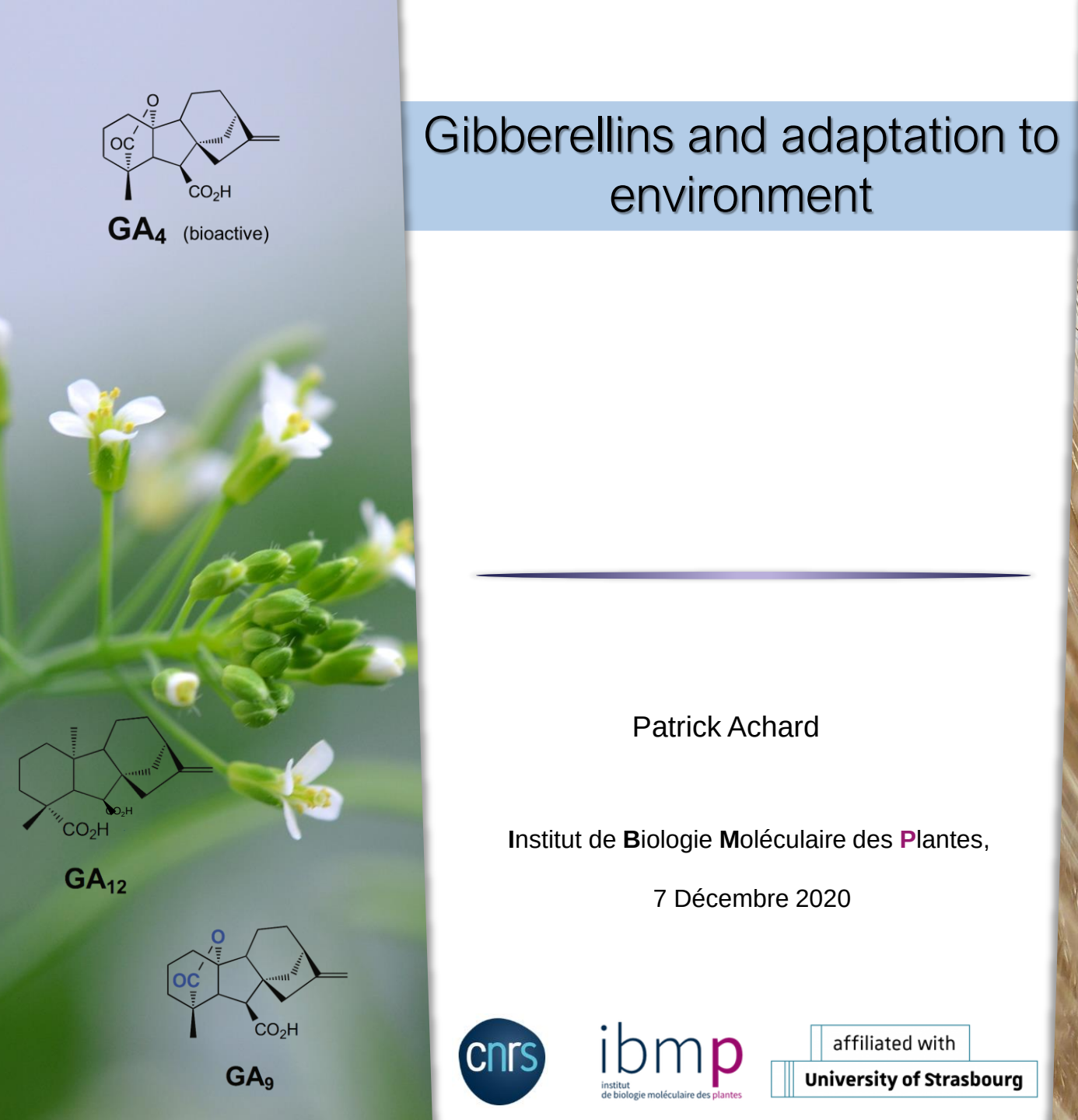
Gibberellins and adaptation to environment



Patrick Achard

Institut de **B**iologie **M**oléculaire des **P**lantes,

7 Décembre 2020

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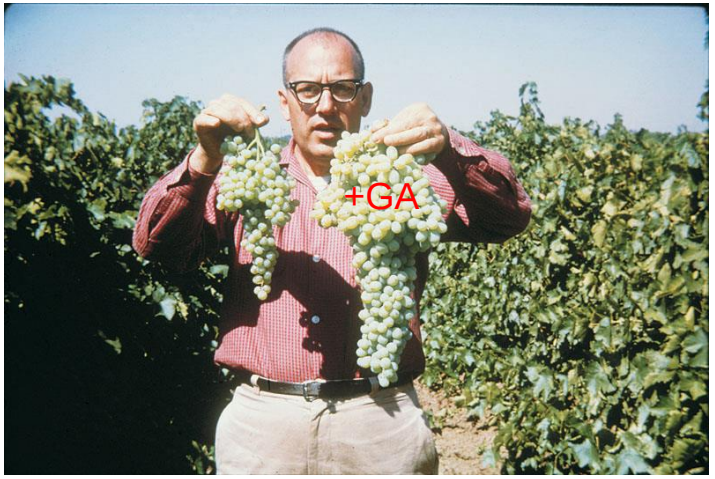
institut de biologie moléculaire des plantes

affiliated with
University of Strasbourg

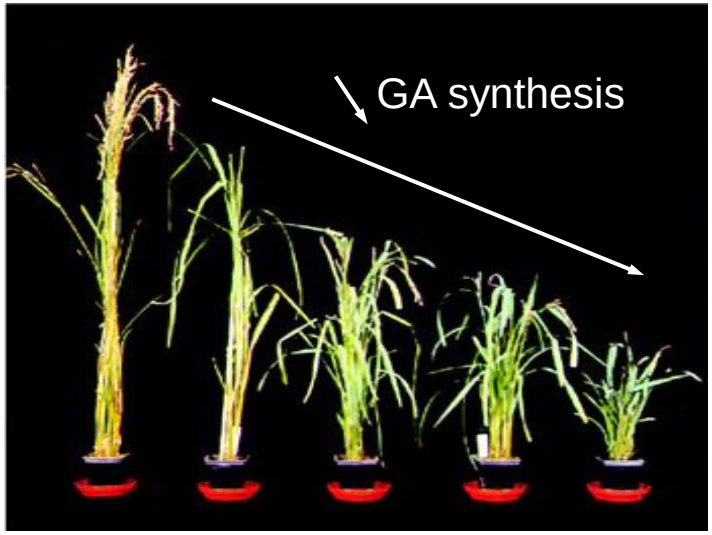
Gibberellins are plant growth hormones

© P. Achard (IBMP)

Tanimoto, An. Bot, vol110 (2012)



Adapted from Sponsel *et al*. Plant Physiol, chap 20 (2006)



Fu X. *et al*. Plant Cell v13 (2001)

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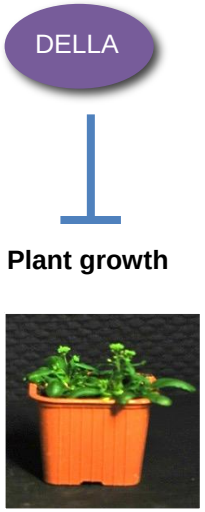
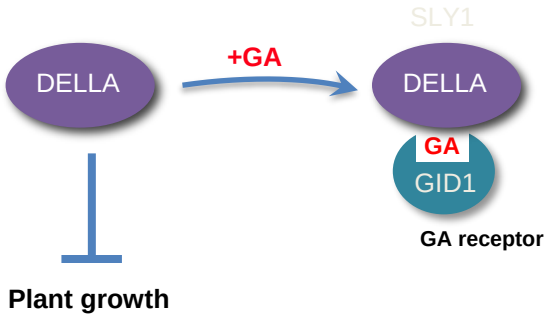
Transduction of the GA signal



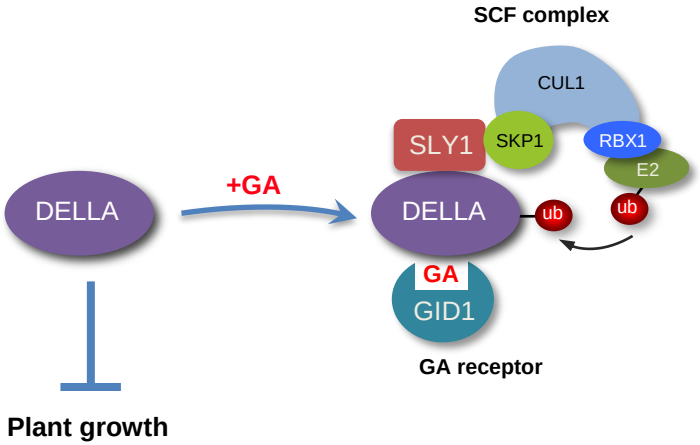
Davière and Achard, *Mol Plant* (2015)

Transduction of the GA signal



Davière and Achard, *Mol Plant* (2015)

Transduction of the GA signal



Davière and Achard, *Mol Plant* (2015)

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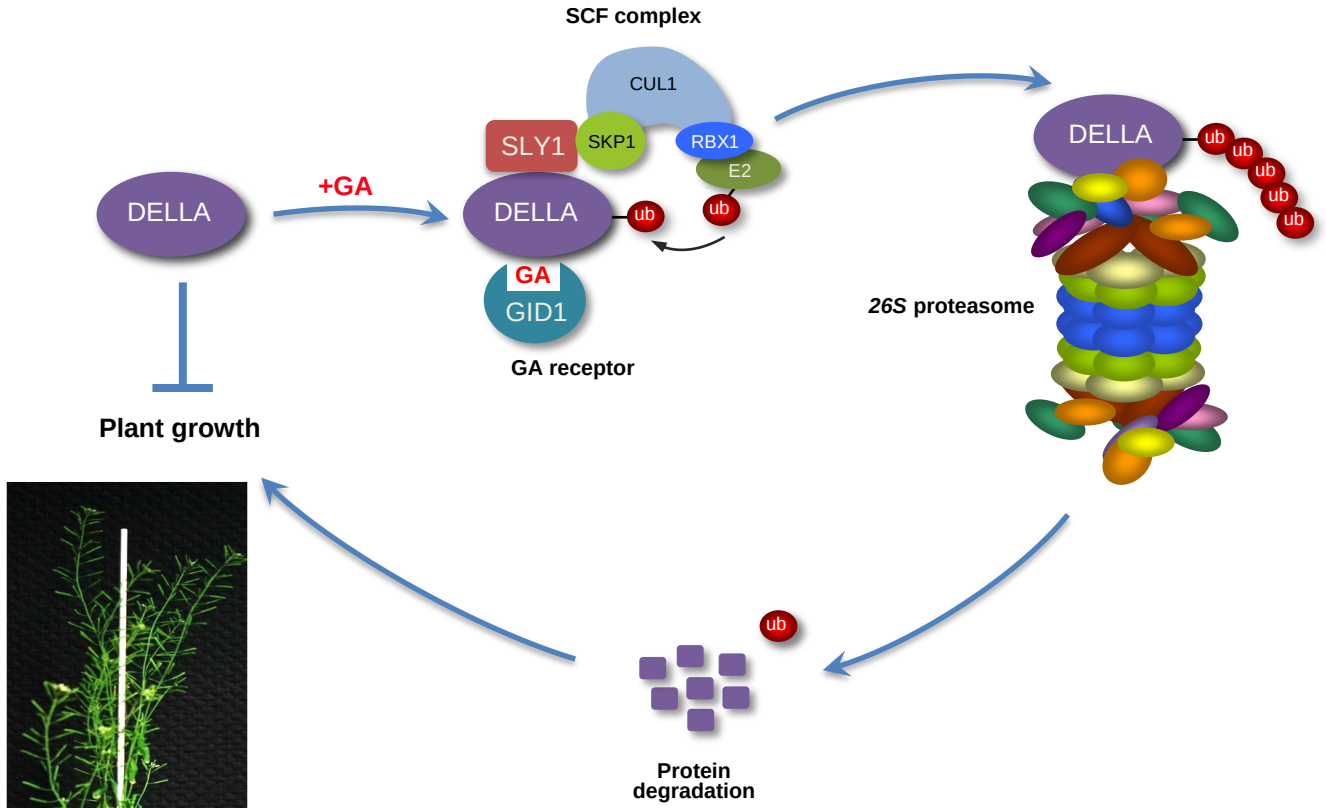

Davière and Achard, *Mol Plant* (2015)

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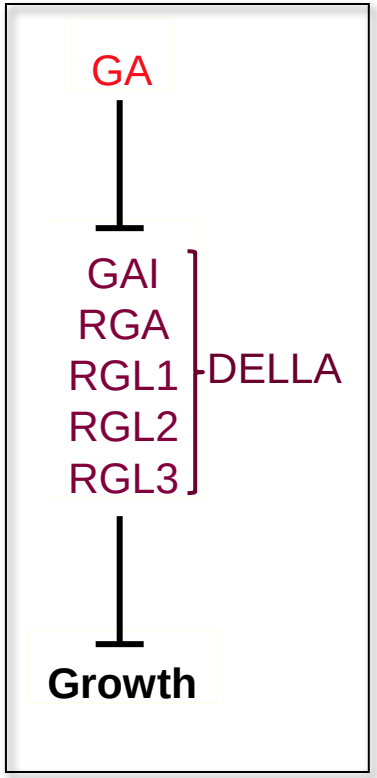
Gibberellins promote growth by overcoming DELLA-mediated growth restraint



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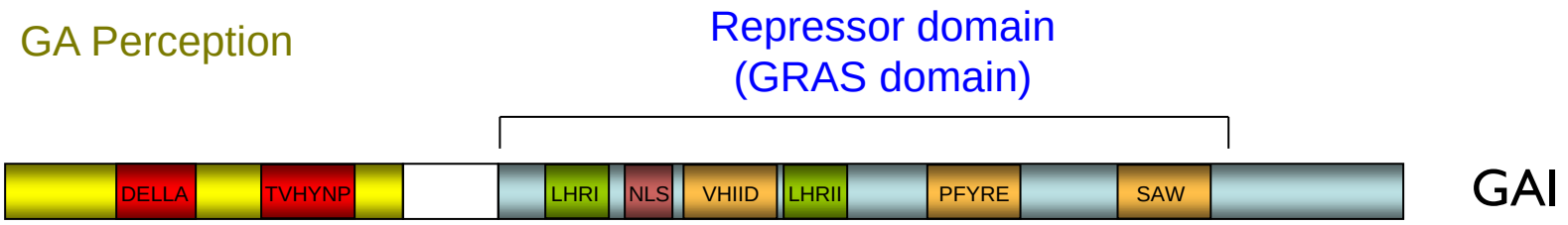
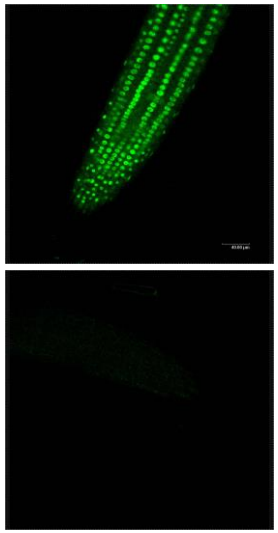
DELLAs belong to the GRAS family of transcriptional regulators



confocal microscopy

pGAI:GAI-GFP



+ GA

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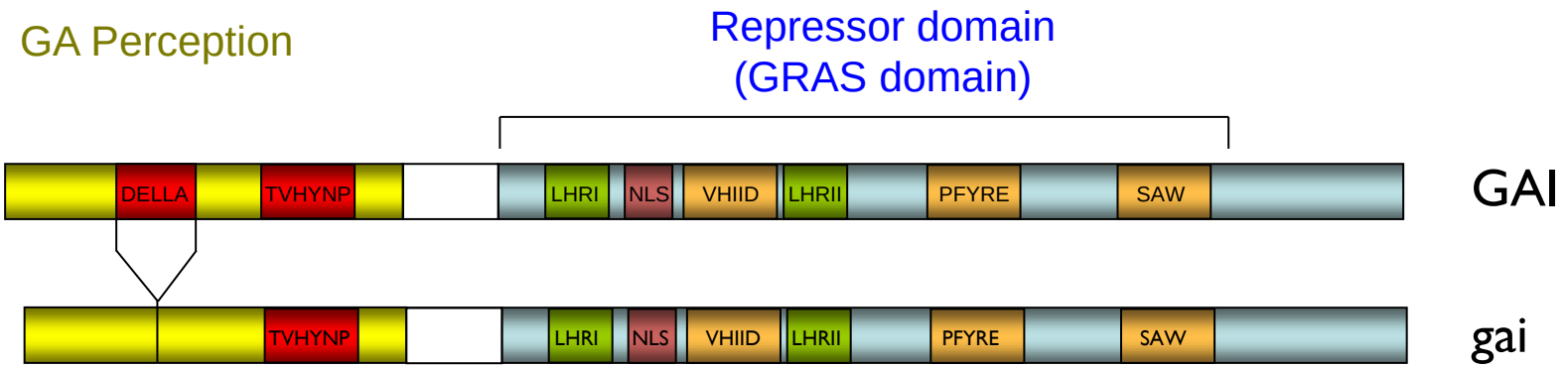
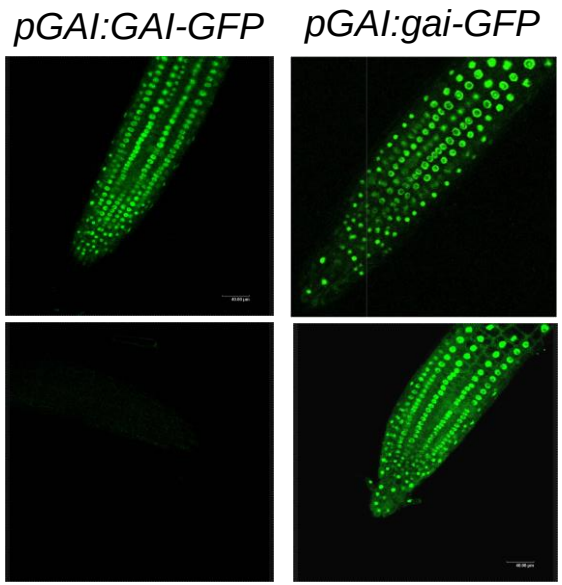
DELLAs belong to the GRAS family of transcriptional regulators



confocal microscopy



GA promotes the degradation of GAI-GFP but not of gai-GFP

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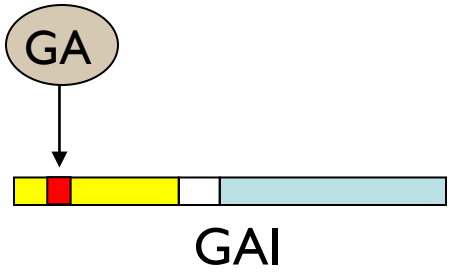
gai : GA-insensitive mutant



WT *gai*

The Green Revolution (1960s)


www.oneaction.ch


© G. Camut

www.cimmyt.com


www.lgseeds.fr

increased crop yields **<u>but also</u>** plant height


www.comptoir-agricole.fr

Increased risk of lodging (height and heavy ears)

Need to reduce height and increase stem stiffness


© CIMMYT

N. Borlaug

Rht1/2 mutant alleles

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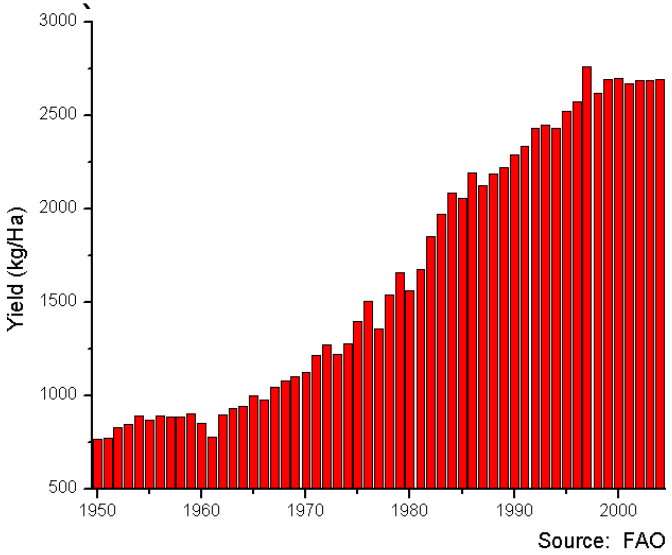

Need to reduce height and increase stem stiffness

Rht1/2 mutant alleles

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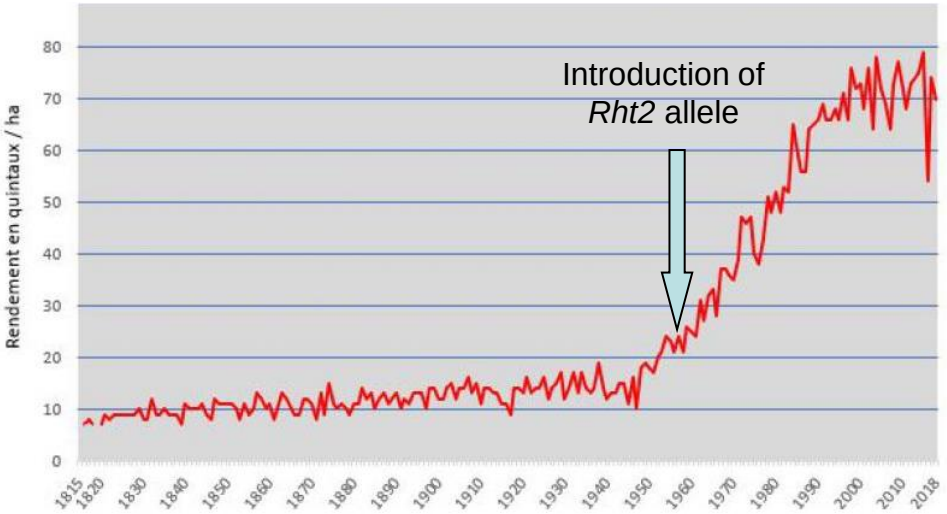
The Green Revolution in Europe

Rht2 wheat (F. Lupton, 1964)

© Plant breeding institute, Cambridge

Annual wheat yield in France



www.academie-agriculture.fr

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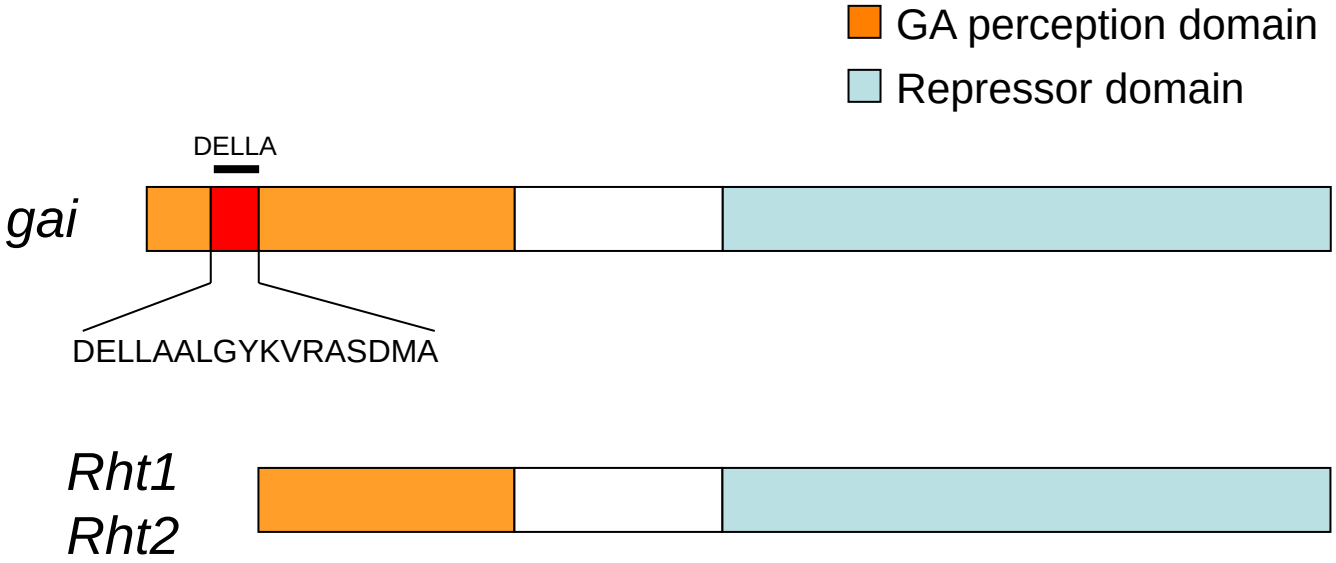
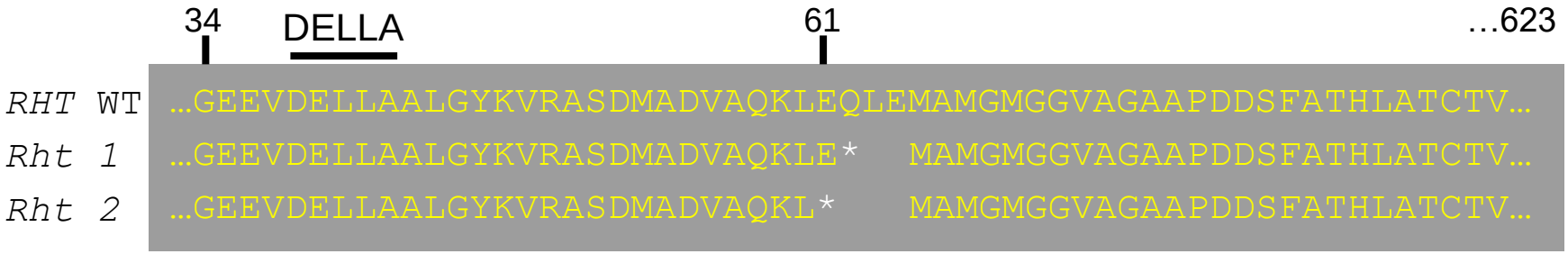
wheat *Rht1*, *Rht2* = *Arabidopsis gai*



Pearce *et al.*, *Plant Phys* (2011)



Peng J. *et al. Nature* (1999)

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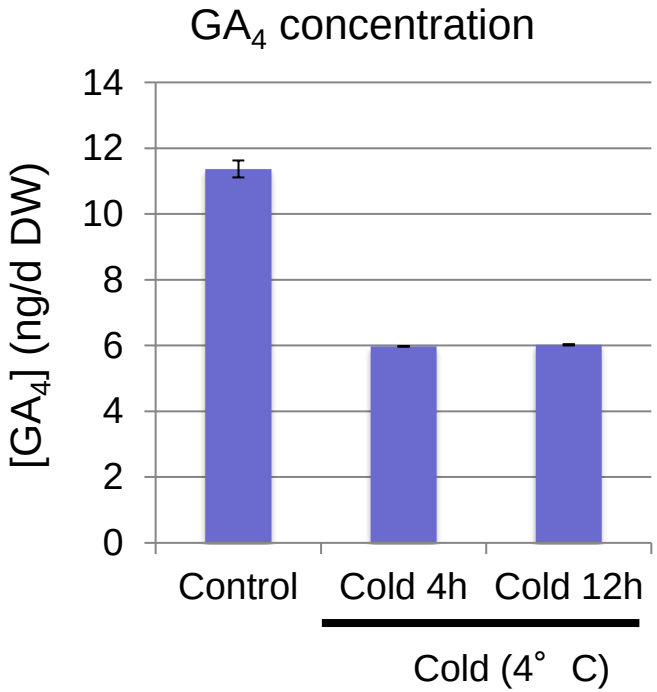
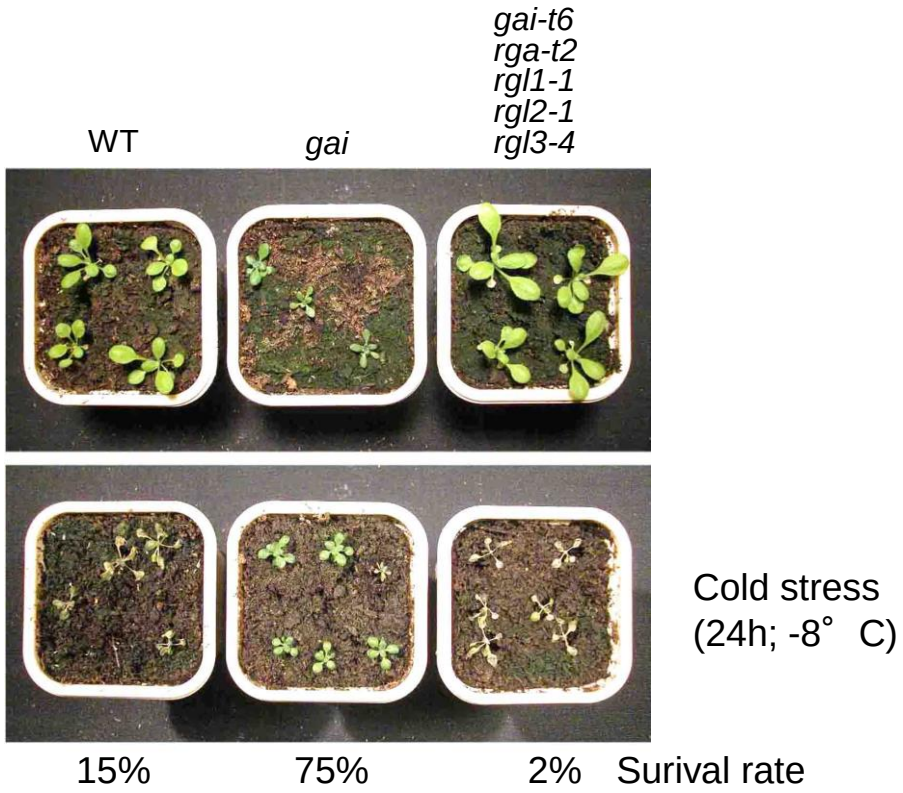
Growth-defense trade-off

Plant growth occurs when environmental resource availability is suitable, in the absence of which, growth must cease to prioritize defense systems.

DELLA function enhances stress resistance





Achard P. *et al. Plant Cell* (2008)

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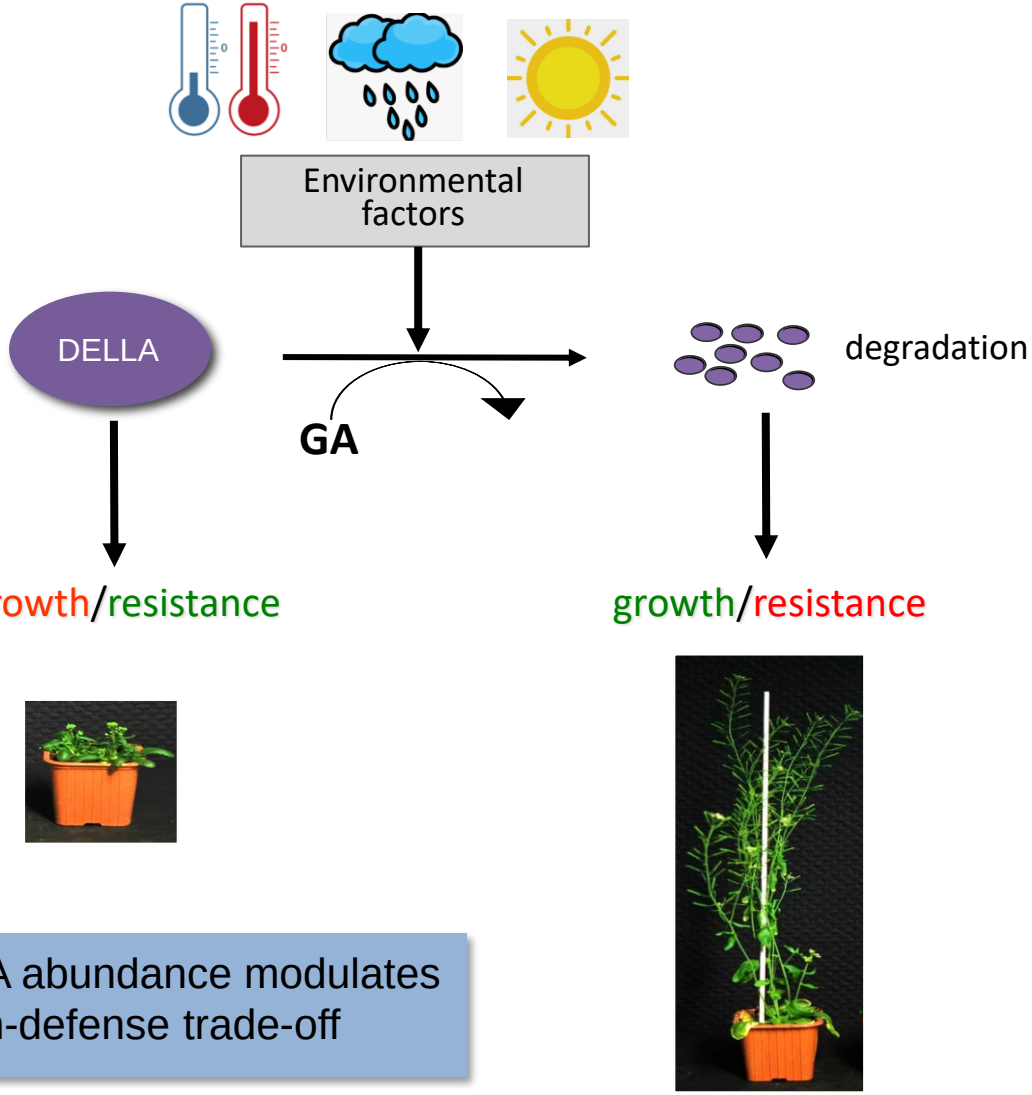
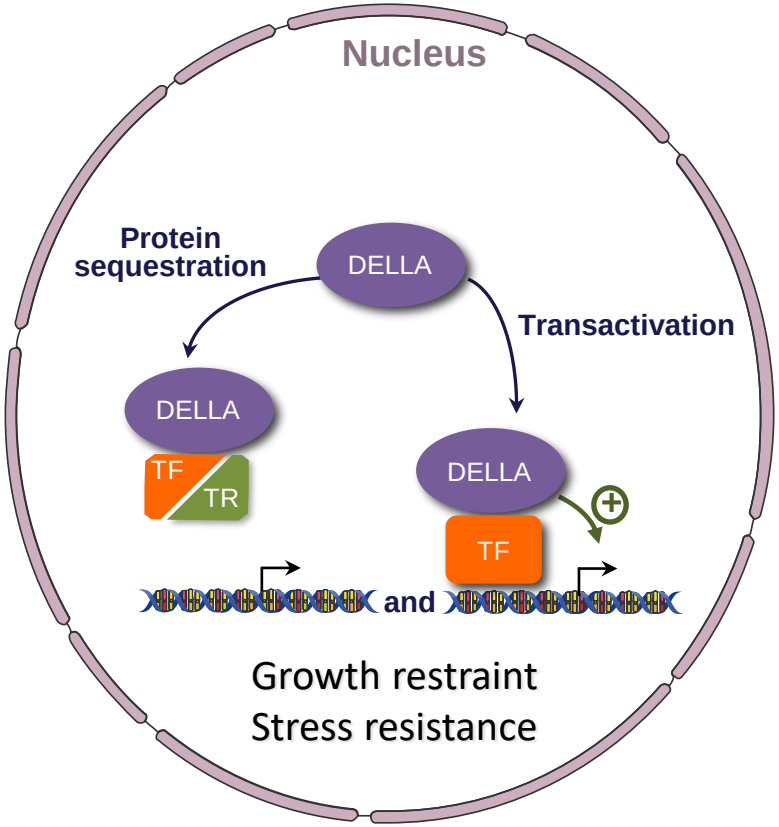
DELLAs: integrators of environmental cues



DELLA abundance modulates growth-defense trade-off

Molecular modes of action of DELLA repressors



TF: transcription factor
TR: transcriptional regulator

Table 1. DELLA-Interacting Proteins (DIPs)[a] Control a Variety of DELLA-Regulated Growth Responses

Mechanism[b]	DIP	Full name	DELLA-related growth response
Transactivation with TF	ABI3 and 5	ABSCISIC ACID INSENSITIVE 3 and 5	Seed germination
	ARR1	ARABIDOPSIS RESPONSE REGULATOR 1	Root meristem size and de-etiolation
	IDD2/GAF1	INDETERMINATE DOMAIN 2/GAI-ASSOCIATED FACTOR 1	Germination and elongation
	IDD3, 4, 5, 9 and IDD10/JKD	INDETERMINATE DOMAIN 3, 4, 5, 9, and 10/JACKDAW	Unknown
	NF-YA1[c]	NUCLEAR FACTOR YA 1	Rhizobial infection and flowering
	NSP2[c]	NODULATION SIGNALLING PATHWAY 2	Rhizobial infection
Transactivation with TR	BOIs	BOTRYTIS SUSCEPTIBLE 1 INTERACTORs	Seed germination, juvenile to adult transition, flowering
Transactivation and TR sequestration	SPL9	SQUAMOSA PROMOTER BINDING PROTEIN-LIKE 9	Flowering
TF sequestration	ALC	ALCATRAZ	Fruit patterning
	ARF6	AUXIN RESPONSE FACTOR 6	Hypocotyl elongation
	BES1	BRI1-EMS-SUPPRESSOR 1	Hypocotyl elongation
	bHLH 38 and 39	BASIC HELIX LOOP HELIX PROTEIN 38 and 39	Root iron uptake
	BZR1	BRASSINAZOLE-RESISTANT 1	Hypocotyl elongation
	CO	CONSTANS	Flowering
	EGL3	ENHANCER OF GLABRA 3	Trichome development
	EIN3	ETHYLENE INSENSITIVE 3	Apical hook development
	FIT	FER-LIKE IRON-DEFICIENCY INDUCED TRANSCRIPTION FACTOR	Root iron uptake
	GL1 and 3	GLABRA 1 and 3	Trichome development
	ML1	MERISTEM LAYER 1	Seed germination
	MYC2	–	Production of flower volatiles
	NF-YC9	NUCLEAR FACTOR YC 9	Seed germination and flowering
	PDF2	PROTODERMAL FACTOR 2	Seed germination
	PIF3	PHYTOCHROME INTERACTING FACTOR 3	Hypocotyl elongation
	PIF4	PHYTOCHROME INTERACTING FACTOR 4	Hypocotyl elongation
	PIF5	PHYTOCHROME INTERACTING FACTOR 5	Apical hook development
	RAP2.3	RELATED TO APETALA 2.3	Apical hook development
	SPL15	SQUAMOSA PROMOTER BINDING PROTEIN-LIKE 15	Flowering
	SCL27	SCARECROW-LIKE 27	Skotomorphogenesis
	SCL3	SCARECROW-LIKE 3	Seed germination, hypocotyl and root elongation
	TCP14	TEOSINTE BRANCHED 1 (TB1), CYCLOIDEA (CYC), PROLIFERATING CELL FACTOR (PCF) 14	Stem elongation, cell division in apical meristem (root and shoot)
CRC sequestration	PKL	PICKLE	Skotomorophogenesis
Co-chaperone sequestration	PFD5	PREFOLDIN 5	Microtubule organization
TR sequestration	BBX24	B-BOX ZINC FINGER PROTEIN 24	Shade avoidance
	D14[c]	DWARF 14	Tillering
	JAZ1	JA ZIM-domain 1	Root growth
	JAZ9	JA ZIM-domain 9	Defense and growth

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Van De Velde *et al*. *Trends Plant Sci*. (2017)

Future perspectives

- Dynamics of DELLA-interacting partners association
- Uncouple DELLA-mediated control of plant growth and stress resistance
- Distribution patterns of gibberellins in plants: GA movement and localization

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