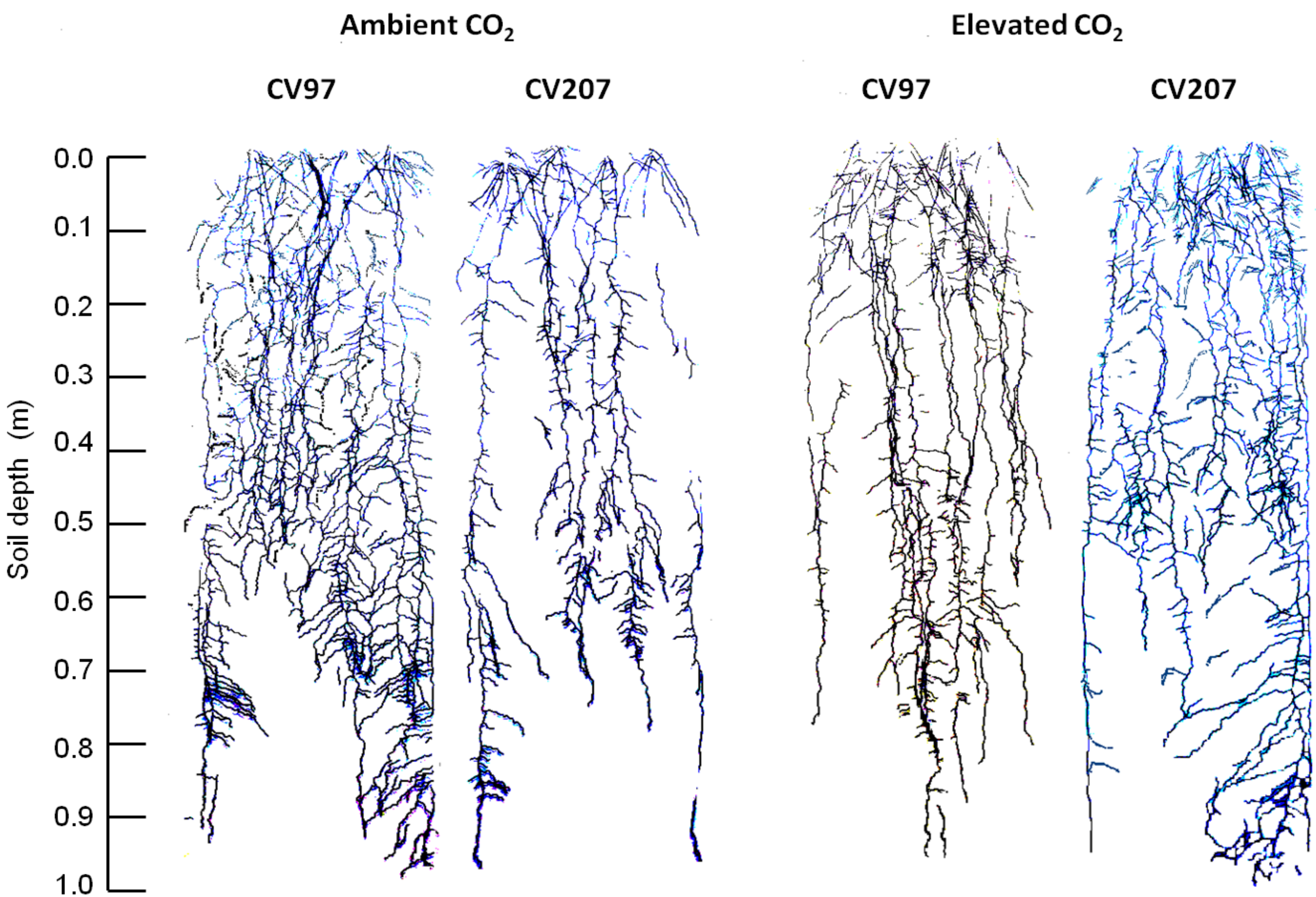
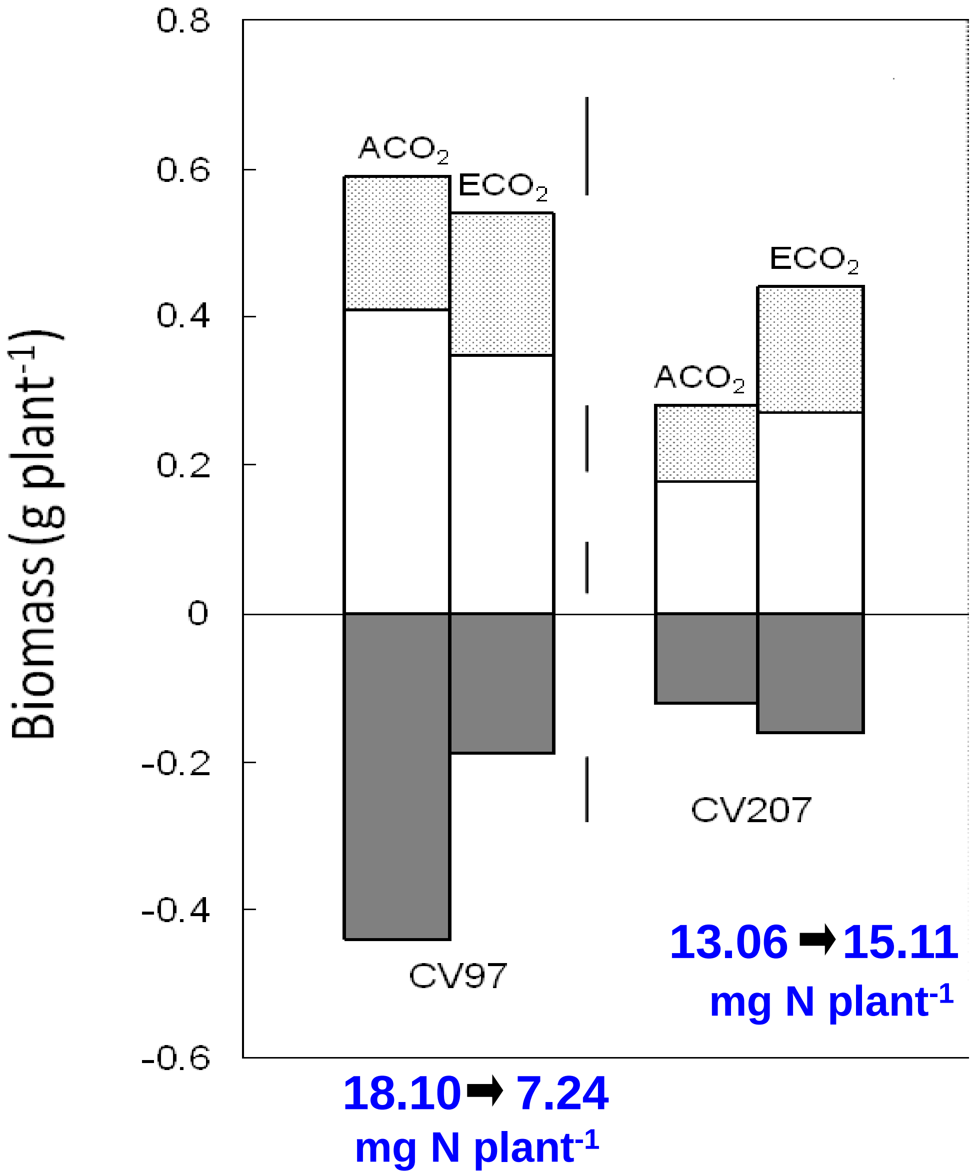
Rooting patterns of the vigour trait under elevated CO_2

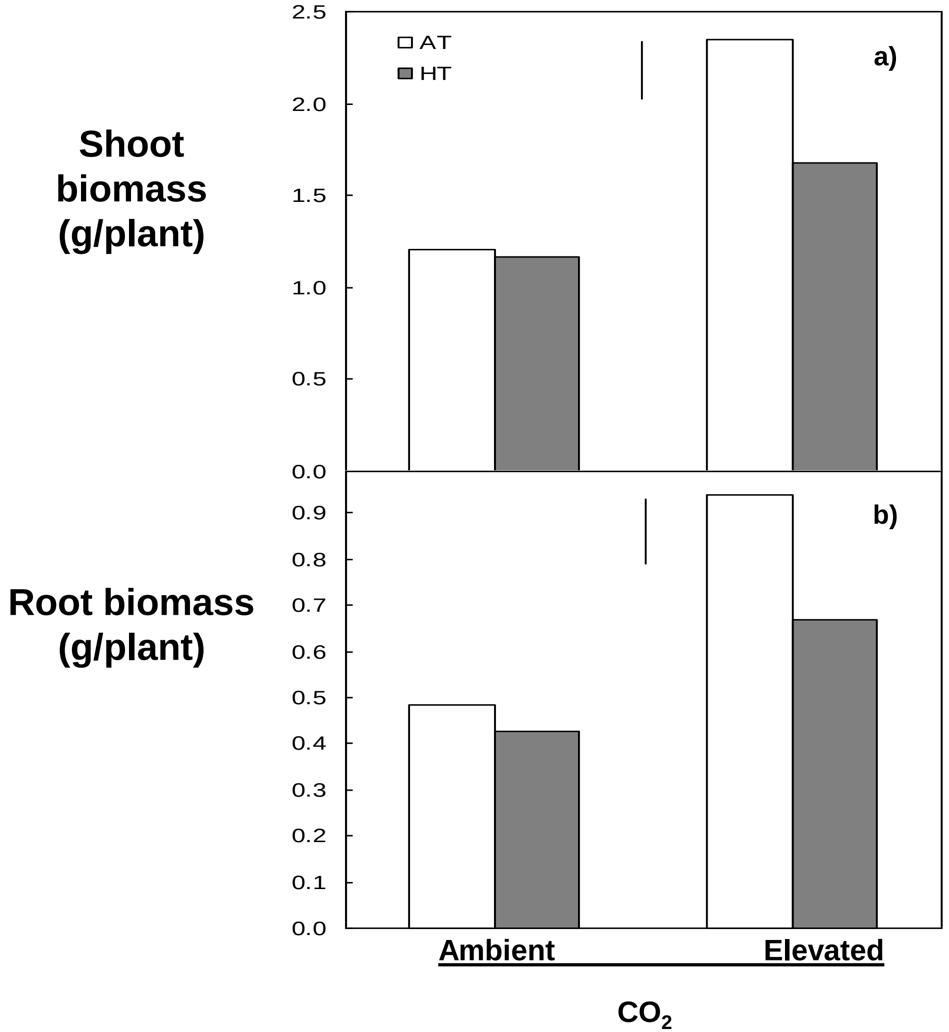


(Benlloch-Gonzalez et al.,2014)



(Benlloch-Gonzalez et al.,2014)

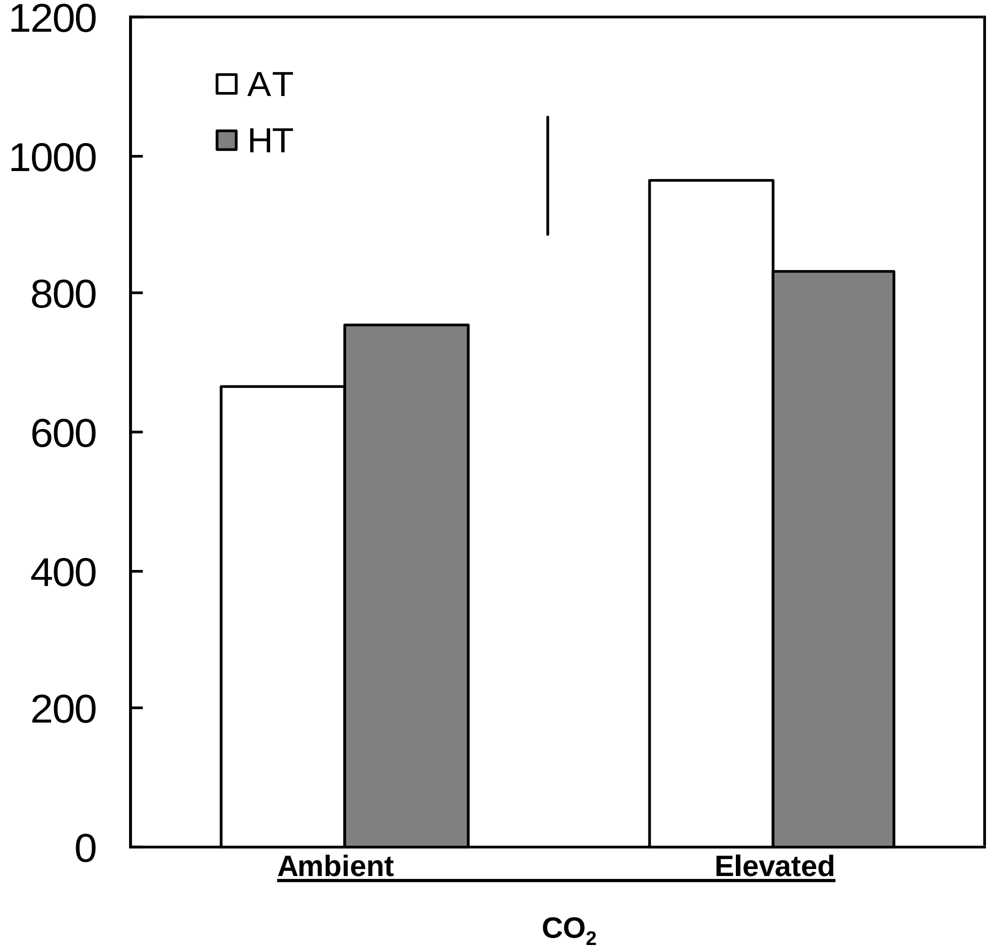
High temperature reduces the positive effect of elevated CO_2 on wheat root system growth



(Benlloch-Gonzalez et al.,2014)

High temperature reduces the positive effect of elevated CO_2 on wheat root system growth

Total root length (cm/plant)



(Benlloch-Gonzalez et al.,2014)

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Thank you