In grafted grapevines, physiological, transcriptional and hormonal responses to nutrient availability are strongly influenced by the rootstock genetic background

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CULTIVATED GRAPEVINE, A GRAFTED PLANT



Rives, 1971 Champagnol, 1984 Ollat et al., 2003 Jones et al., 2009

Conferred

vigour

Howell, 2001 Skinkis and Vance, 2013 **Keller, 2015**

CONCLUSION

PERSPECTIVES

How the rootstock controls the scion development?

- Nitrogen is an essential nutrient crucial for grapevine growth, berry yield and quality
- Nitrate is the main source of nitrogen
- Nitrate availability is heterogeneous in the soil
- Nitrate sensing and uptake are regulated by the rootstock to ensure an optimal absorption of this nutrient
- Root and shoot growth are regulated in response to nitrate availability, especially through root to shoot long distance hormone signalling



Are the rootstocks different in terms of nitrate sensing and uptake?

CONCLUSION

PERSPECTIVES

HORMONAL REGULATION OF SCION GROWTH

- Strigolactones:
- Mainly synthesized in the roots
- Regulated by nitrogen availability
- Inhibit axillary bud outgrowth
- Involved in arbuscular mycorrhizal fungi symbiosis in the rhizosphere

Waldie *et al.*, 2014 Al-babili *et al.*, 2015 Lopez-Obando *et al.*, 2015 Pandey *et al.*, 2016





Do strigolactones contribute to the rootstock-dependent regulation of scion growth?

CONCLUSION

PLANT MATERIAL

• Choice of two rootstock genotypes known to differently control the growth of the same scion





ARE THE ROOTSTOCKS DIFFERENT IN TERMS OF NITRATE SENSING AND UPTAKE?

- Profiling of the short term transcriptomic responses in the roots
- Heterogeneous nitrate availability





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ARE THE ROOTSTOCKS DIFFERENT IN TERMS OF NITRATE SENSING AND UPTAKE?

• Split root system



ARE THE ROOTSTOCKS DIFFERENT IN TERMS OF NITRATE SENSING AND UPTAKE?

• *De novo* assembly of RNA sequencing results

Combination	Description	Positive	Negative	Total
CC /1102D	HN3 vs LN3	132	73	205
CS/1103P	HN24 vs LN24	5	3	8
	HN3 vs LN3	449	103	552
CS/KGIVI	HN24 vs LN24	221	710	931

- 172 common differentially expressed genes (DEGs) in both combinations related to nitrogen
- A more pronounced response in CS/RGM:
 - More DEGs
 - Common DEGs with a higher LFC

CONCLUSION

STRIGOLACTONE GENE CLUSTER

FUNCTIONAL CHARACTERIZATION OF GRAPEVINE STRIGOLACTONE GENES

- Genes involved in SL biosynthesis mainly expressed in the roots
- Over-expression of grape genes in Arabidopsis restored hyper-branched mutants to the WT branching phenotype
- Overexpressing grapevine cells secreted SL-like compounds able to induce the germination of *P. ramosa* seeds

Phelipanche ramosa seeds

Pouvreau et al., 2013

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Grapevines produce SL-like compounds with similar roles as in other plant species.

CONCLUSION

IS SL PRODUCTION INDUCED BY N LIMITING CONDITIONS AND IMPACTED BY THE ROOTSTOCK IN MICROGRAFTS?

• Phenotypic and molecular responses to nitrate - Hydroponic experiments

IS SL PRODUCTION INDUCED BY N LIMITING CONDITIONS AND IMPACTED BY THE ROOTSTOCK IN MICROGRAFTS?

• Hydroponics – Experimental design

 ∇ Exudates collection

DO N LIMITING CONDITIONS INDUCE EXPRESSION OF SL BIOSYNTHESIS GENES?

• Hydroponics – Gene expression profiling

MAX1

RESULTS

DO N LIMITING CONDITIONS INDUCE EXPRESSION OF SL BIOSYNTHESIS GENES?

• Hydroponics – Gene expression profiling

- Expression of genes involved in SL biosynthesis is regulated by N availability in grafted grapevines.
- This induction was higher in CS/RGM roots.

IS THE GENE EXPRESSION INDUCTION ASSOCIATED WITH SL PRODUCTION?

• Hydroponics – Bio-assays

Pre-cultured in perlite	Full nutrient solution	0N solution	Treatment				
H ₂ O	HN	DN			HN		
H ₂ O	HN	→ ON			ON		
0)	79	14 16	21	23	28	35
-		Week 1	Week 2				(Days)

CONCLUSION

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IS THE GENE EXPRESSION INDUCTION ASSOCIATED WITH SL PRODUCTION?

• Hydroponics – Bio-assays

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Combination

CS/1103P

CS/RGM

Condition

•••• HN

ON

IS THE GENE EXPRESSION INDUCTION ASSOCIATED WITH SL PRODUCTION?

• Hydroponics – Bio-assays

- In N limiting conditions, grafted grapevines produced SL-like compounds.
- SL production induction is earlier and stronger in CS/RGM plants.

CONCLUSION

PERSPECTIVES

IS THE GENE EXPRESSION INDUCTION ASSOCIATED WITH SL PRODUCTION?

• Hydroponics – Bio-assays

- In N limiting conditions, grafted grapevines produced SL-like compounds.
- SL production induction is earlier and stronger in CS/RGM plants.

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IS THE GENE EXPRESSION INDUCTION ASSOCIATED WITH SL PRODUCTION?

• Hydroponics – Bio-assays

Are these results reproducible with older plants grown in greenhouse?

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IN GREENHOUSE CONDITIONS, 1103P CUTTINGS ARE MORE BRANCHED THAN RGM.

- Woody cuttings of 1103P and RGM were grown and watered with LN (0.8 mM N) or HN (5 mM N) solutions during 45 days
- HN: main stem growth was promoted in RGM compared to 1103F
- LN:
- Reduction of LB outgrowth for RGM
- Reduction of stem development in 1103P

Greenhouse experiments confirmed that N limiting conditions induce a stronger inhibition of bud outgrowth for RGM.

IN GREENHOUSE CONDITIONS, CS/1103P IS MORE BRANCHED THAN CS/RGM.

- CS/1103P and CS/RGM plants were grown and watered with HN (5 mM N) solution during 45 days
- CS/1103P plants are more branched than CS/RGM plants
- Differences even more pronounced after one year of culture

Bud outgrowth was reduced when RGM is the rootstock.

IN SUMMARY

- In response to a heterogeneous nitrogen availability, CS/RGM transcriptome was more impacted than CS/1103P
- Gene co-expression network analysis revealed a strigolactone-specific gene cluster
- Putative genes involved in SL pathway seem to play similar role as in other species
- In N limiting conditions, RGM seems to produce more SLs
- SL production is correlated to a higher LB outgrowth inhibition in N limiting conditions for RGM or CS/RGM

NITROGEN, THE OTHER MINERALS AND THE ROOT GROWTH

- Interaction between N and P
- Transcriptional and post-transcriptional regulation of the same protein, HSR1 Medici et al., 2015
- Nitrate drives the phosphate starvation response through IDR1 Medici et al., 2016
- Root growth regulation Kellermeier et al., 2014
- How do grapevine rootstocks modify phosphorus concentration in scion? Gautier et al., 2018 Poster P99

P availability regulates SL biosynthesis and has a synergetic action with N for association with arbuscular mycorrhizal fungi.

CONCLUSION

PERSPECTIVES

GRAPEVINE AND ITS RHIZOSPHERE

A ► R&D PROGRAMS ► VITIRHIZOBIOME: ROLE OF RHIZOSPHERE AND ROOT MICROBIOME ON YOUNG VINE PLANTS' FUNCTIONING

R&D PROGRAM

VITIRHIZOBIOME: Role of rhizosphere and root microbiome on young vine plants' functioning

NEWS

CONTACT THE PROJECT

Virginie Lauvergeat

TOPICS

Relation between yield and longevity

FAST FORWARD TO :

PROJECT SUMMARY

Added on 14/06/2018

CONCLUSION

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BORDEAUX

