

Exploiting Hormones To Change The Architecture Of Wheat



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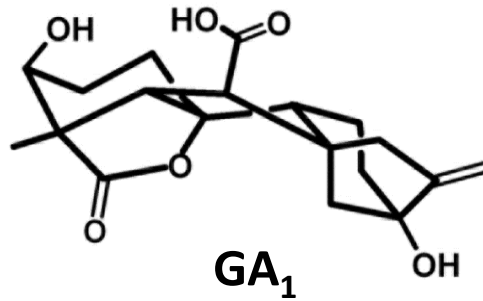
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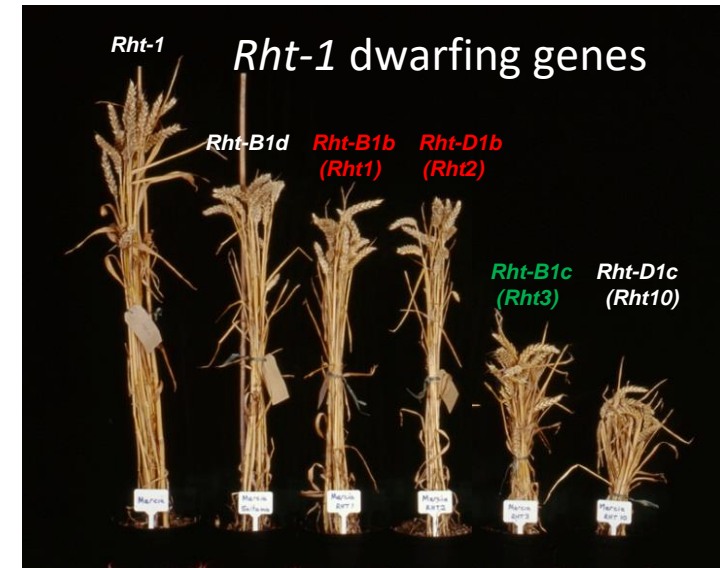
Rht-1 Dwarfing Genes And Gibberellins



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Gibberellins promote stem elongation



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



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Why Do We Need New Wheat Dwarfing Alleles?

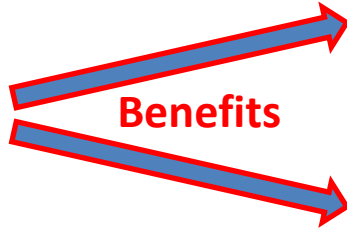


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Rht-1 dwarfing alleles



Lodging control



Benefits

Higher HI



Limitations....

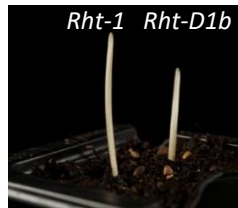
Few available alleles



Reduced NUE



Reduced seedling vigour



Fertility defects



Reduced grain size



Rht-1

Rht-B1c

Reduced PHS resistance



Rht-1

Rht-D1b

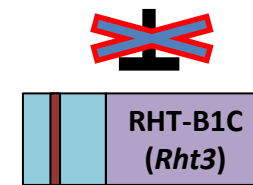
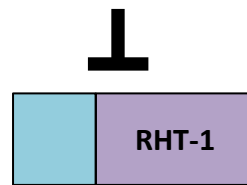
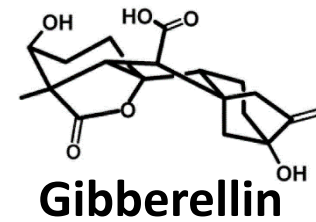
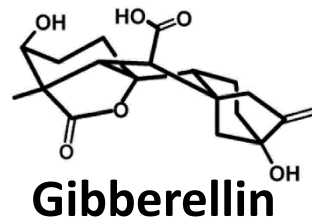
Strategy: Generate a wide selection of new *Rht-1* alleles



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The Mode of Action Of *Rht-1* Dwarfing Genes



Stem Elongation

Stem Elongation

Stem Elongation

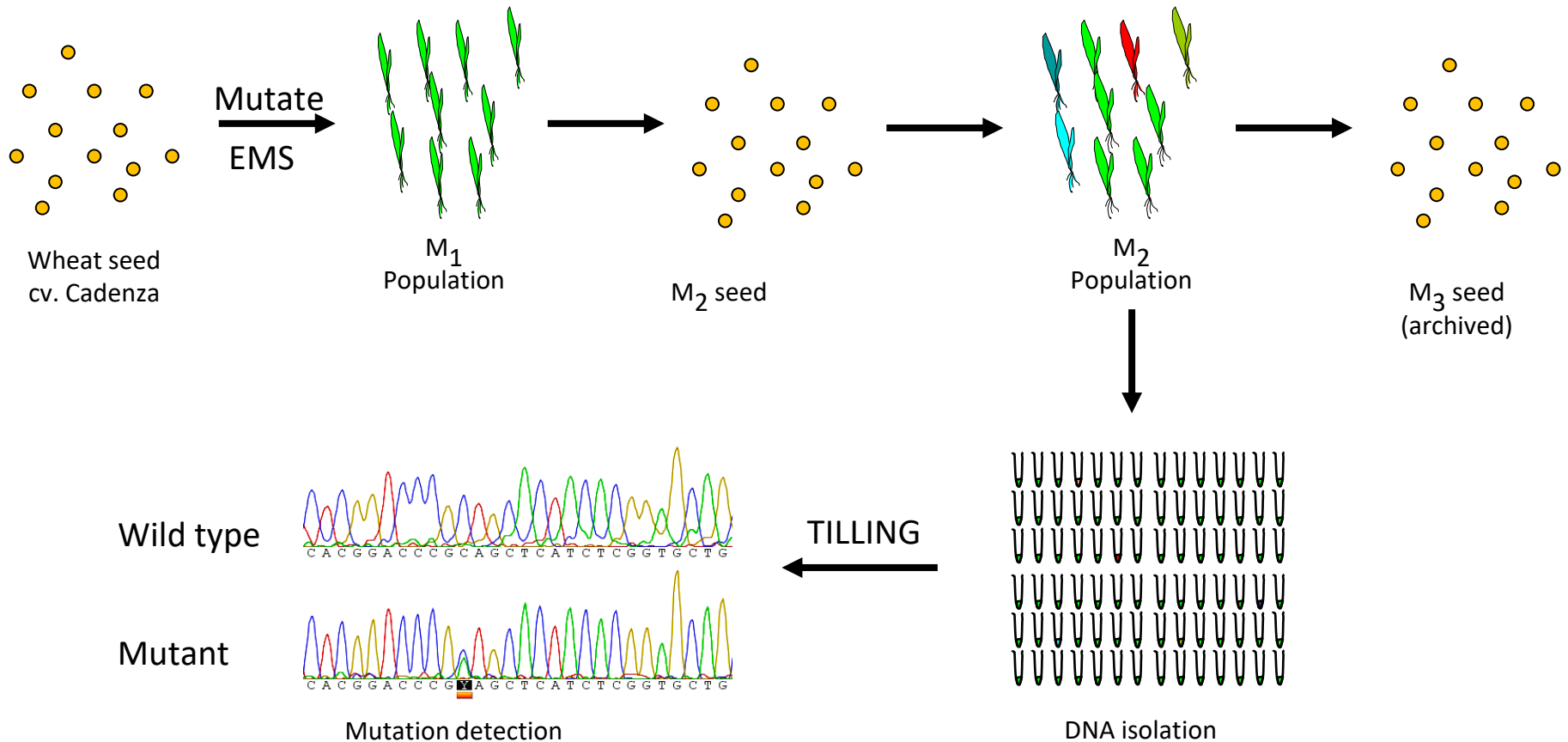




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TILLING To Generate New *Rht-1* Dwarfing Genes

TILLING in wheat: A resource initiated by Andy Phillips in WGIN (1)



Rakszegi *et al.* 2010, Krasileva *et al.* 2017



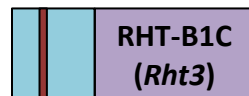
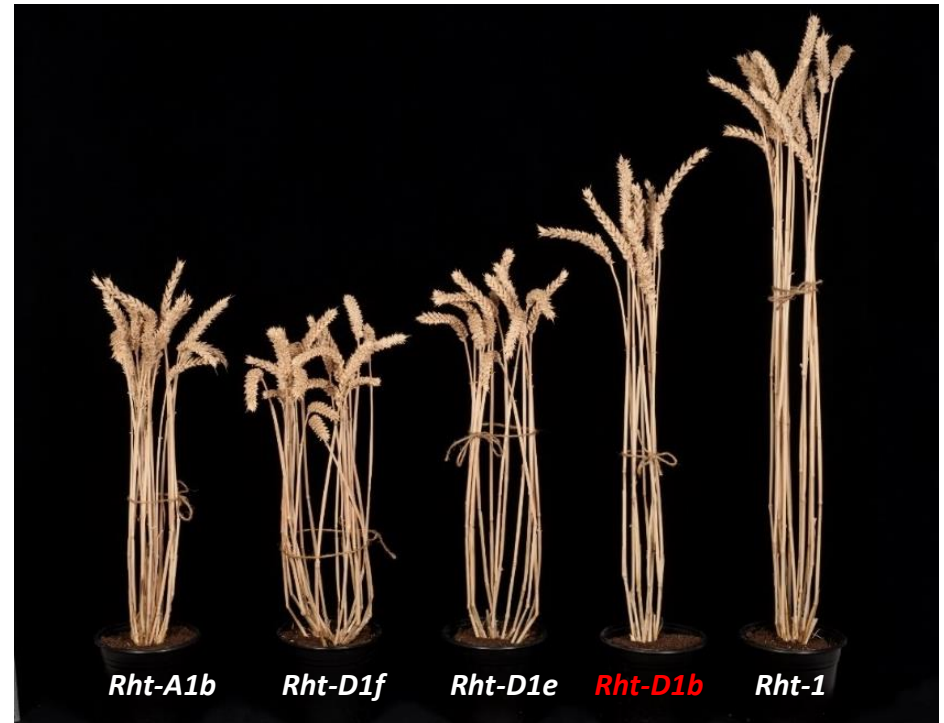
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Generating New *Rht-1* Dwarfing Alleles Using TILLING



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Assessment of 2nd Generation Wheat Dwarfing Alleles



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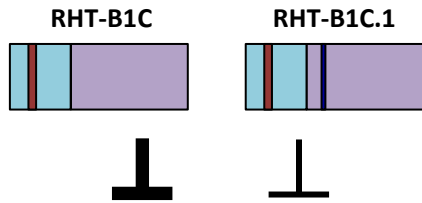
syngenta

Generating The 3rd Generation Of *Rht-1* Dwarfing Alleles



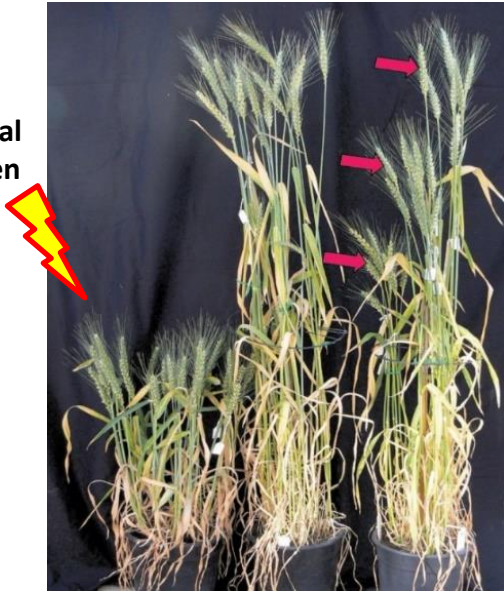
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Rht-B1c suppressor screen



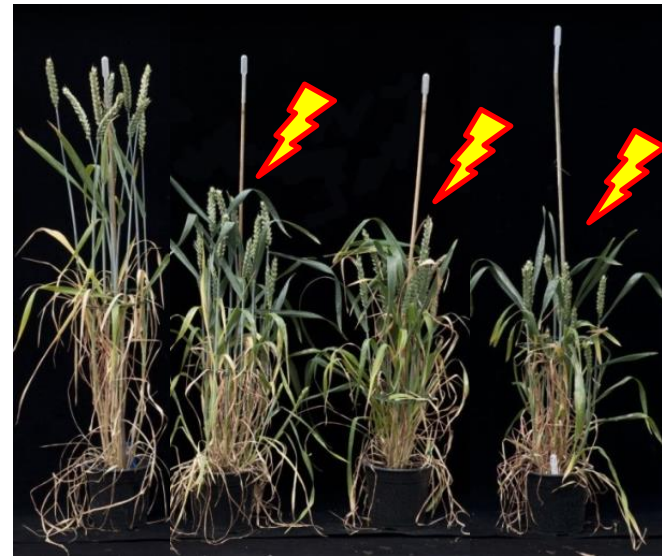
Stem Elongation

Chemical
mutagen



Chandler and Harding (2013)

Perform a similar EMS-based screen
using our *Rht-A1* and *D1* Alleles



Cadenza *Rht-D1e* *Rht-A1b* *Rht-D1f*



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Screening For New *Rht-1* Dwarfing Alleles In The Field



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Identifying New *Rht-1* Dwarfing Alleles



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Rht-1
dwarfing
mutation

Rht-1 Suppressor mutations



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An Extensive Collection Of New *Rht-1* Dwarfing Alleles



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- Sixteen new *Rht-1* dwarfing alleles have been introgressed into elite wheat varieties. Field assessment to commence in 2023.
- Perfect markers available.
- Phenotypic data (cv. Cadenza) has been collected from 3 years of field trials.



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Effects On Plant Height And Grain Yields In The Field



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- The new alleles provide consistent effects on height reduction in the field.
- Grain yield data has identified some promising alleles.

Allele	Height reduction (2019) *	Height reduction (2020)	Grain yield (85% DM; 2020)
Rht-D1b (Rht2)	22%	19%	+3%
Rht-D1f	37%	35%	+10%
Rht-D1e	32%	33%	+13%
Rht-D1f.2	17%	21%	+12%
Rht-D1f.4	17%	19%	+12%
Rht-D1e.2	24%	24%	+12%
Rht-D1f.4	17%	19%	+12%
Rht-D1f.12	26%	26%	+8%
Rht-D1e.1	24%	22%	+2%
Rht-D1f.5	20%	19%	0%
Rht-D1f.10	21%	21%	-4%
Rht-D1f.8	5%	7%	-14%

* compared to Cadenza

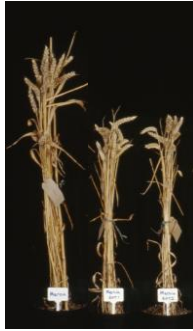


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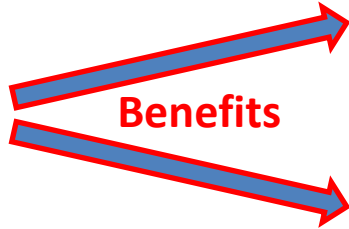


Do The New Dwarfing Alleles Provide Other Improved Traits?

Rht-1 dwarfing alleles



Lodging control



Benefits

Higher HI



Limitations....

Few available alleles



Reduced NUE



Fertility defects



Rht-1 *Rht-D1b*

Reduced seedling vigour



Rht-1 *Rht-D1b*

Reduced PHS resistance



Reduced grain size



Rht-1

Rht-B1c





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Do The New *Rht-1* Dwarfing Alleles Provide Better Resistance To Preharvest Sprouting?

Preharvest Sprouting



The result of premature germination of grain under adverse weather conditions

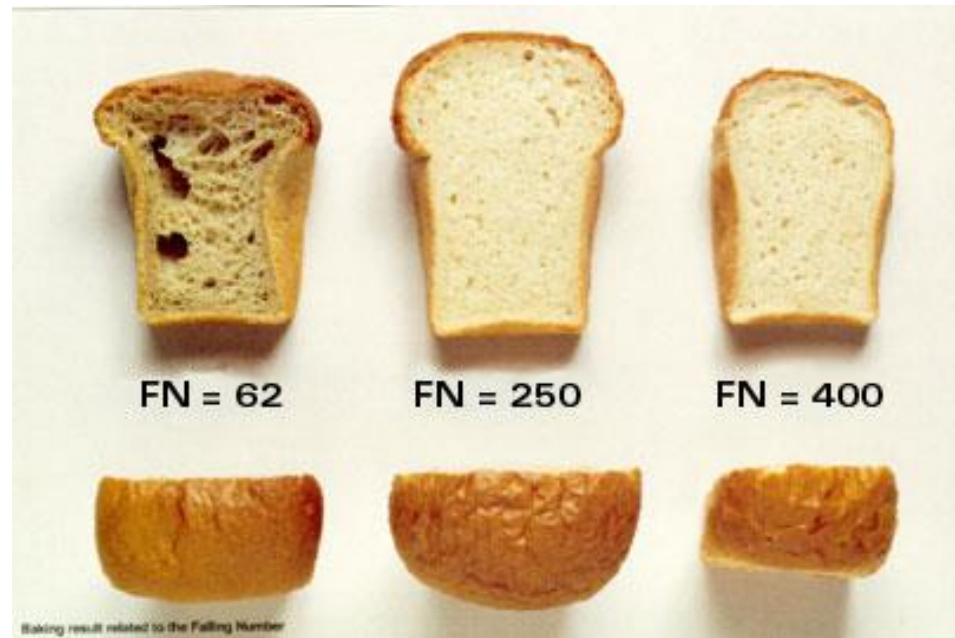
Germination results in gibberellin controlled α -amylase expression, leading to loss of breadmaking quality.

Some *Rht-1* alleles improve preharvest sprouting resistance and reduce α -amylase expression



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HFN and breadmaking quality



Low HFN (high amylase) leads to poor quality bread

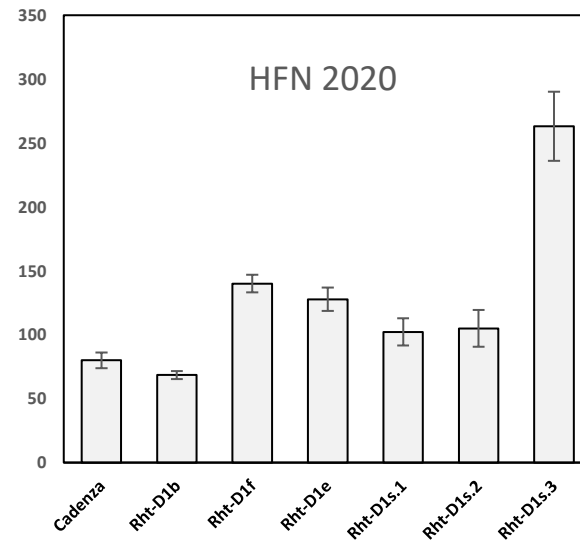
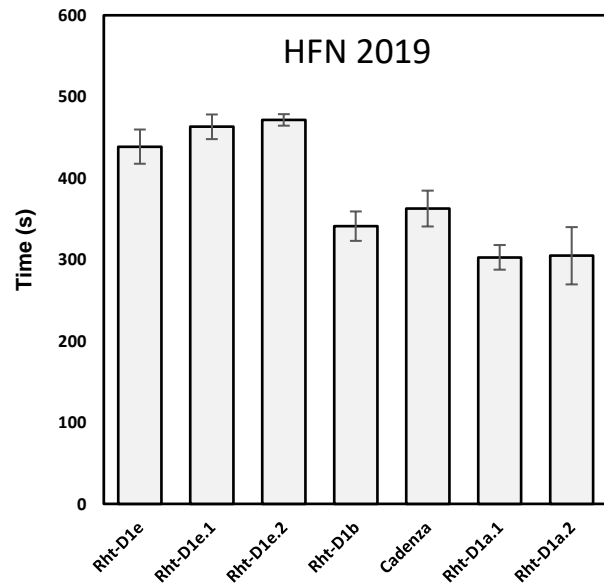
New *Rht-1* Alleles Have Higher HFN Values



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August 2020 was wet!

New *Rht-1* alleles have higher HFN



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Using Genome Editing To Generate New Dwarfing Alleles



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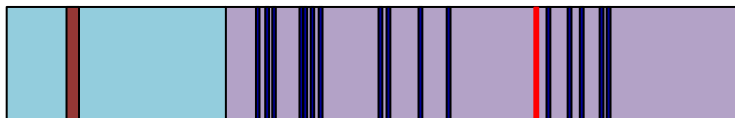
The range of genetic variation induced by chemical mutagens is limited (G>A, C>T).



Genome editing using targeted Adenosine deaminase (A>G, T>C)

Rht-D1f
dwarfing
mutation

Rht-1 Suppressor mutations



Genome edited mutation



Rht-D1f

Rht-D1f derived
Genome edited
mutants

Cadenza



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Alison Huttly and Andy Phillips

Summary



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- An extensive collection of new *Rht-1* dwarfing alleles have been generated.
- Some of the alleles may provide resistance to PHS and improve grain quality.
- Knowledge of the gibberellin pathway in wheat is allowing us to conduct targeted approaches to generate new material.



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Acknowledgements



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