

Modifying Wheat Architecture for Improved Traits



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Generating Novel *Rht-1* Dwarfing Alleles



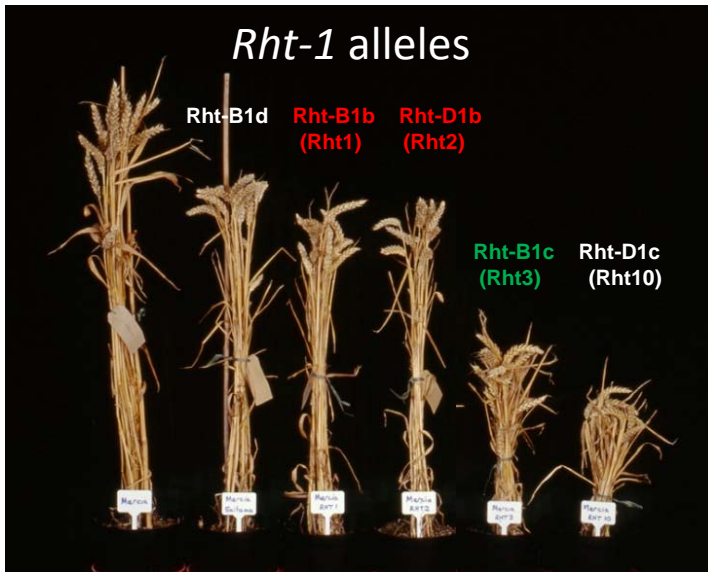
Steve Thomas
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Wheat *Reduced height-1 (Rht-1)* Dwarfing Genes

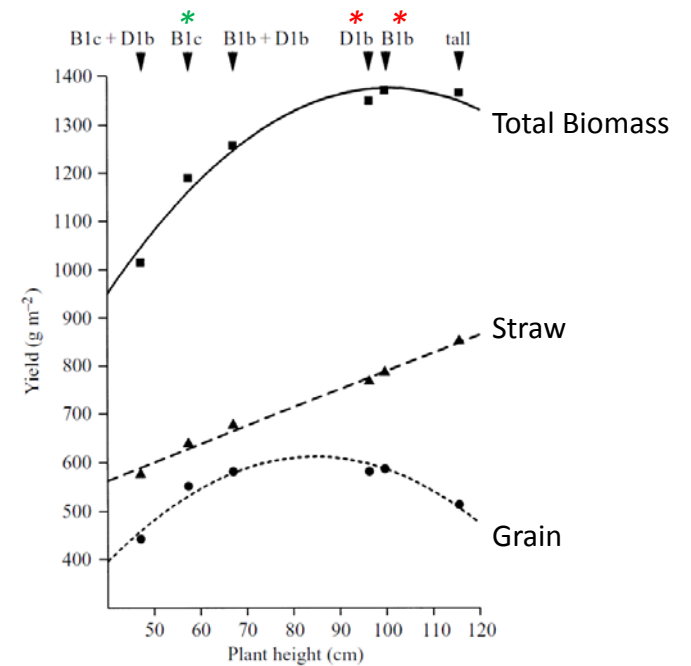


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Peng *et al.* 1999 and Pearce *et al.* 2011

***Rht-1* alleles increase the harvest index**



Flintham *et al.* 1997

...and protect against lodging



Adverse Pleiotropic Effects are Associated with *Rht-1* Dwarfing Alleles



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Rht-1 semi-dwarfing alleles reduce stem elongation and increase grain yield



Adverse pleiotropic effects....

Reduced grain size



Rht-1 *Rht-B1c*
Flintham *et al.*, 1997

Reduced seedling vigour



Rht-1 *Rht-D1b*
Ellis *et al.*, 2004

Reduced PHS resistance



Van De Velde *et al.*, 2017,

Fertility defects

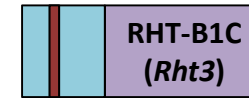
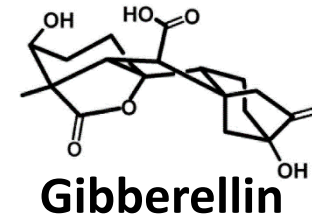
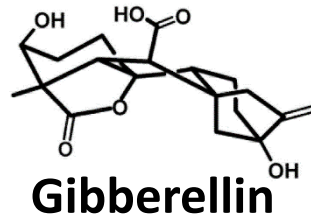


Rht-1 *Rht-D1b*

Rht-1 Dwarfing Genes Block GA-Responsive Growth



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GA responses

GA responses

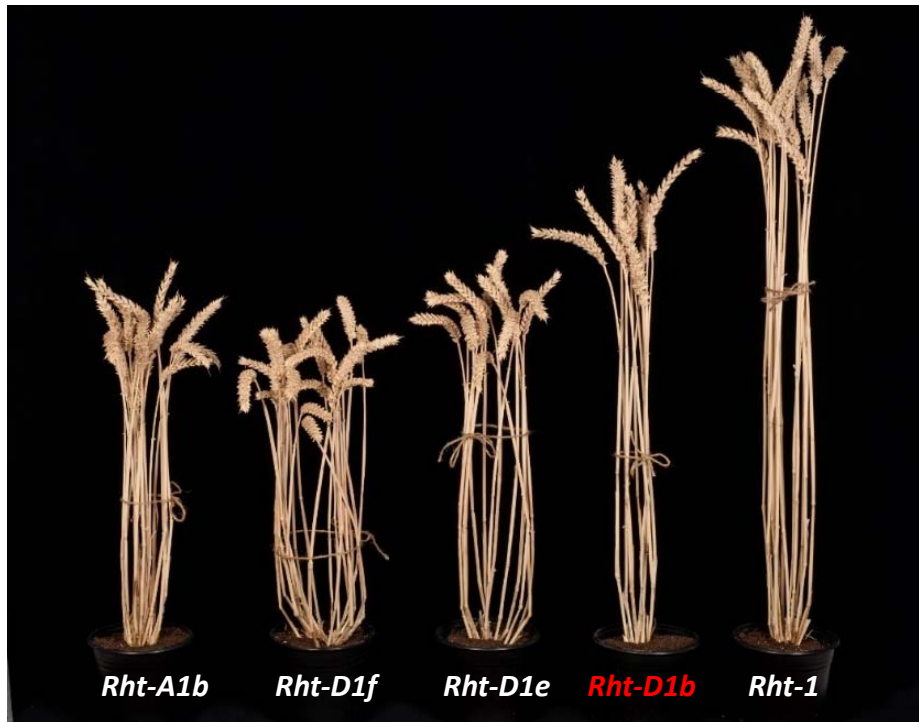
GA responses



Novel *Rht-1* Alleles Identified by TILLING



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Assessment of Novel Wheat Dwarfing Alleles for Effects on Height, Yield and Other Traits



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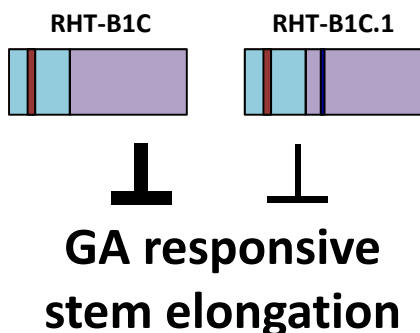


Extending our Range of *Rht-1* Alleles.



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Rht-B1c suppressor screen



Intragenic *Rht-B1c* Suppressor mutations



Chandler and Harding (2013)

Perform suppressor screen using our *Rht-A1* and *D1* Alleles



Cad Rht-D1e Rht-A1b Rht-D1f

Rht-A1b and *Rht-D1f* Suppressor Screen (2017)



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Rht-D1f Suppressor Screen (2017)

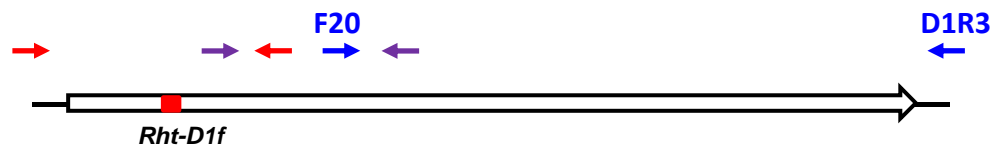


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212 *Rht-D1f* M2 plants were analysed

Identification of Intragenic *Rht-D1* mutations

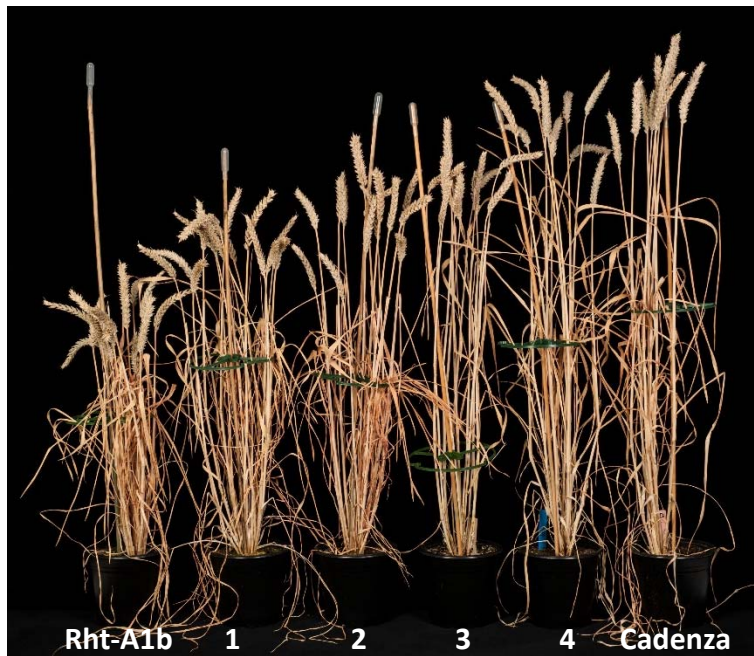


Rht-A1b and *Rht-D1e* Suppressor Mutants

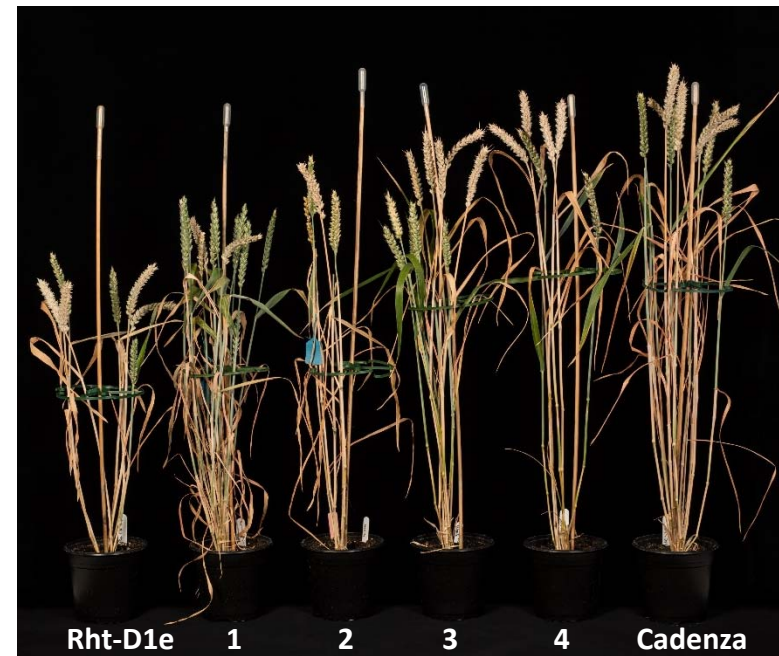


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Rht-A1b M3S Lines



Rht-D1e M3S Lines



41 Potential Novel *Rht-1* Dwarfing Alleles



Characterisation of *Rht-A1b* and *Rht-D1f* Suppressor Lines



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Stature and Yield



Grain Size



Seedling Vigour



PHS Resistance



Fertility



Rht-1

Rht-D1b

Acknowledgements



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VCU Staff at Rothamsted

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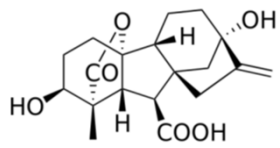


Target Pathways for Manipulation of Architecture and Stress Responses



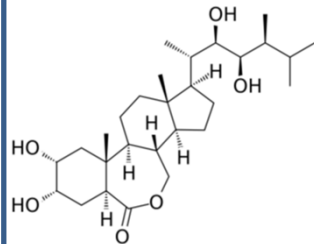
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Gibberellins



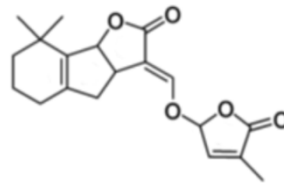
Stature
Fertility
Grain size

Brassinosteroids



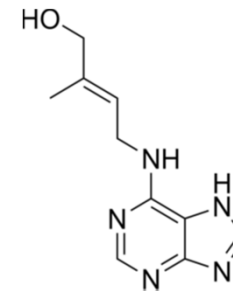
Stature
Stem strength
Disease resistance

Strigolactones



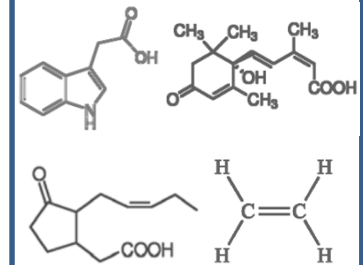
Branching/Tillering
Stature
Stress responses

Cytokinins



Grain number

Auxin ABA Ethylene Jasmonate



Abiotic stresses



e.g. rice *sd-1*



e.g. barley *uzu*



e.g. rice *IPA1 (WFP)*



e.g. rice *Gn1*



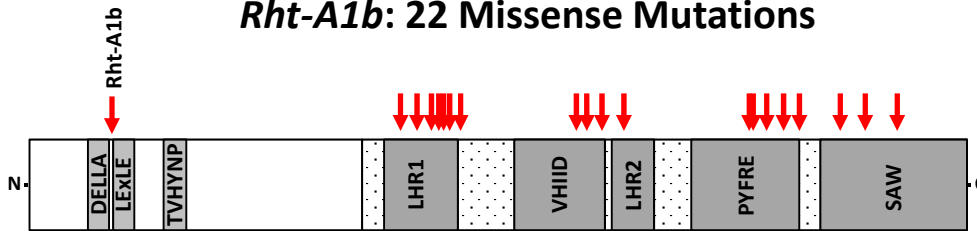
e.g. barley *ABA8'OH*

Rht-A1b and Rht-D1f Suppressor Mutations

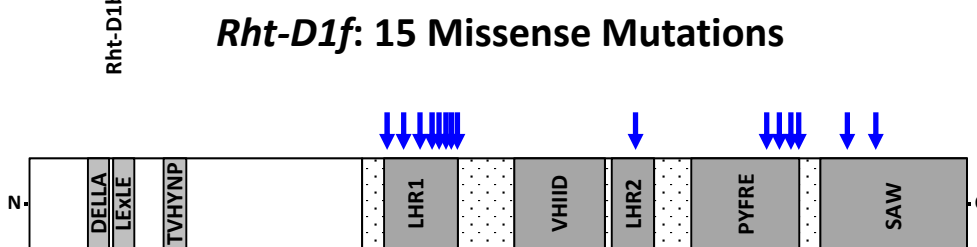


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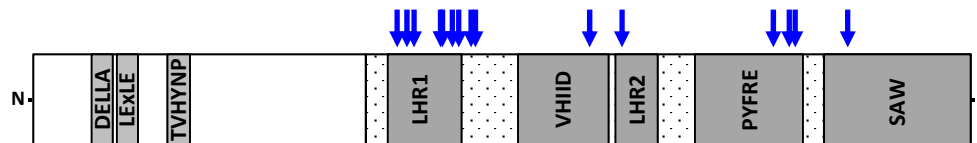
Rht-A1b: 22 Missense Mutations



Rht-D1f: 15 Missense Mutations



Rht-B1c: 15 Missense Mutations



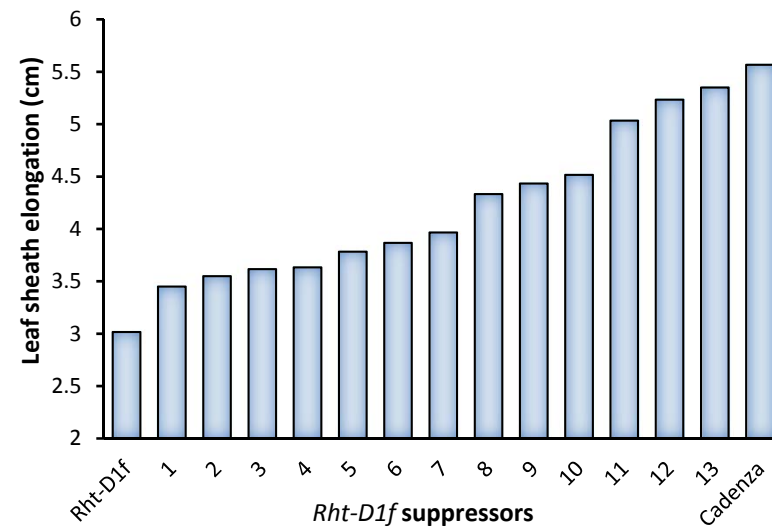
Chandler et al. 2013

Rht-D1f Suppressor Lines Display Differences in Leaf Sheath Elongation



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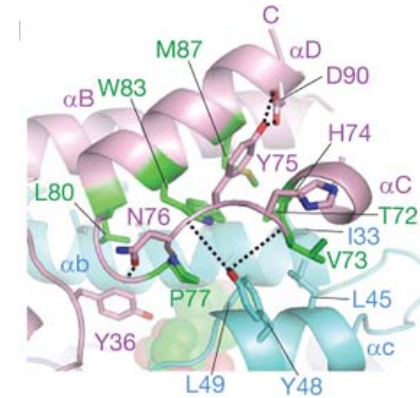
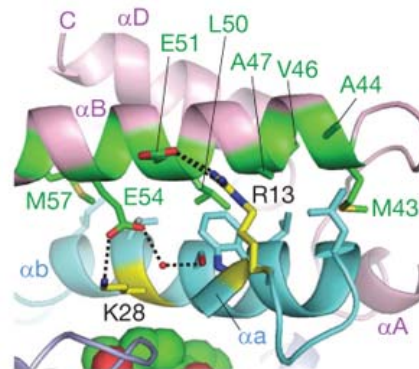
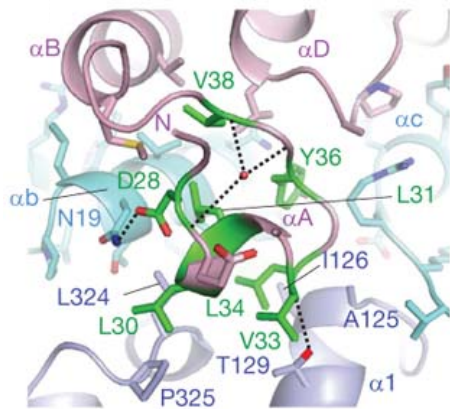
Leaf sheath elongation is sensitive to GA



DELLA Mutations Which Prevent GID1 Binding Cause a GA-Insensitive Dwarf Phenotype

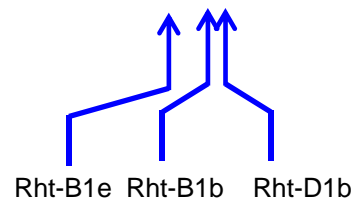


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Murase *et al.* Nature 2008

SLR1	AAGEEEDVDELLAALGYKVRSSDMADVAQKLEQLEMAMGGVSAPGAADDGFVSHLATDTVHYNP	SDLSSWVESMLSELN	111
Rht-D1	AAGEGEEVDELLAALGYKVRASDMADVAQKLEQLEMAMGGVGAGAAPDDSFATHLATDTVHYNP	PTDLSSWVESMLSELN	110
RGA	EDGGGNMDELLAVLGYKVRSSSEMAEVALKLEQLETMMSN-----VQEDGLS-HLATDTVHYNP	SELYSWLDNMLSELN	110
	* : ***** . ***** : : * : * : * : * : * : * : *	. : * . : ***** : : * * * : : *****	



Novel Brassinosteroid (BR) Dwarfing Genes as Alternatives for Improving Wheat Architecture.



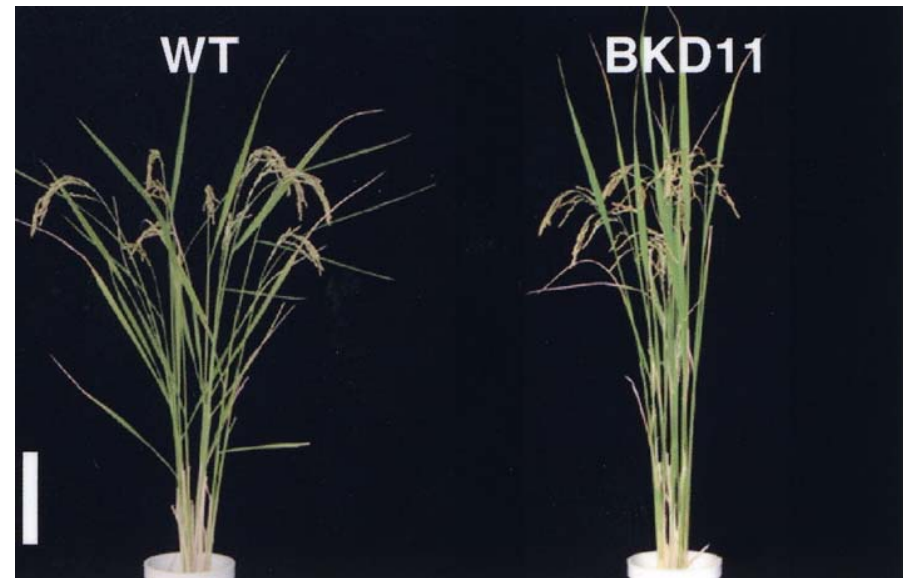
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***Hvbri1 (uzu1)* mutations are used widely in barley breeding**



Dockter et al. 2014

***Osbr1* mutations can increase yield potential in rice**

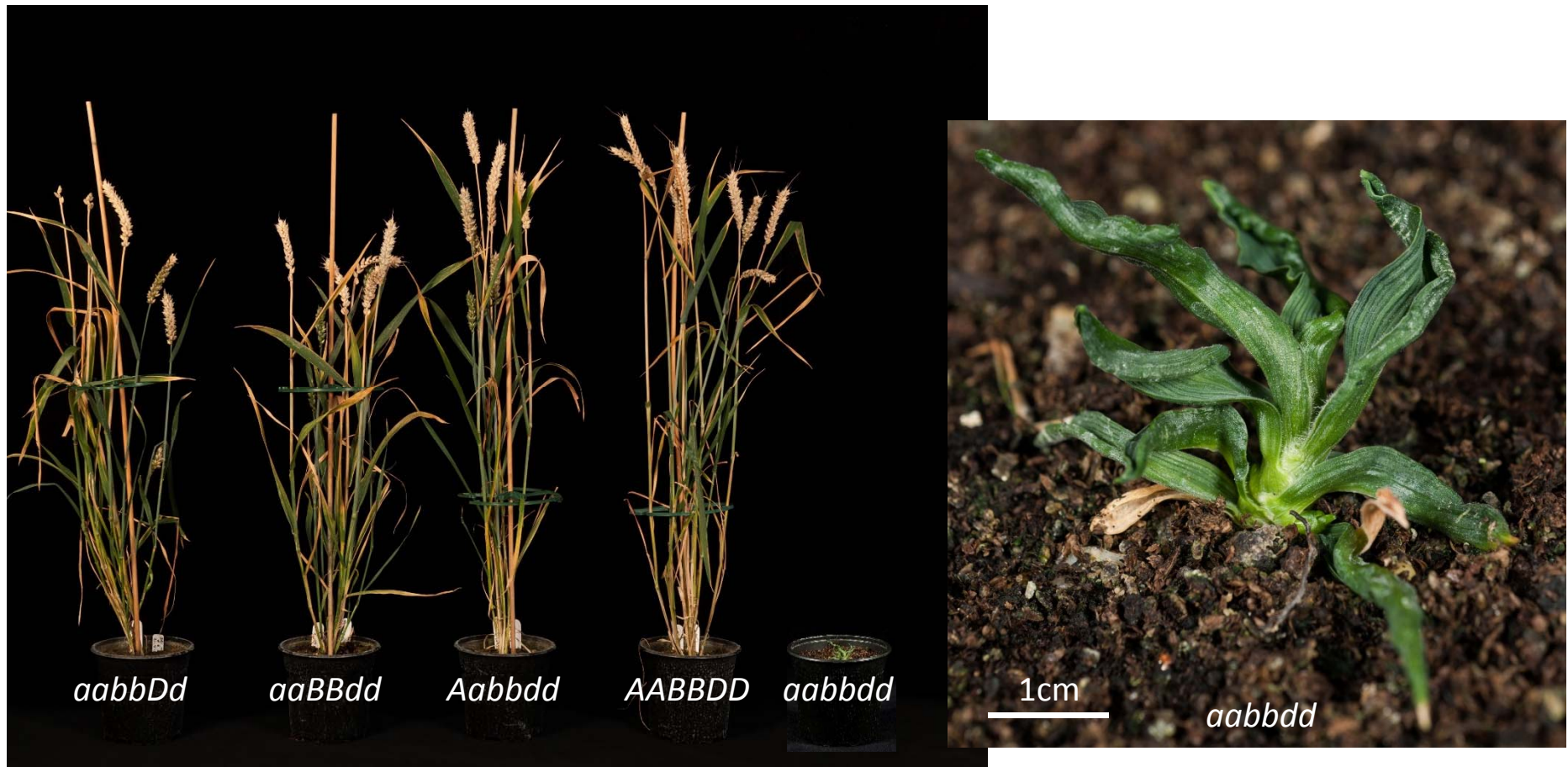


Morinaka et al. 2006

The *tabri1* Triple Mutant has a Severe Dwarf Phenotype



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Current Status of all Architecture Target Genes



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Pathway	Gene	Trait	Mutations identified	1st cross	2nd cross	Homozygote	Phenotype	Back-cross	Field trial
BR	BRI1	Stature					dwarf	BC ₁ F ₁	
BR	BZR1	Stature							
BR	CPD	Stature							
BR	DIM	Stature						BC ₁ F ₁	
CK	CKX2	Grain number							
GA	GA1ox1	Grain size							
GA	GA20ox1	Stature/fertility							
GA	GA20ox2	Stature/fertility							
GA	GA2ox3	Stature/stress							
GA	GA3ox2	Stature							
GA	GA3ox3	Grain size							
GA	GACPS	Stature							
GA	GID1	Stature					dwarf	BC ₁ F ₁	
GA	Rht-1 GOF	Stature					dwarf		
GA	Rht-1 LOF	Stature					slender	BC ₂ F ₂	
SL	D14	Tiller number/stature							
SL	D3	Tiller number/stature							
SL	SPL14 GOF	Tiller number/stature							
SL	SPL17 GOF	Tiller number/stature							
IAA	AUX/IAA	Male fertility/heat stress							
JA	JAZ	Male fertility/heat stress							
ET	ETR1	Male fertility/heat stress							

The *tagid1* Triple Mutant has a Dwarf Phenotype



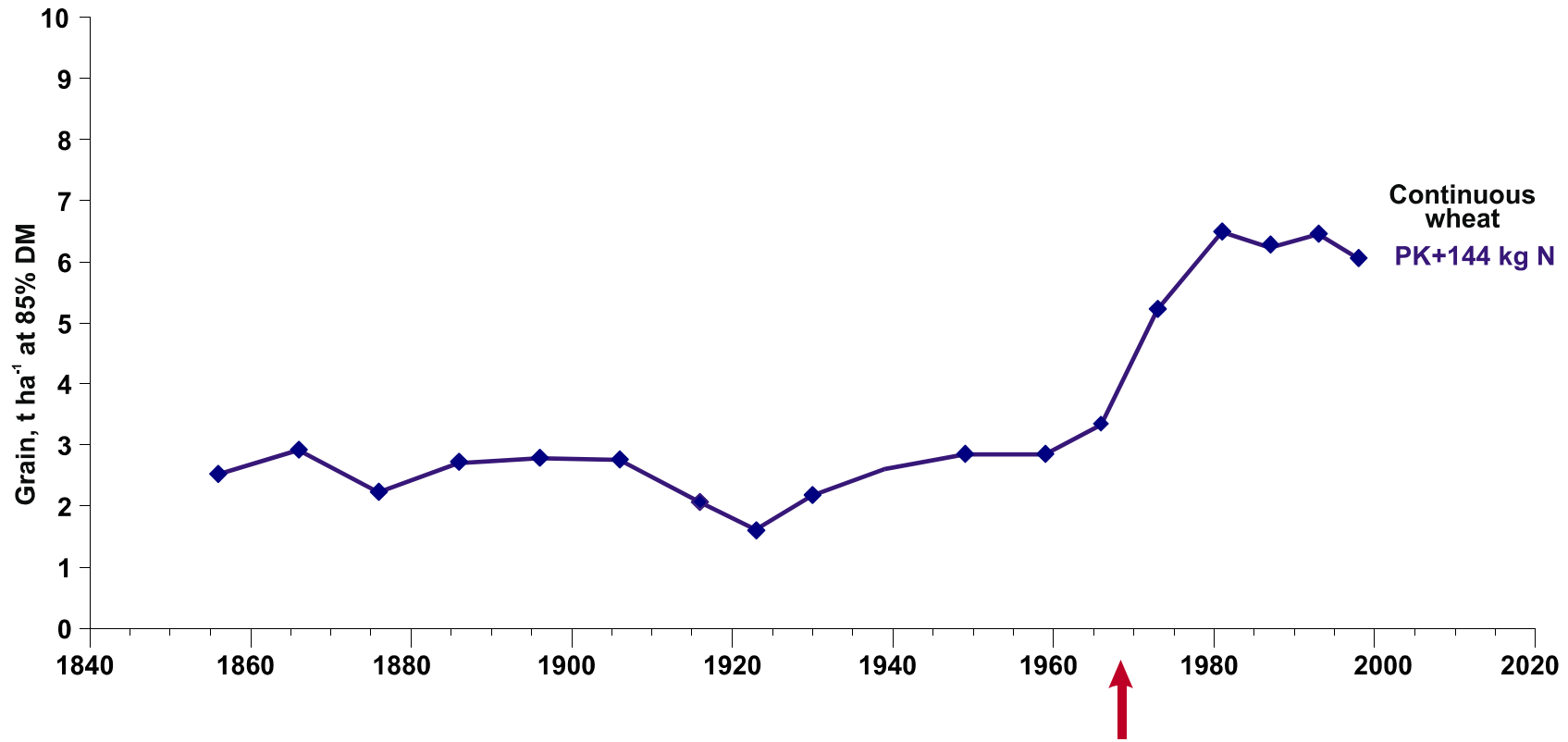
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Broadbalk: Mean Yields of Wheat Grain



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Introduction of modern dwarf cultivars

