


Effect of Nitrogen Fertilization on Grape Berry Aromatic Potential and on Wine Aromas

Pierre Helwi, Ph.D
Assistant Professor and Extension Viticulture Specialist
Texas A&M AgriLife Extension Service

université de BORDEAUX
Texas A&M AgriLife Extension

The Terroir Concept

Climate

Temperature

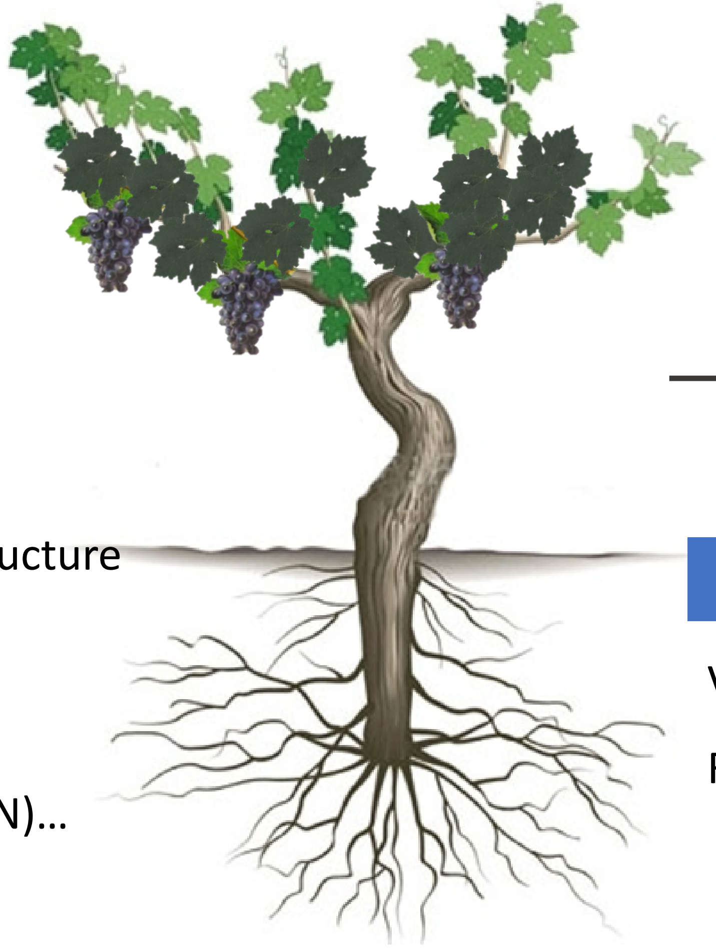
Radiation

Precipitation

Human factor

Viticulture practices

Winemaking



Grape quality potential

Wine quality

Soil

Composition and physical structure

Water availability

Pedoclimate

Mineral nutrition: Nitrogen (N)…

Genetic factors

Variety

Rootstock

Seguin 1986; Vaudour 2002; van Leeuwen *et al.,* 2006

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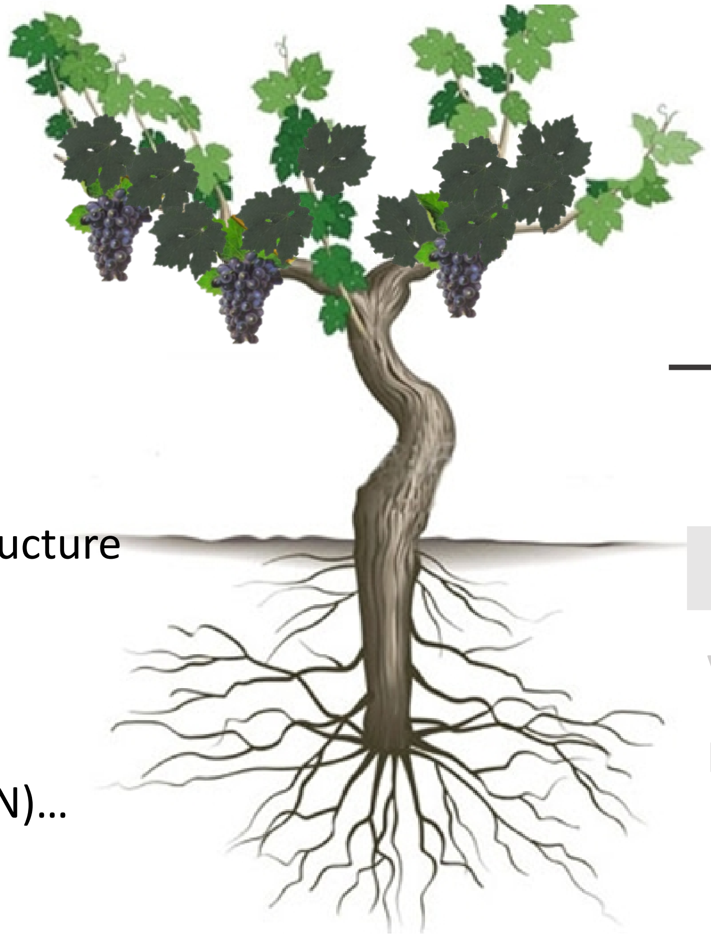

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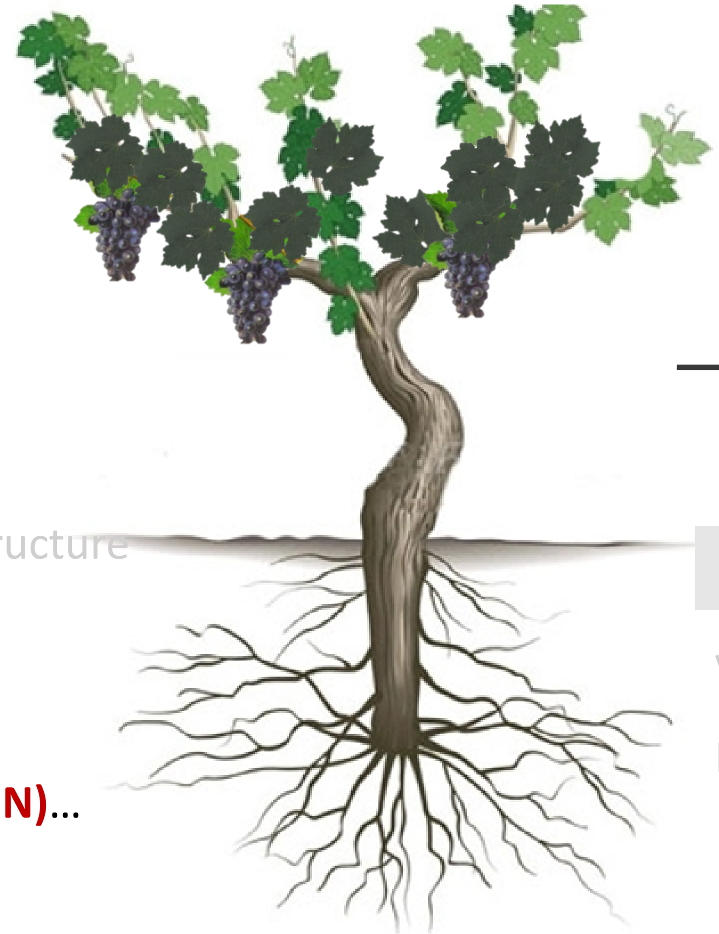

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Mineral nutrition: **Nitrogen (N)**…

Genetic factors

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Seguin 1986; Vaudour 2002; van Leeuwen *et al.,* 2006

Nitrogen Effect

Vine physiological consequences

Vigor

Shoot growth cessation

Yield

Ripening

Sensibility to cryptogamic diseases

…

Bell *et al.*, 2005; Hilbert *et al.*, 2003; Lillo *et al.*, 2008; Schreiner *et al.*, 2012

Nitrogen Effect

Vine physiological consequences	Grape berry composition
Vigor	Sugar
Shoot growth cessation	Total acidity
Yield	Polyphenols
Ripening	Aroma compounds
Sensibility to cryptogamic diseases	…
…	

Bell *et al.*, 2005; Hilbert *et al.*, 2003; Lillo *et al.*, 2008; Schreiner *et al.*, 2012

Aroma Compounds

Primary aromas (Grape berry)






Secondary aromas (Fermentation)



Tertiary aromas (Ageing)



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Primary aromas (Grape berry)






Secondary aromas (Fermentation)



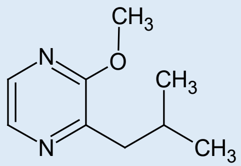
Tertiary aromas (Ageing)



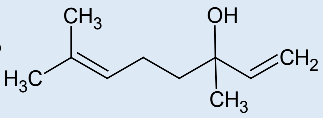
Primary/Varietal Aroma Compounds

Free aroma compounds

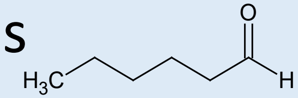
Methoxypyrazines



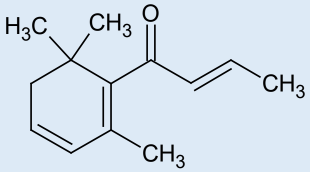
Free terpenes



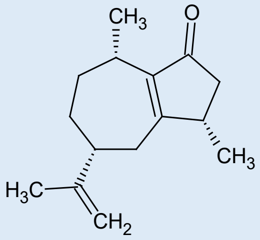
C6 compounds



C13 norisoprenoïds

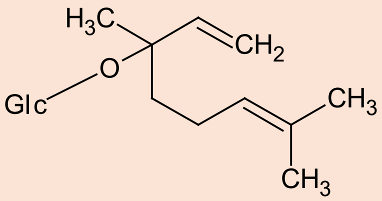


Rotundone

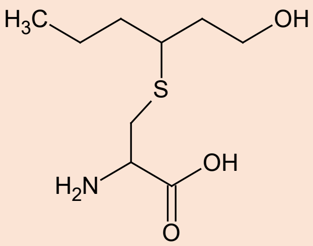


Aroma compounds **precursors**

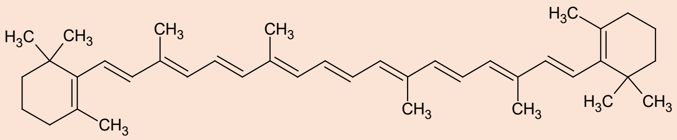
Terpene glycosides



Volatile thiols precursors



Carotenoid derivatives

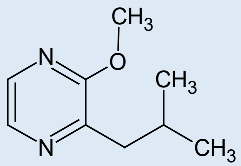


Gunata *et al.,* 1985; Tominaga *et al.,* 1998; Allen *et al.,* 1999; Peyrot des Gachons *et al.,* 2002; Sala *et al.,* 2004, Ribereau-Gayon, 2006; Ebeler and Thorngate, 2009

Primary/Varietal Aroma Compounds

Free aroma compounds

Methoxypyrazines



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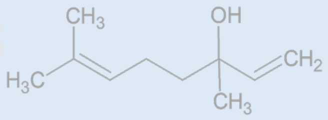
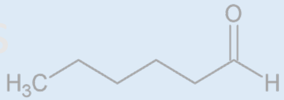
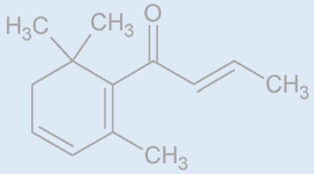


C6 compounds



C13 norisoprenoids



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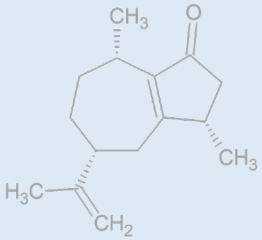

Aroma compounds **precursors**

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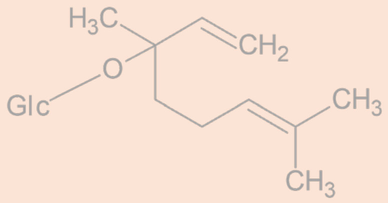

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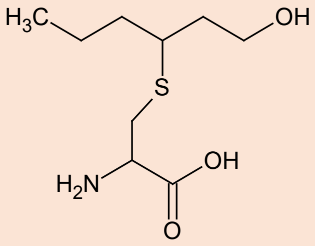
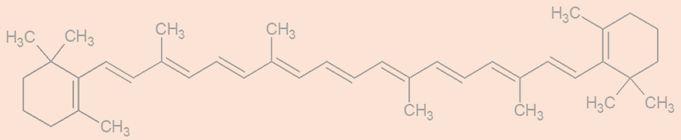


Carotenoid derivatives



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Methoxypyrazines

SBMP

(3-secbutyl-2-methoxypyrazine)

IPMP

(2-isopropyl-3-methoxypyrazine)

IBMP

(3-isobutyl-2-methoxypyrazine)

	SBMP	IPMP	IBMP
Perception threshold	1 ng L^{-1}	1 ng L^{-1}	2 ng L^{-1}
Level in wine	< 10 ng L^{-1}	< 10 ng L^{-1}	5-30 ng L^{-1}

Butterey *et al.*, 1969; Murray *et al.*, 1975; Mihara *et al.*, 1991; Lacey *et al.*, 1991; Roujou de Boubée *et al.*, 2000; Culleré *et al.*, 2009

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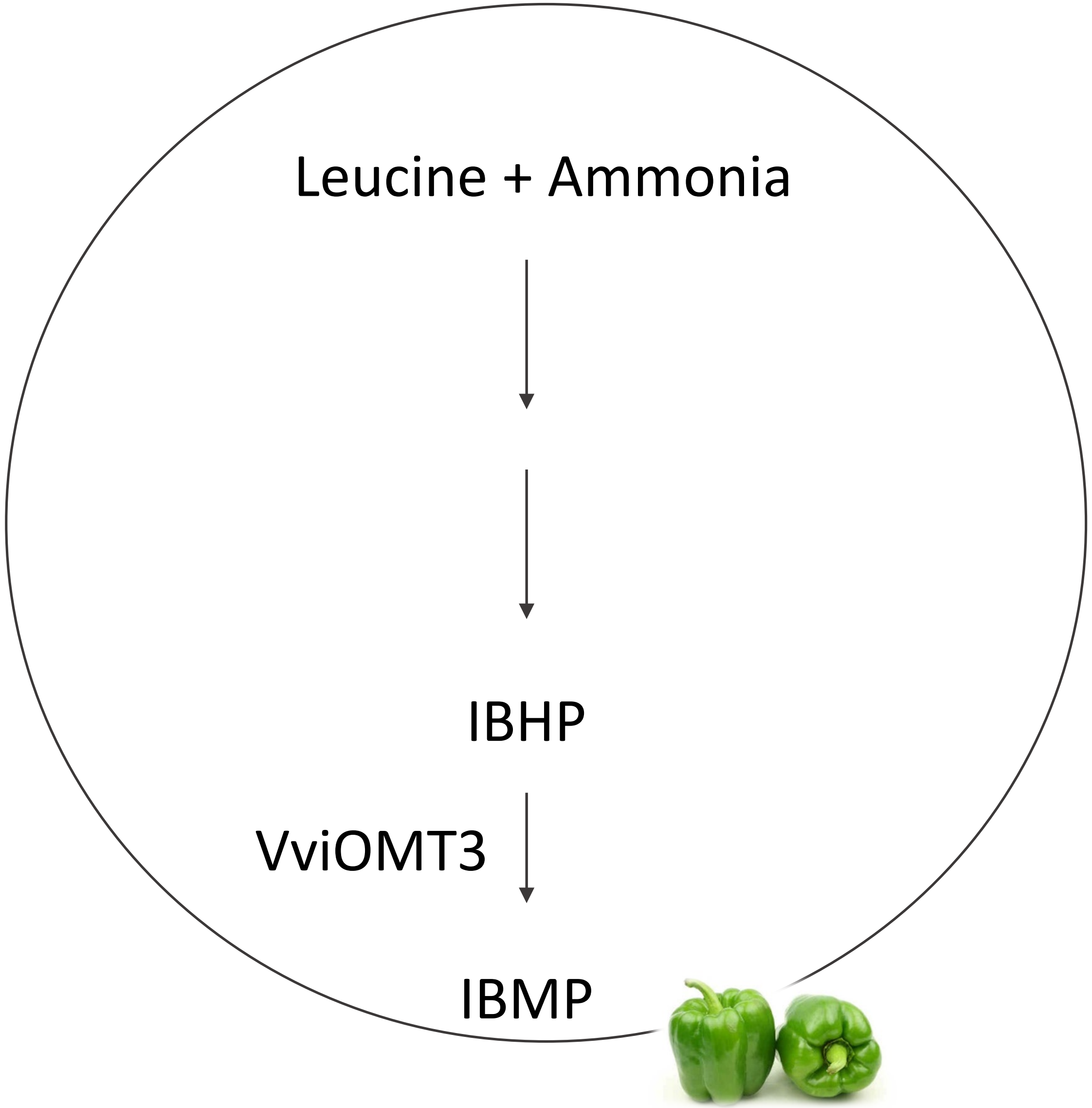
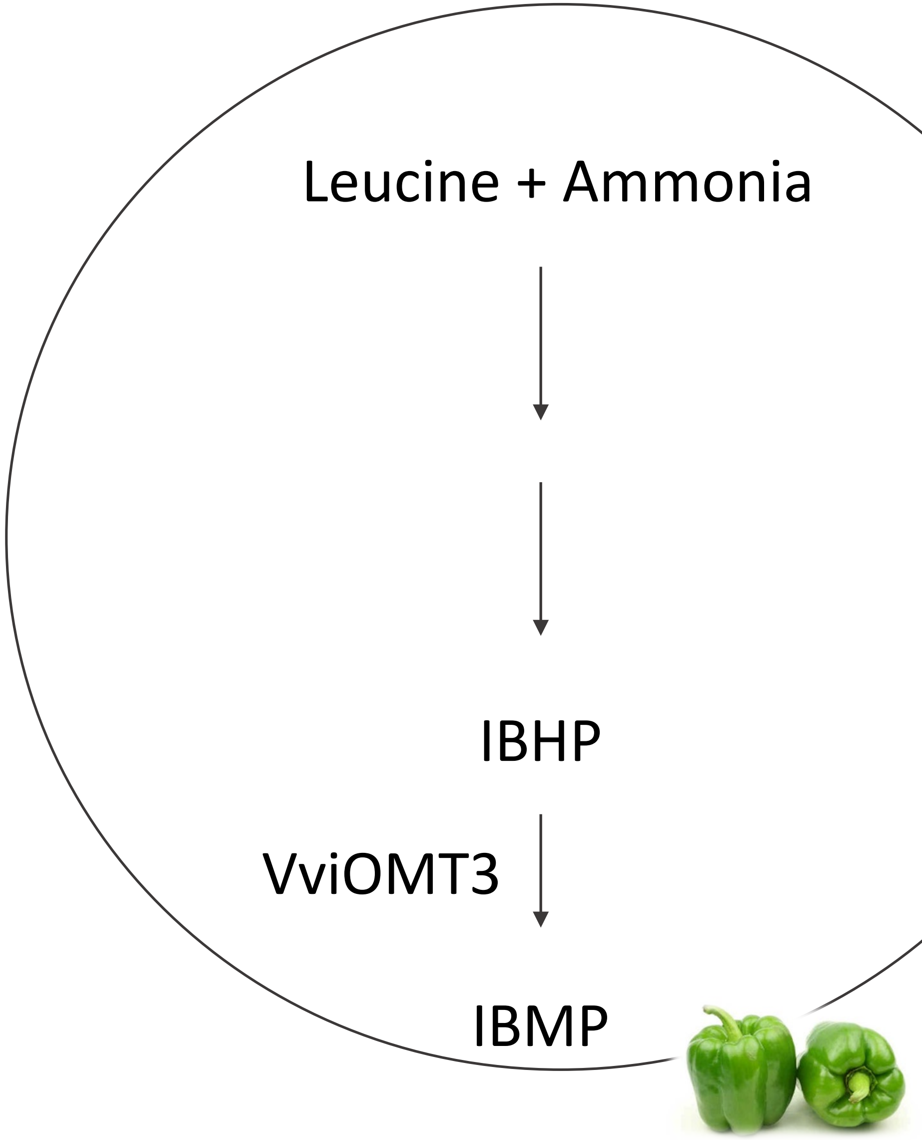
IBMP

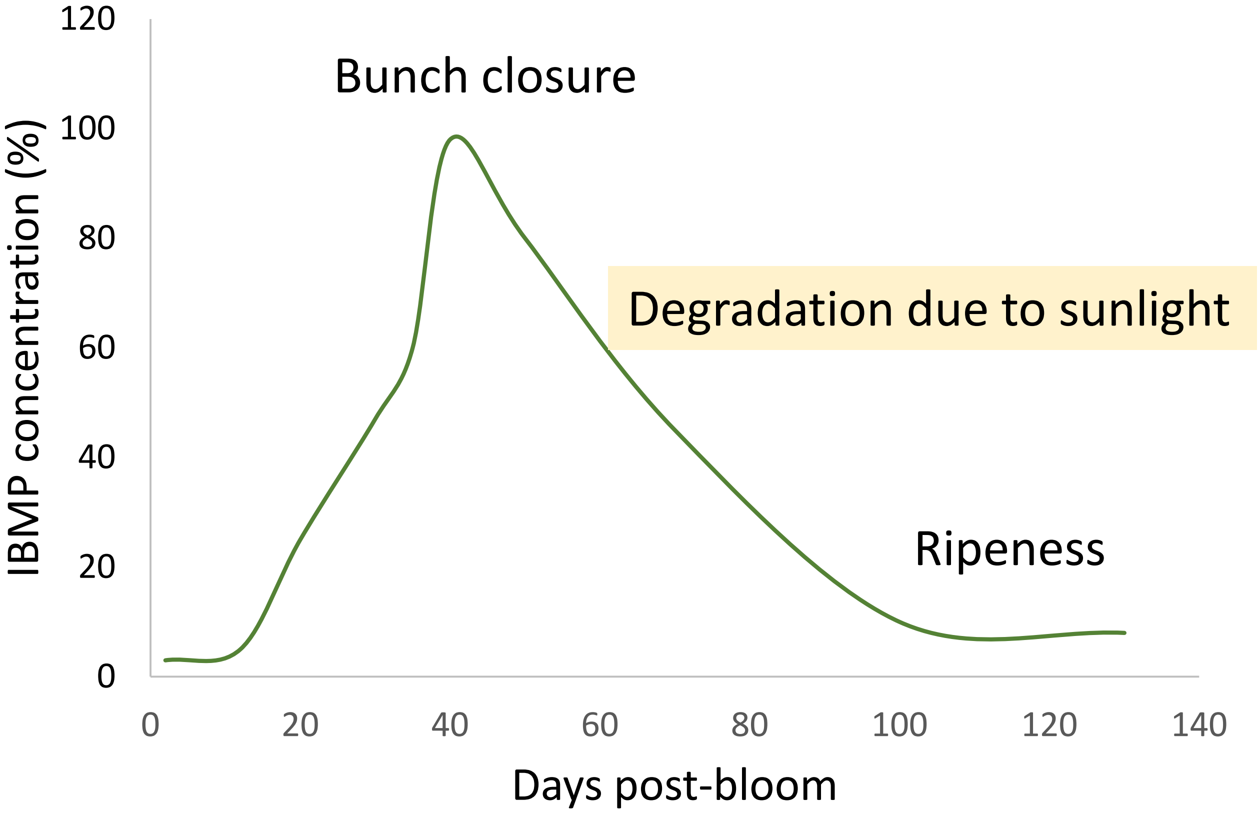


- Stable compound with levels present in must comparable to levels in wine.
- Considered negative aroma in red wines.
- In white wines, its presence (to a certain extent) can be acceptable as it gives some freshness.

Kennedy, 2002; Guillaumie *et al.,* 2013; González-Barreiro *et al.,* 2015

IBMP





Modified from Ryona *et al.*, 2008

Volatile Thiols

	4MSP	3SH	4MSPOH	A3SH
	(4-methyl-4-sulfanylpentan-2-one)	(3-sulfanylhexan-1-ol)	(4-methyl-4-sulfanylpentan-2-ol)	(3-sulfanylhexyle acetate)
Perception threshold	0.8 ng L^{-1}	60 ng L^{-1}	55 ng L^{-1}	4 ng L^{-1}
Level in wine	0-120 ng L^{-1}	150-3500 ng L^{-1}	15-150 ng L^{-1}	0-500 ng L^{-1}

Darriet *et al.*, 1995; Tominaga *et al.*, 1998; Tominaga *et al.*, 2000; Tominaga *et al.*, 2003

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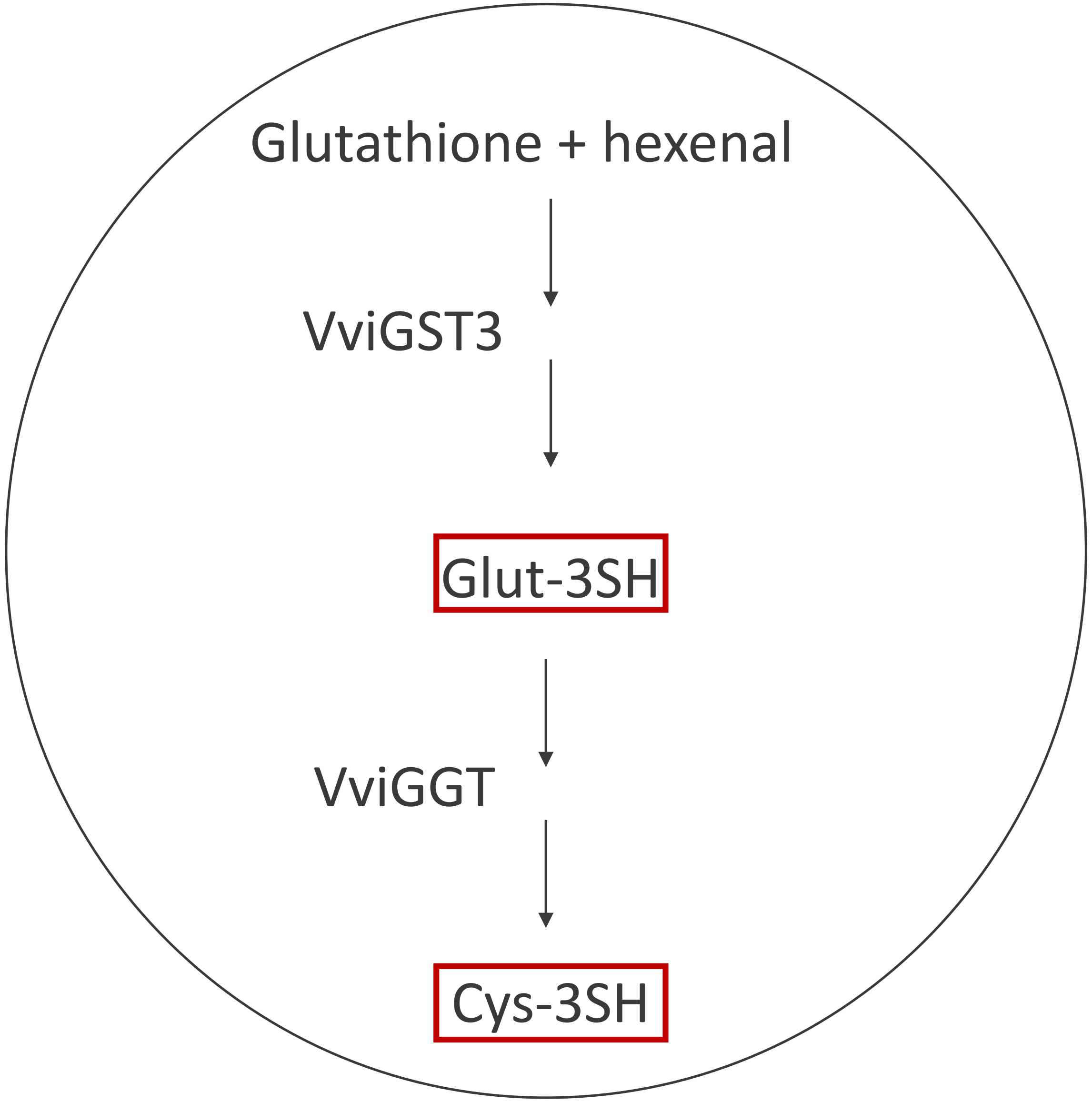
3SH

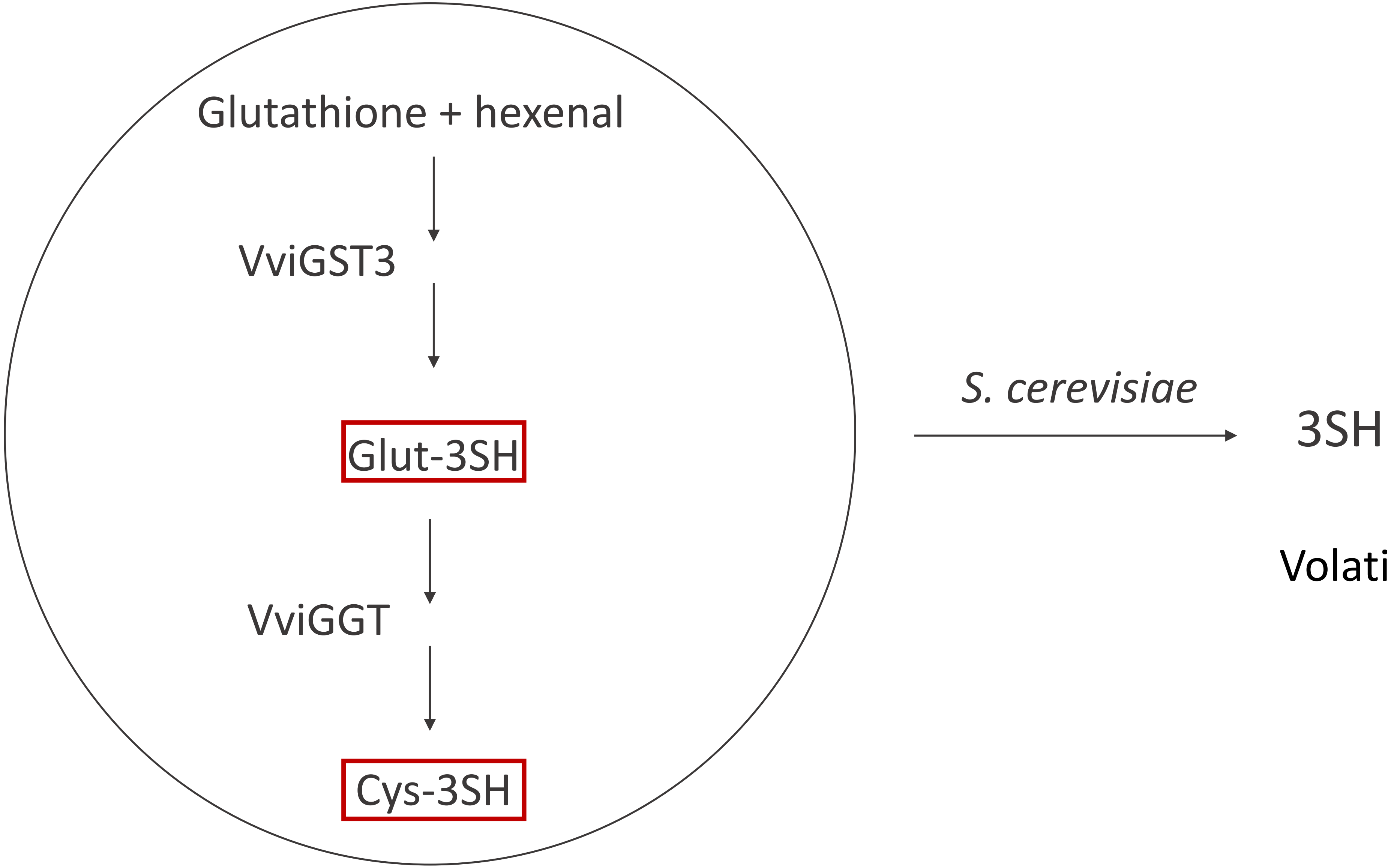


Non-volatile and non-odorous precursors:

- Glutathion-3SH (Glut-3SH)
- Cystein-3SH (Cys-3SH)

Modified from Thibon *et al.*, 2011; Kobayashi *et al.*, 2010

3SH



Volatile and odorous

Modified from Thibon *et al.*, 2011; Kobayashi *et al.*, 2010

What’s in the literature?

Many trials studied the effect of terroir components on the aroma compounds in question but none the direct and only effect of N.

Direct effect of vine nitrogen status on aroma compounds without interference with vine water status and vigor

Objectives

In the absence of water deficit and vigor variation

1. Determine the **direct** effect of vine N status on the content of :
   - IBMP and 3SH precursors in grape berries and musts
   - IBMP and 3SH in wines

2. Determine the response of *VviOMT3*, *VviGST3* and *VviGGT* to nitrogen supply

3. Search for other key genes involved in biosynthetic pathways of these aroma compounds and study their responses to nitrogen nutrition

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Experimentations

Vintages - 2013 & 2014

Vineyards (YAN < 150 mg/L)

Pessac-Léognan **-** Sauvignon blanc & Cabernet-Sauvignon

Sancerre **-** Sauvignon blanc & Pinot noir

Potted plants - Villenave d’Ornon

Château COUHINS

HB HENRI BOURGEOIS

CHATEAU DE FONTAINE-AUDON SANCERRE

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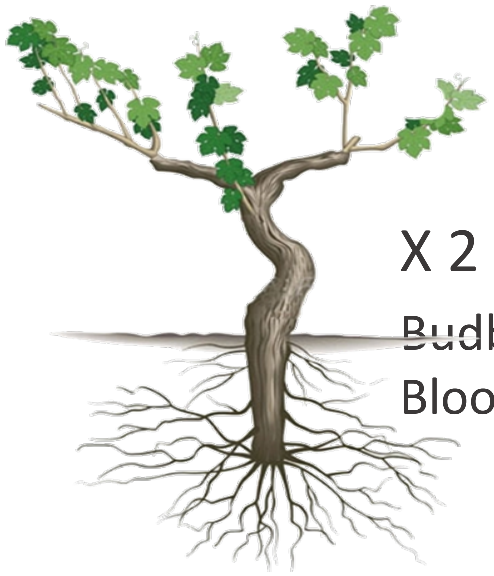
Château COUHINS

HB HENRI BOURGEOIS

TERROIR SILEX CHATEAU DE FONTAINE-AUDON SANCERRE APPELLATION SANCERRE CONTRÔLÉE

Experimentations

Control

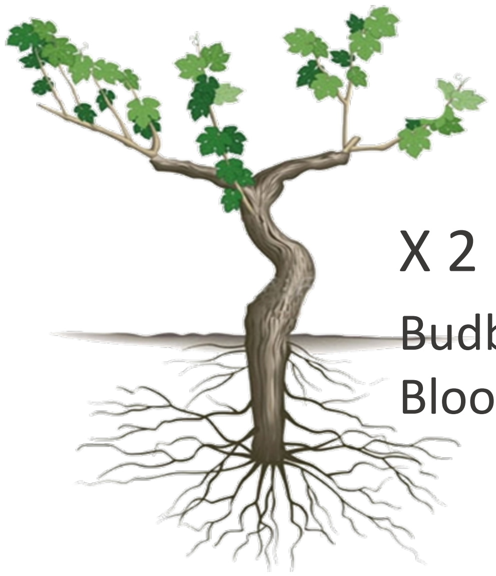


X 2

Budbreak

Bloom

Soil N50



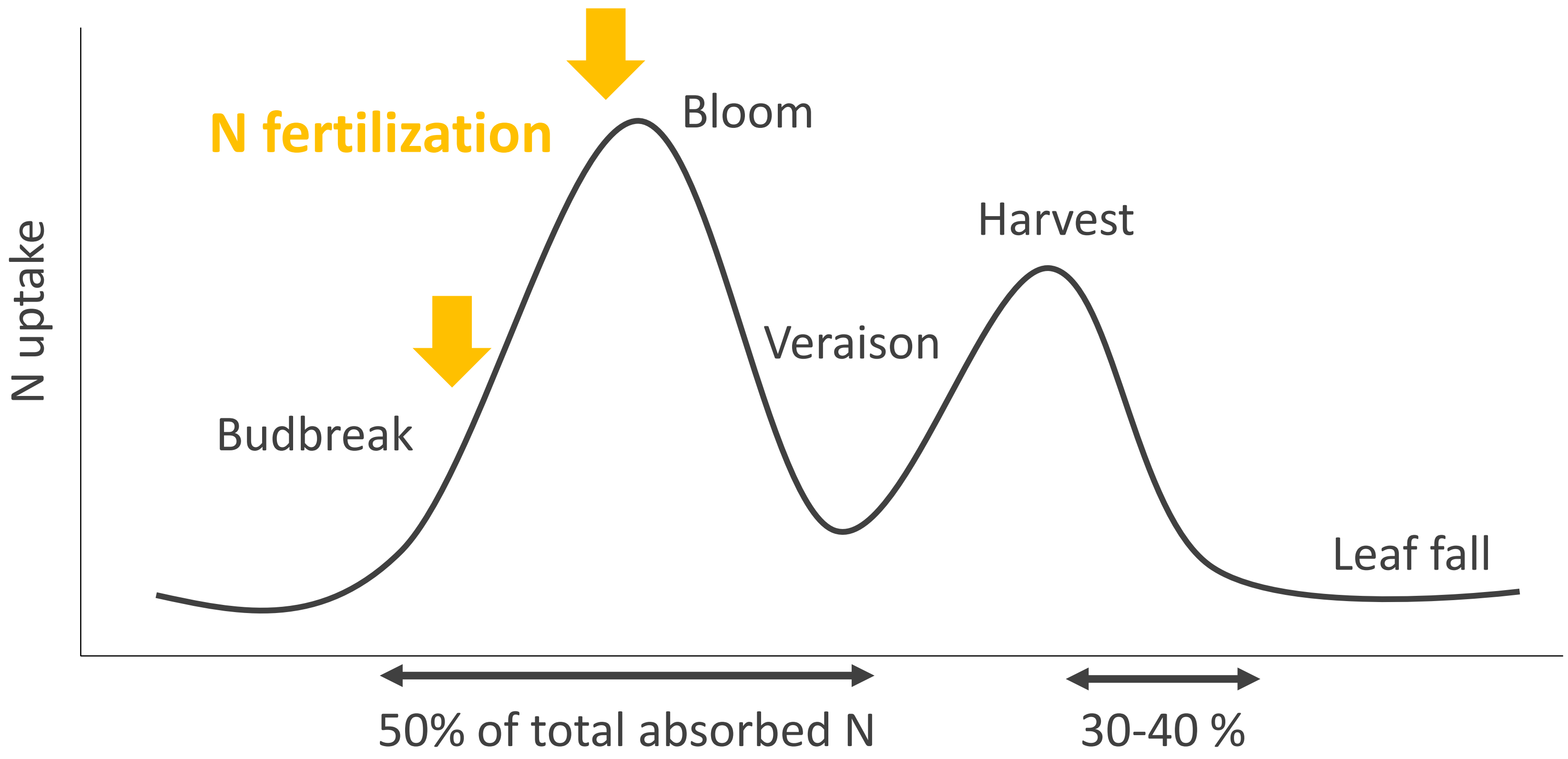
X 2

Budbreak

Bloom

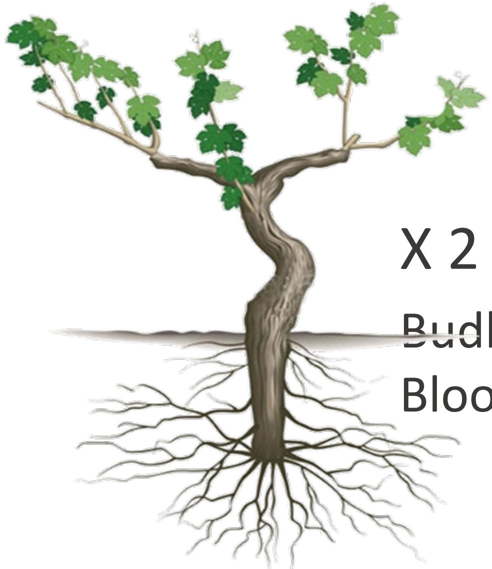
Soil N100

Experimentations



Experimentations

Control

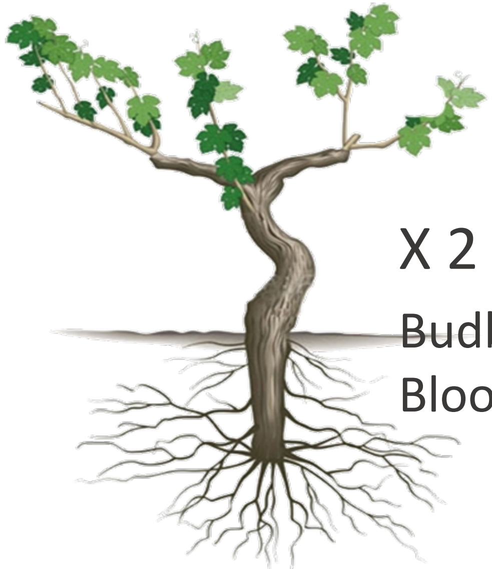


X 2

Budbreak

Bloom

Soil N50



X 2

Budbreak

Bloom

Soil N100

Experimentations

Control

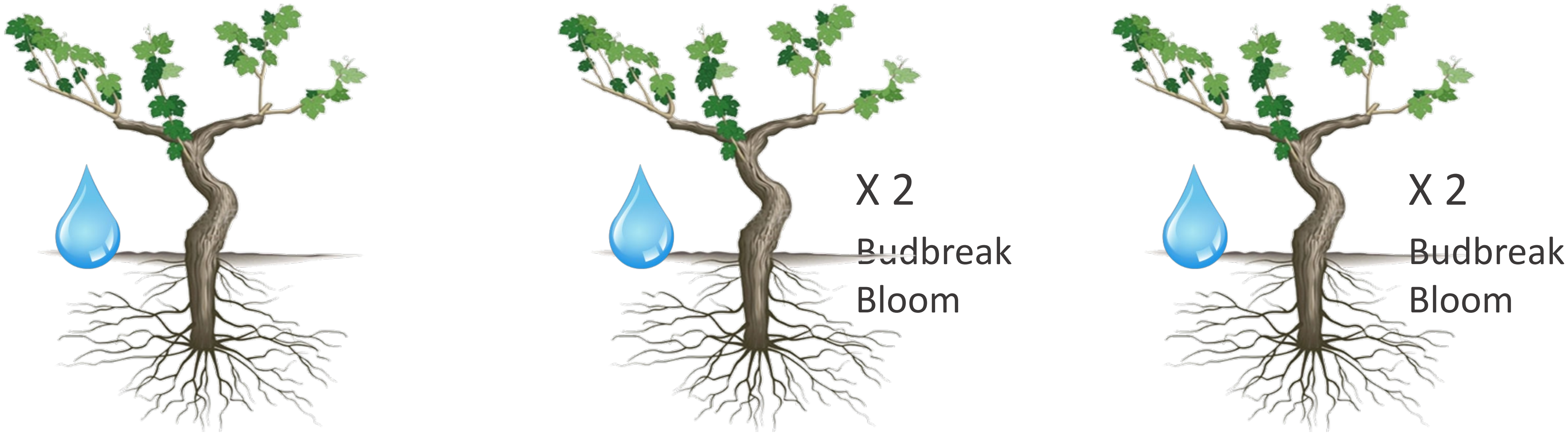
X 2
Budbreak
Bloom

Soil N50

X 2
Budbreak
Bloom

Soil N100

Experimentations



Control

Soil N50

Soil N100

Berry sampling

Bunch closure (BC) – Mid-veraison (MV) – Mid-ripening (V+28) – Ripeness (V+35)

(9° Brix) (19° Brix) (23° Brix)

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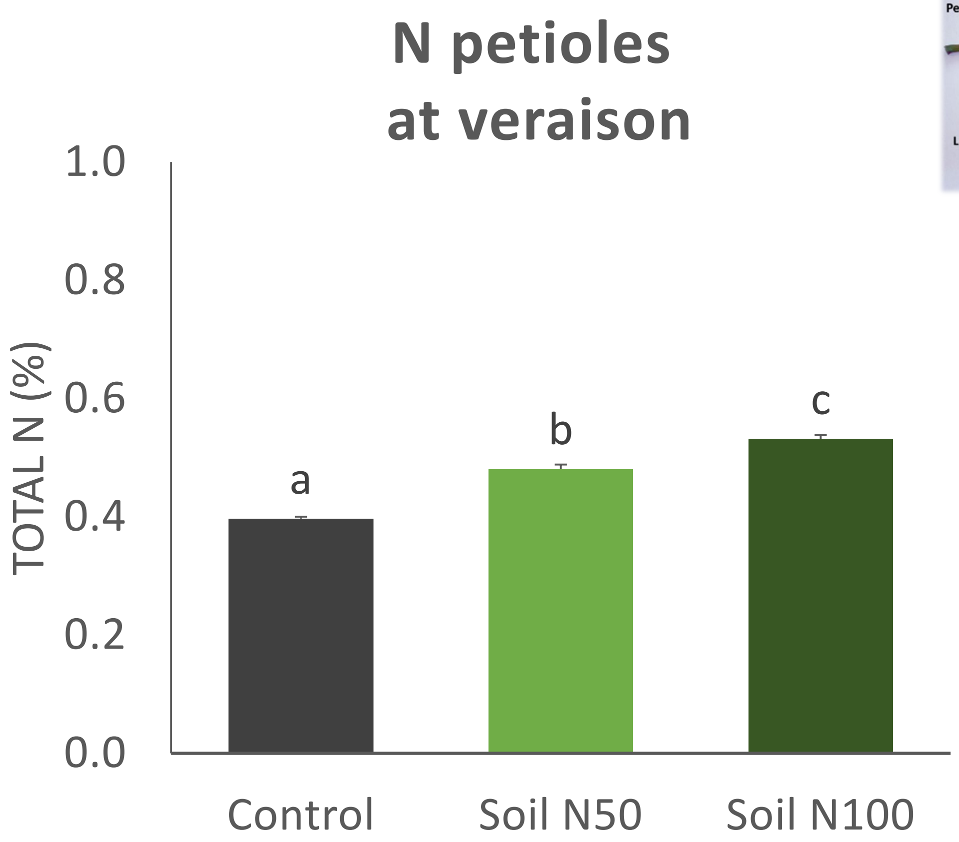
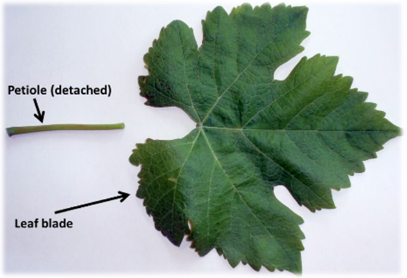
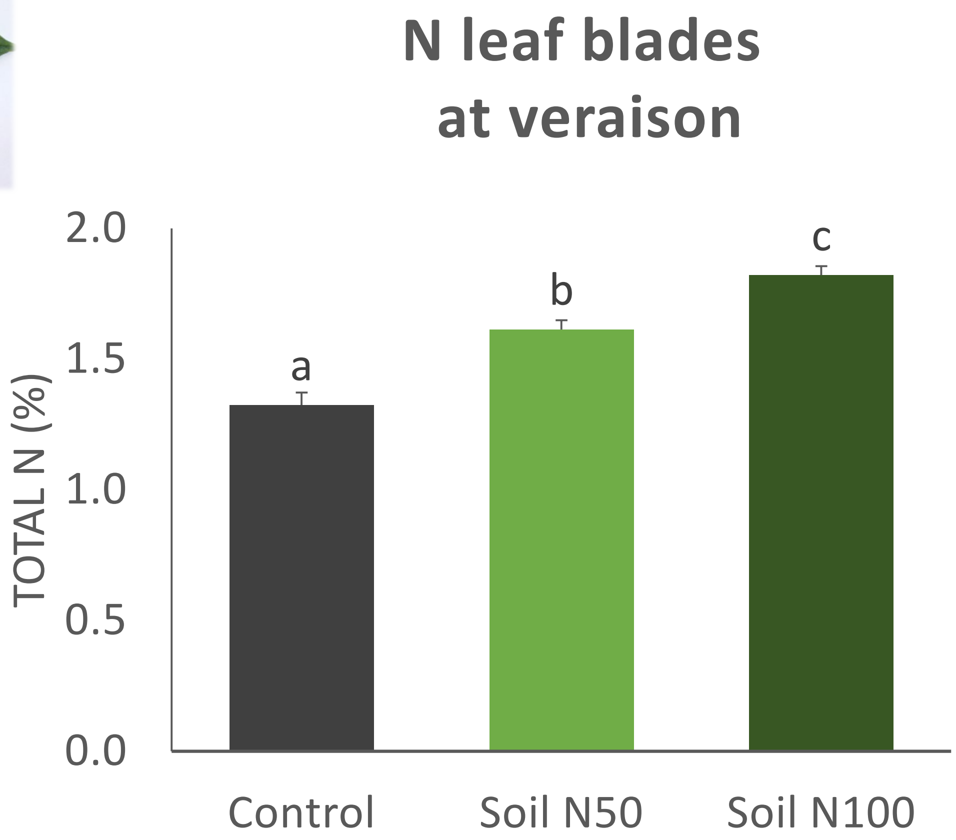
Vine Nitrogen Status







Petioles and leaf blades at veraison showed higher N status for fertilized modalities compared to control.

Vine Nitrogen Status

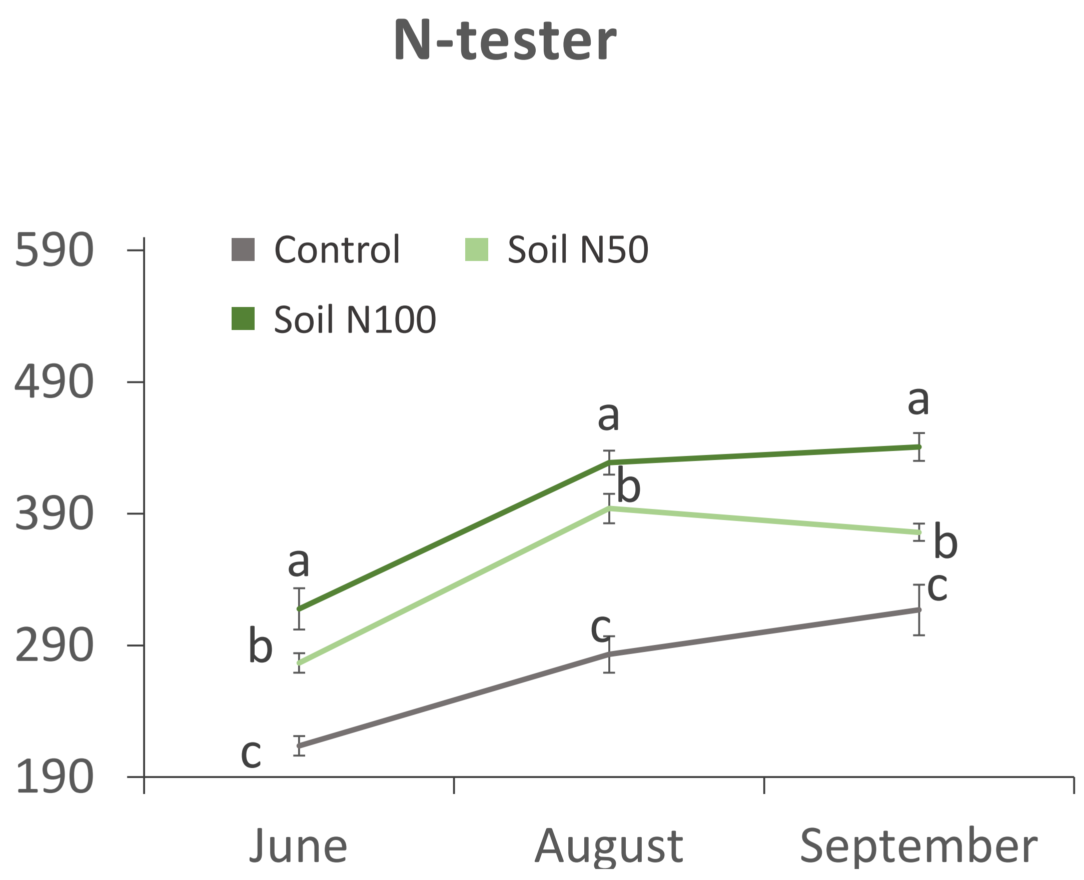
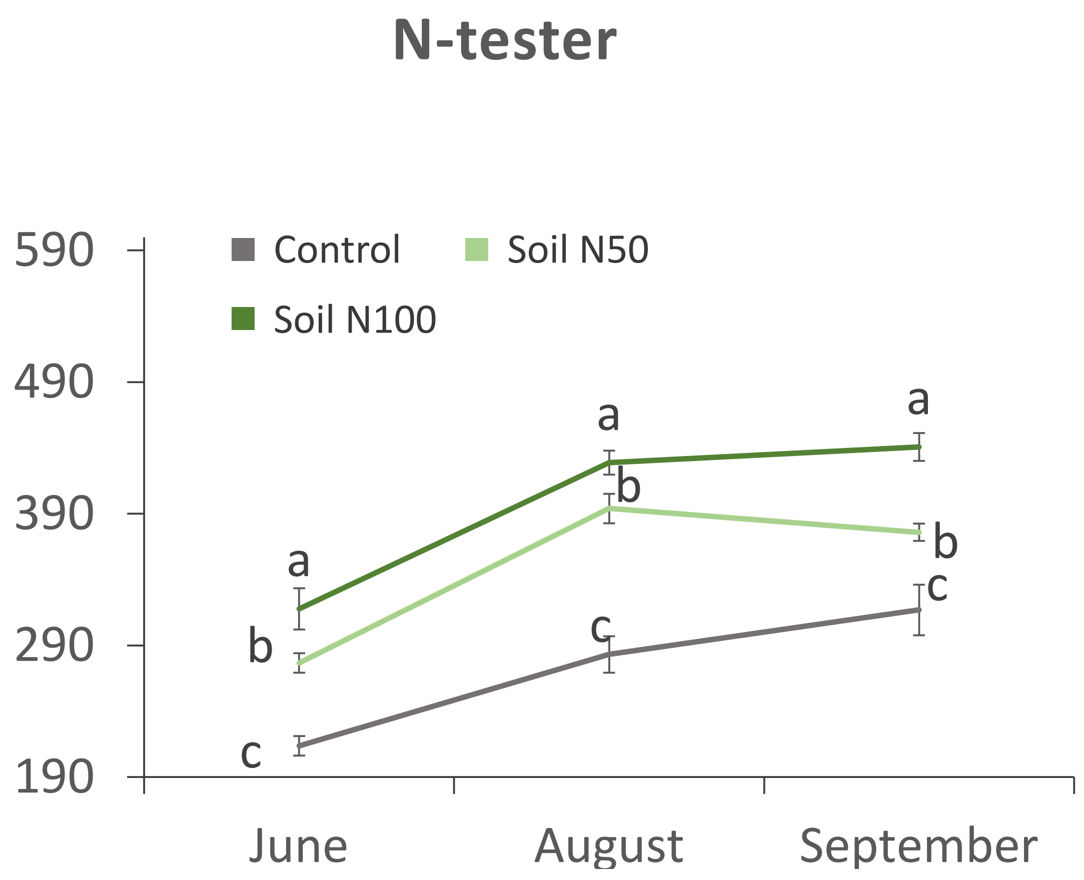
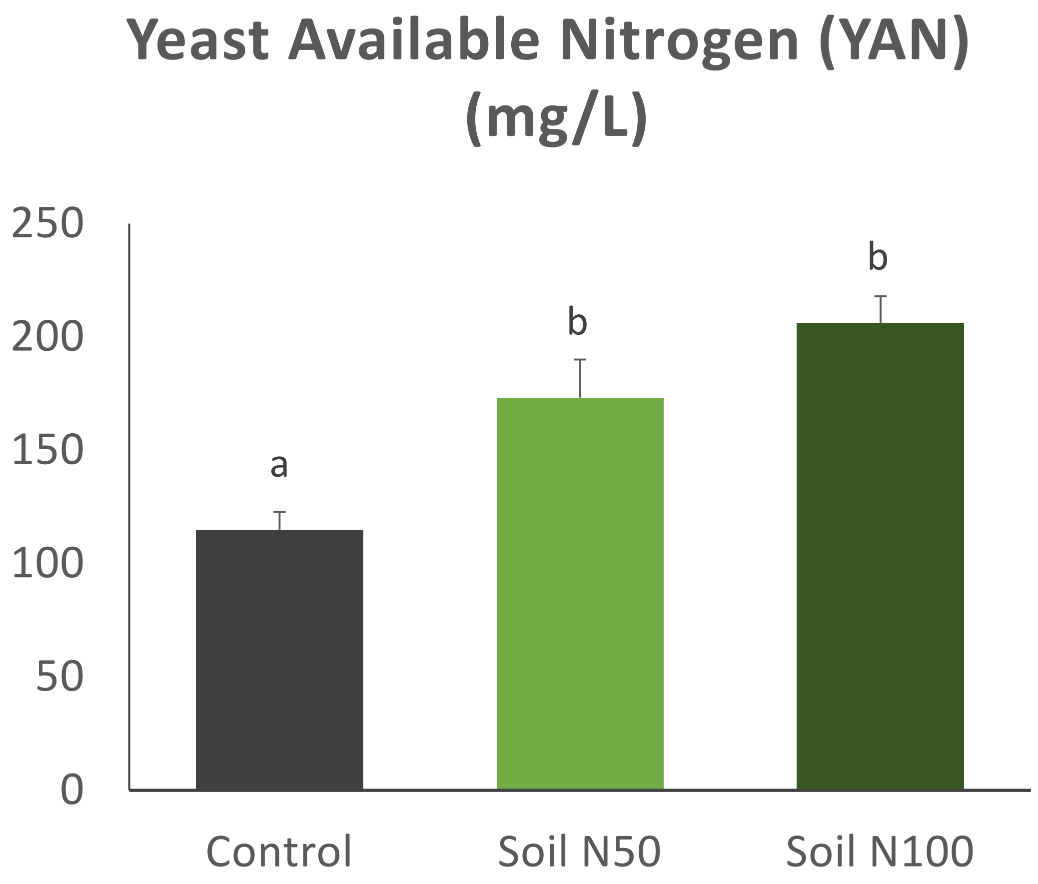


Photo: farm-store.eu

Higher N status for fertilized modalities compared to control.

Vine Nitrogen Status





Higher N status for fertilized modalities compared to control.

Vine Nitrogen Status

1. Nitrogen was assimilated by vines in fertilized treatments.
2. Fertilized treatments have higher N status compared to control.

Objectives

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Vine Water Status

Stem Water Potential (MPa)

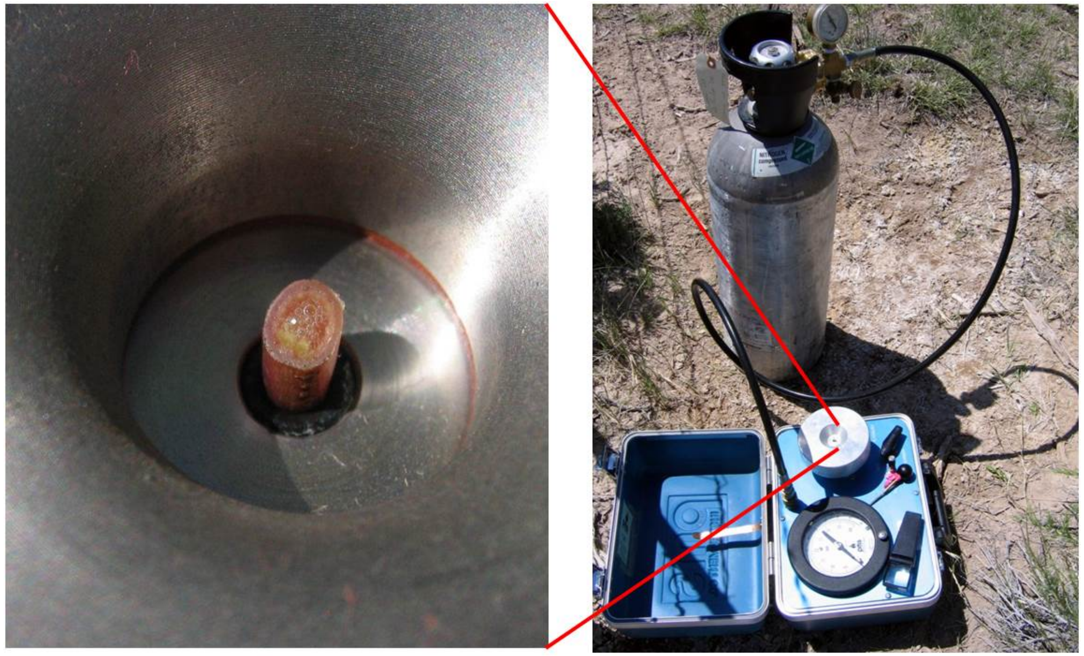
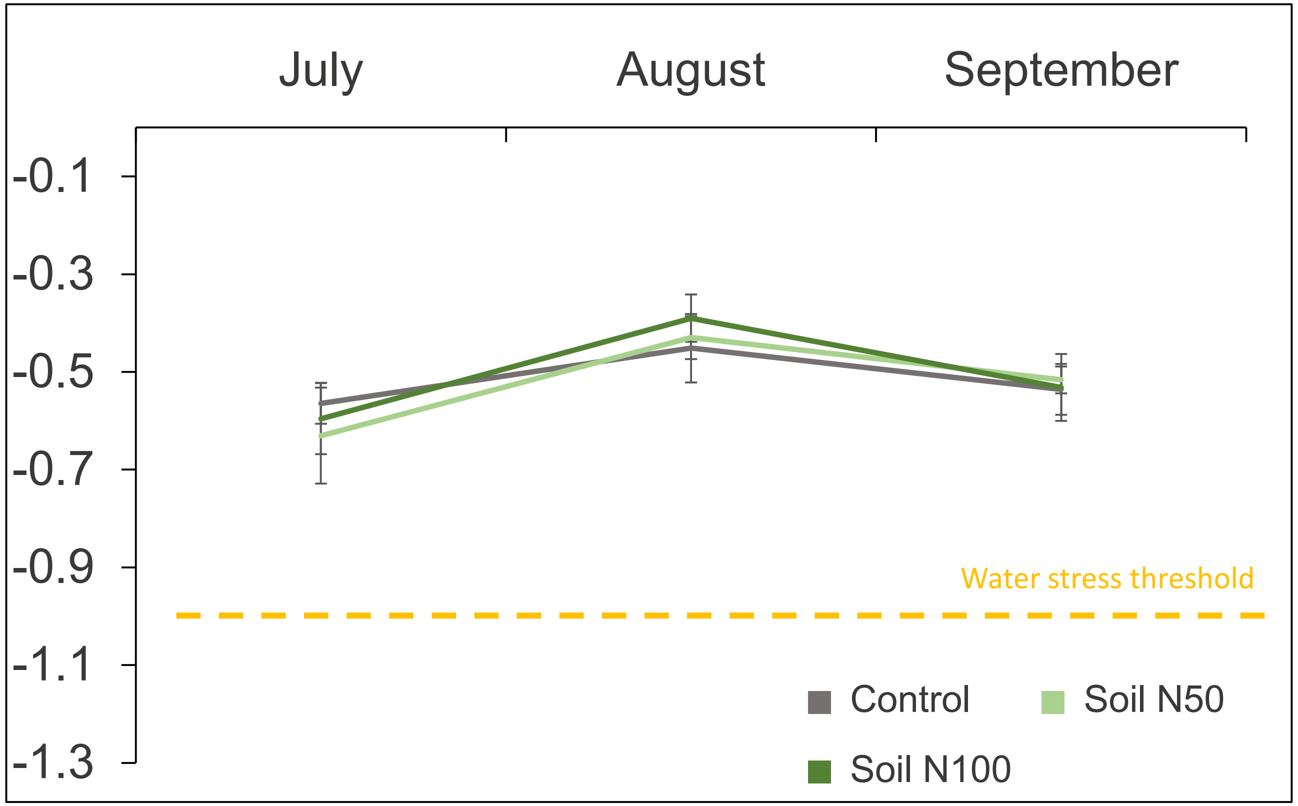
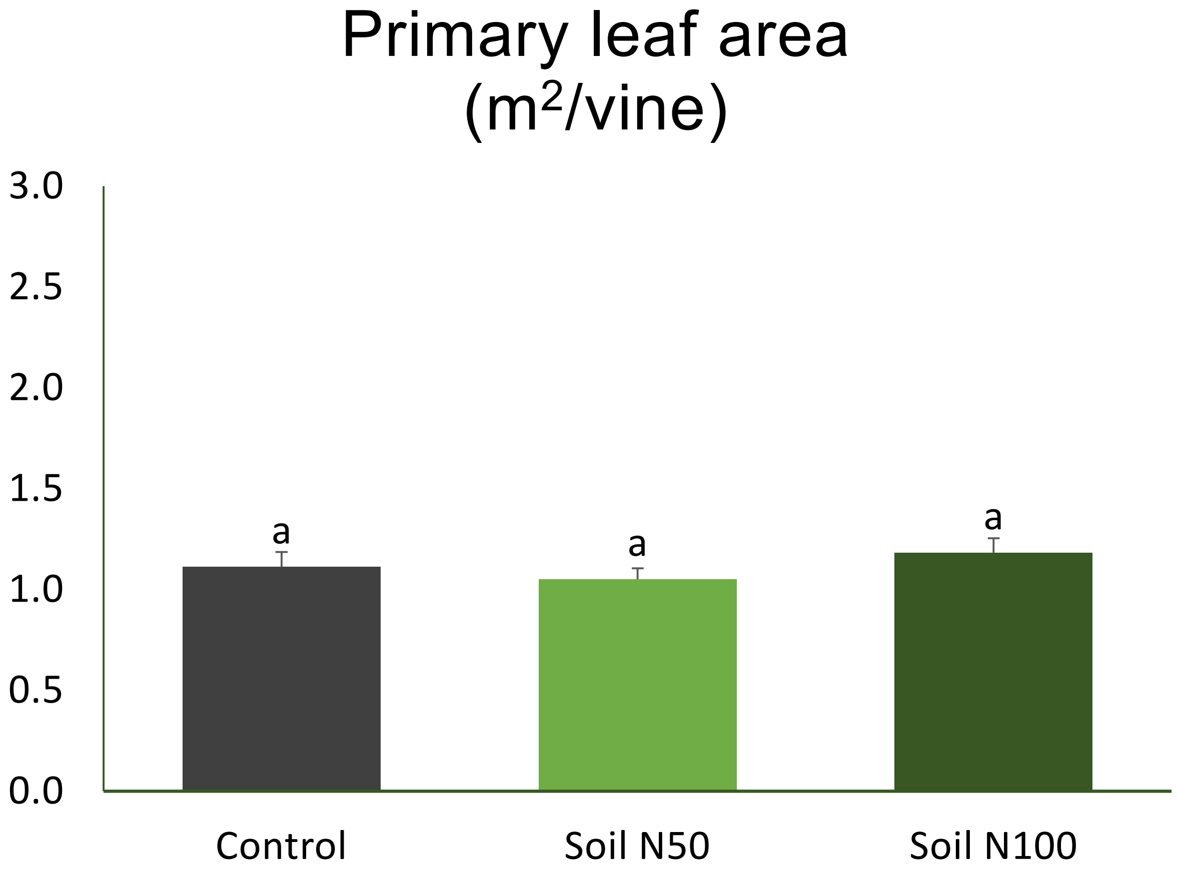


Photo: Colorado State University



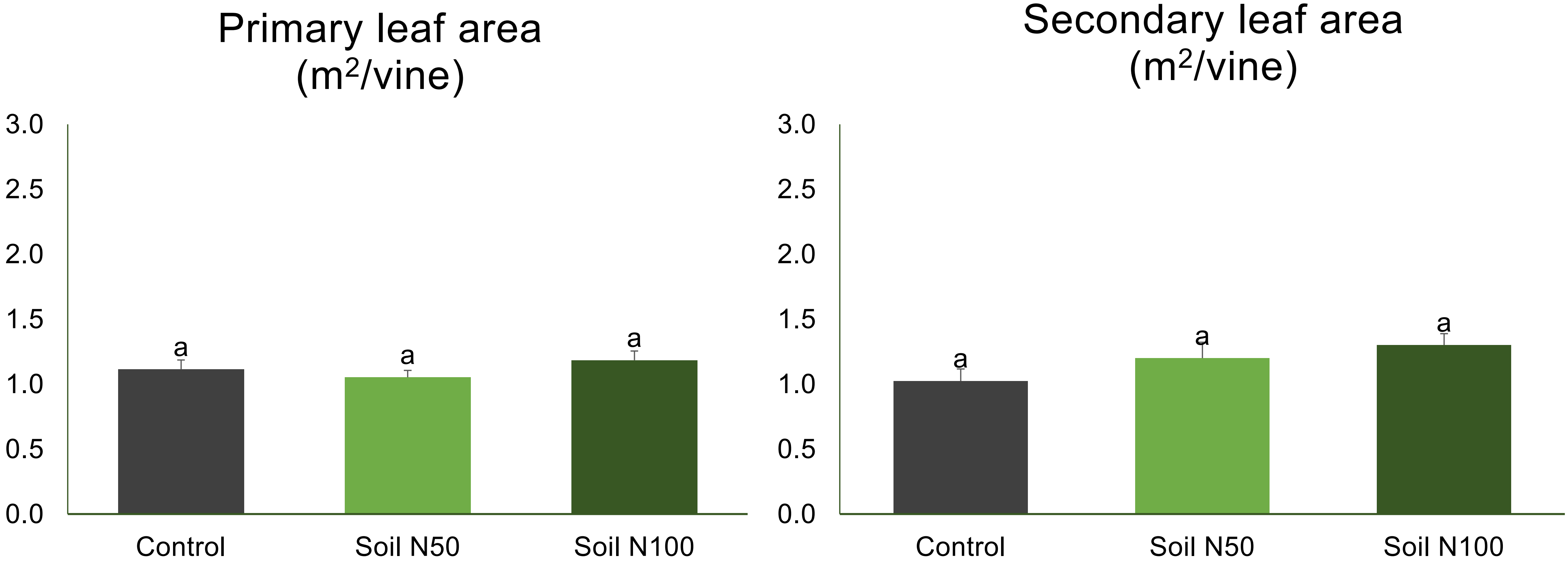
Absence of water deficit during the season

Vine Vigor



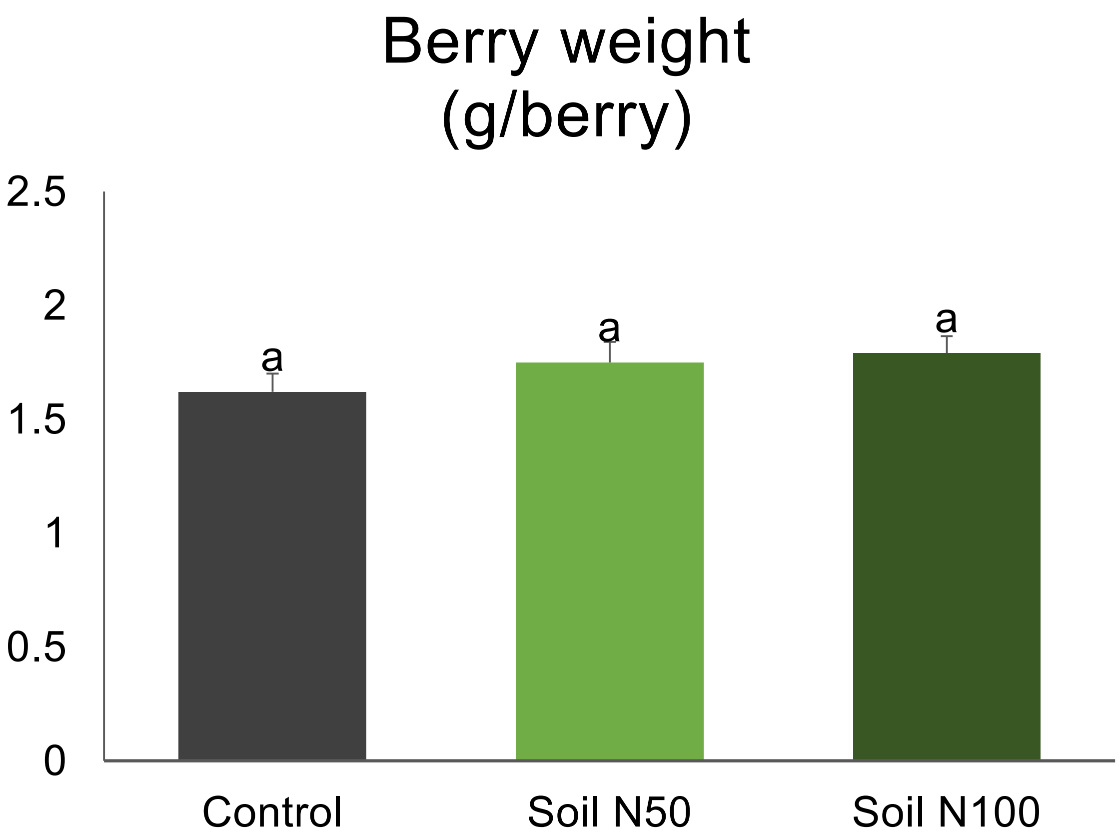
LICOR leaf area meter

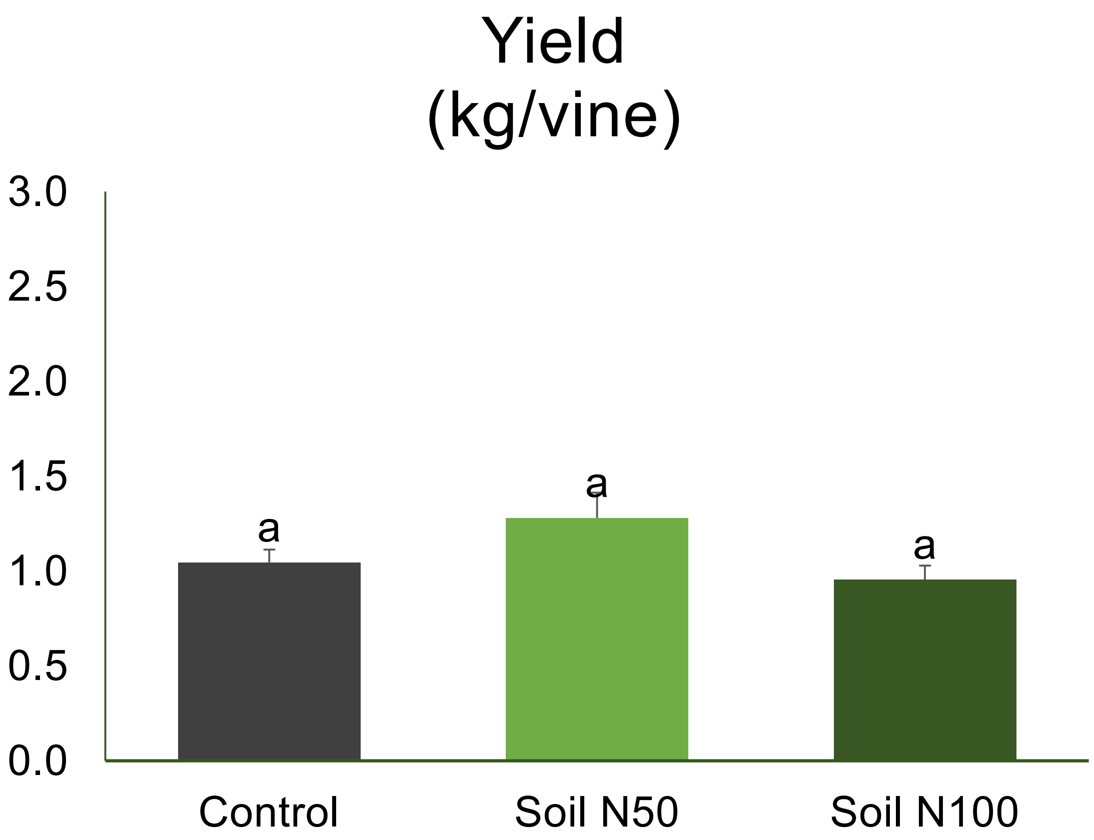
Vine Vigor



No effect of N supply on vigor.

Yield Components





No effect of N supply on yield components.

Summary

Absence of water deficit during the season

Summary

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No difference in vigor and yield between treatments

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Absence of water deficit during the season

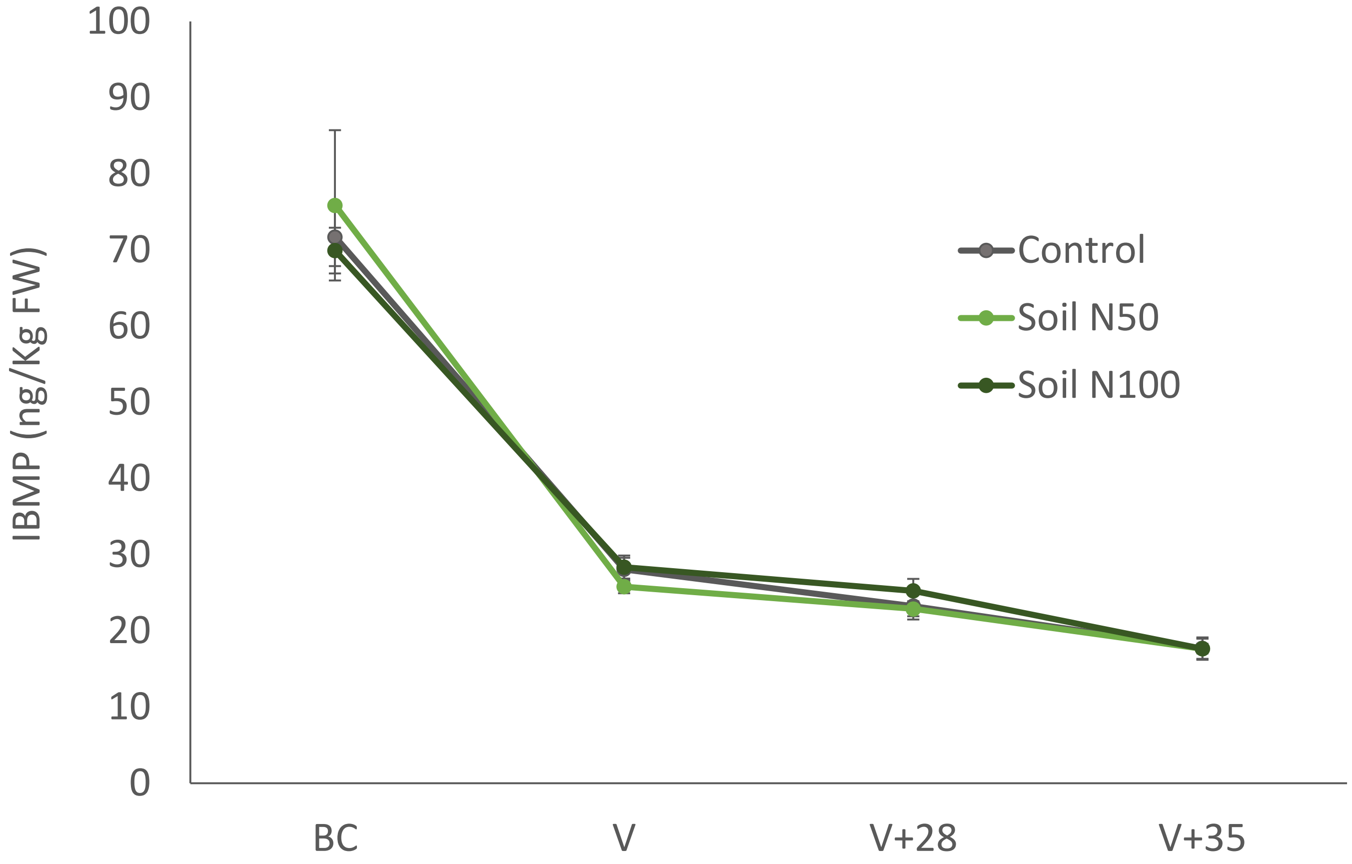
No difference in vigor and yield between treatments

Difference in vine N status - Higher N status for fertilized modalities mainly for the soil N100.

Direct impact of vine nitrogen status on aroma compounds without interference with vine water status and vigor

IBMP – Free Aroma Compound

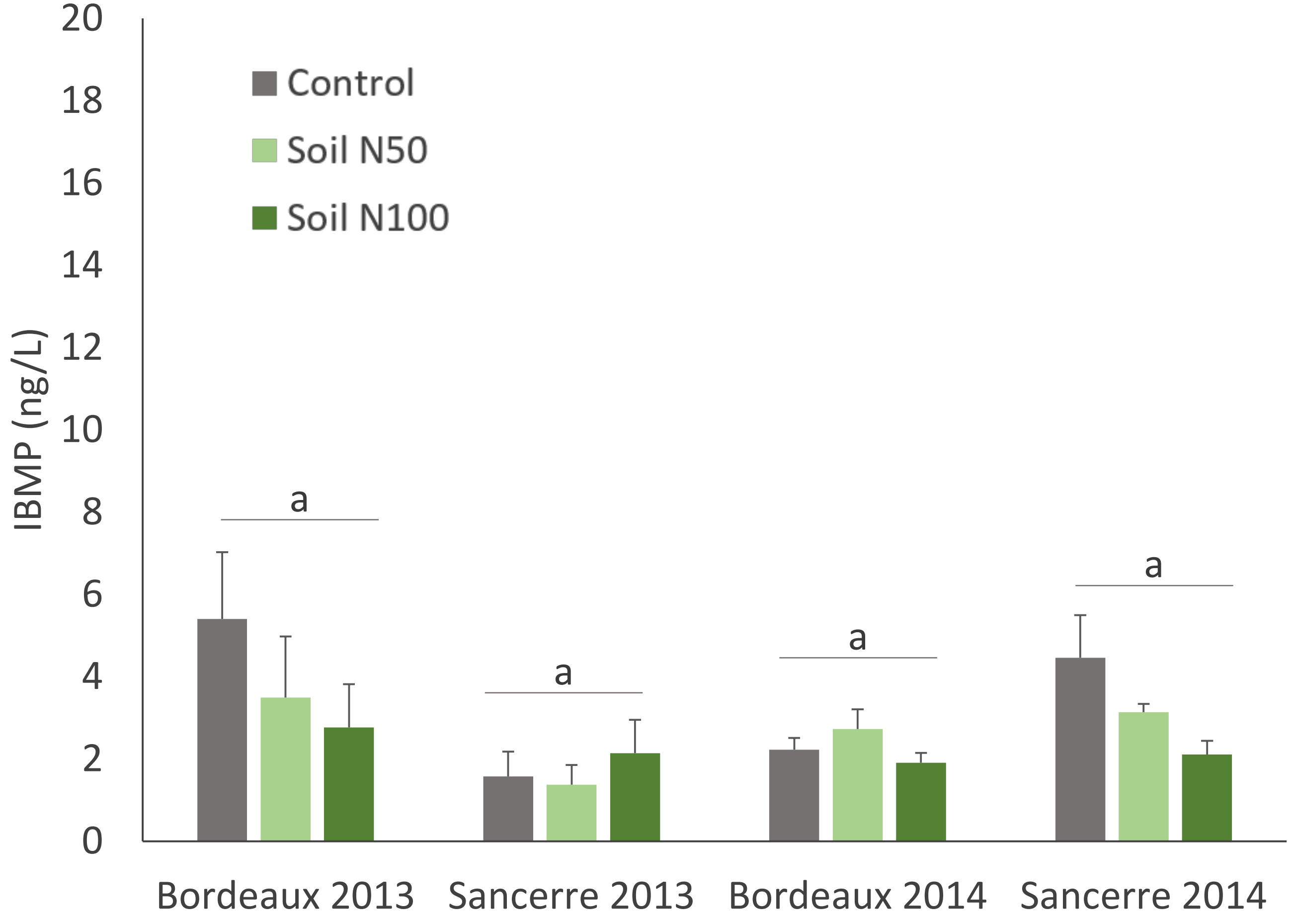
In grape berries



No effect of vine N status on IBMP levels in grape berries

IBMP – Free Aroma Compound

In wine

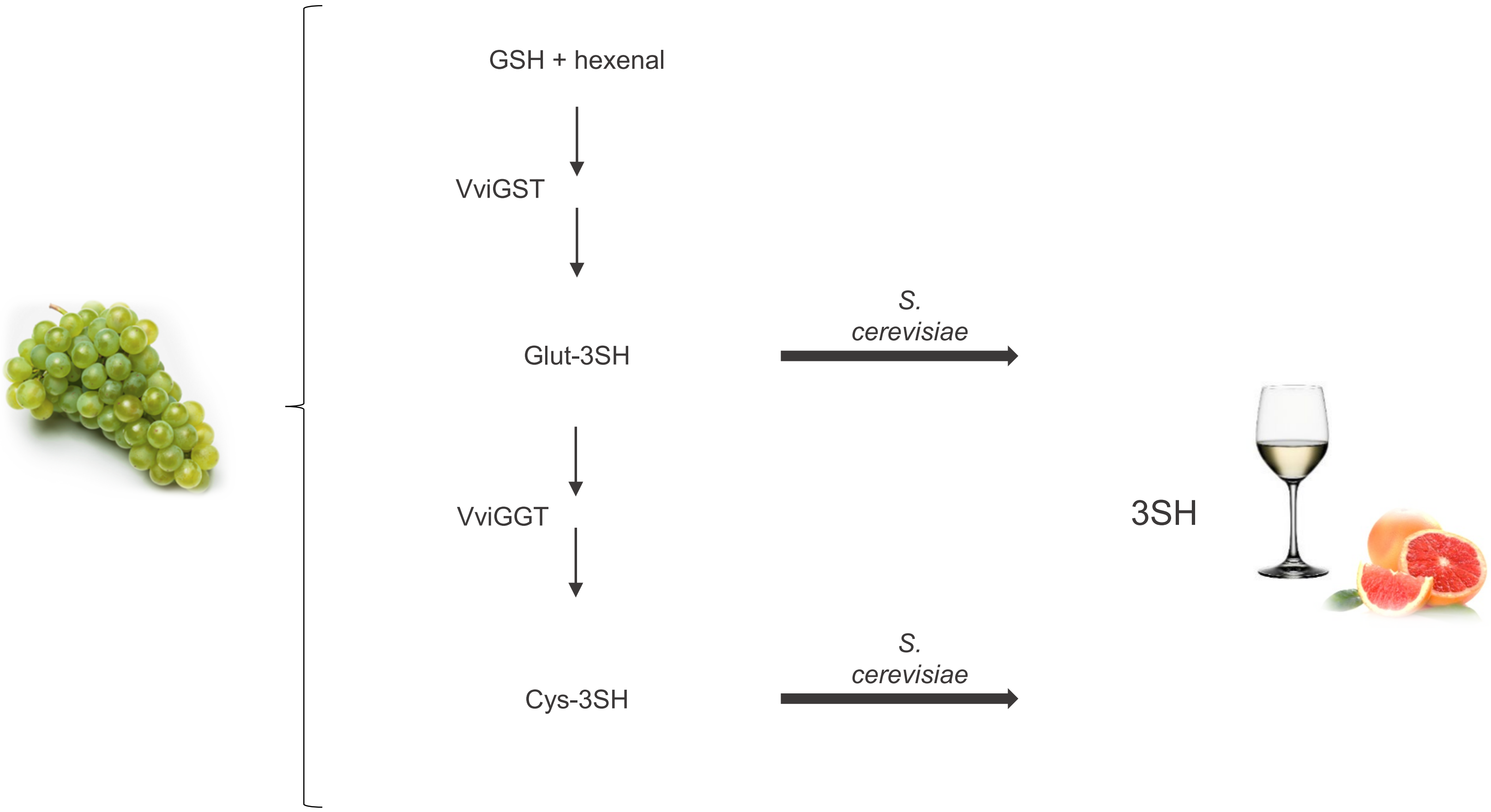


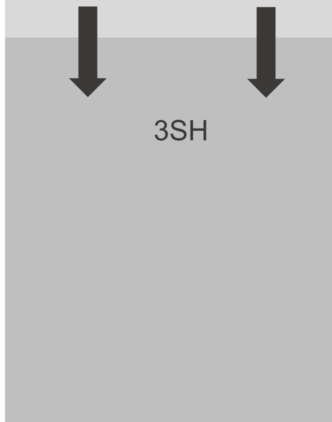
No effect of vine N status on IBMP levels in wine.

No <u>direct</u> effect of vine nitrogen status on IBMP level in grape berries and wines

Vine nitrogen status does not have a direct impact on IBMP in grape berries and wines
Helwi *et al.*, 2015, Journal of Agriculture and Food Chemistry (JAFC)

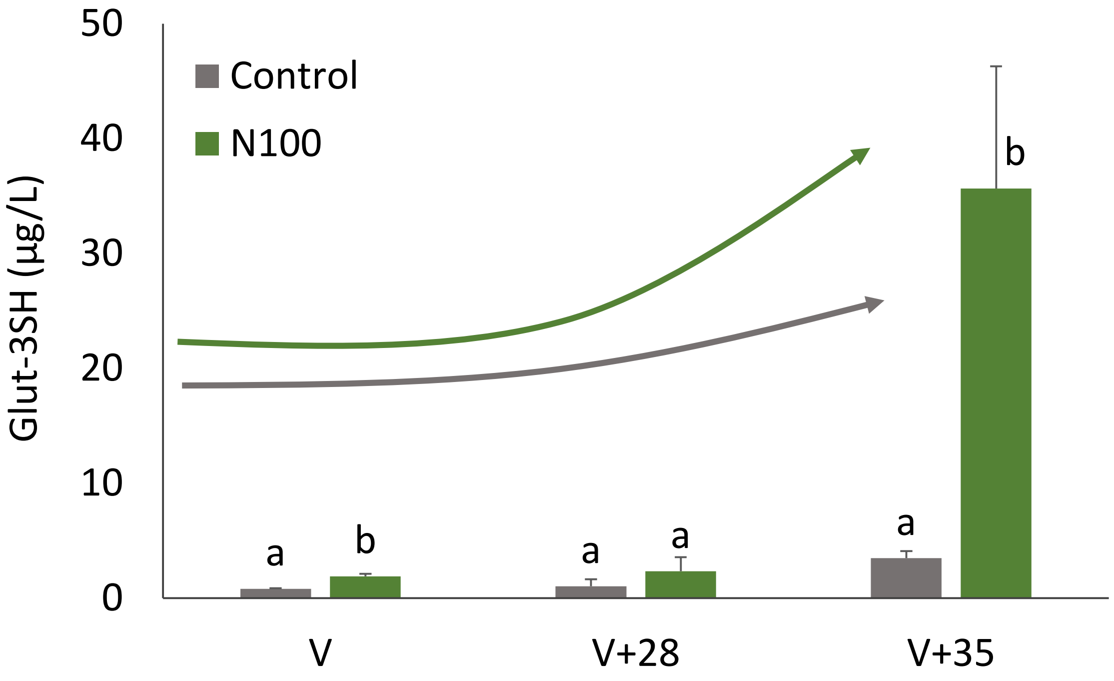
3SH and its Precursors

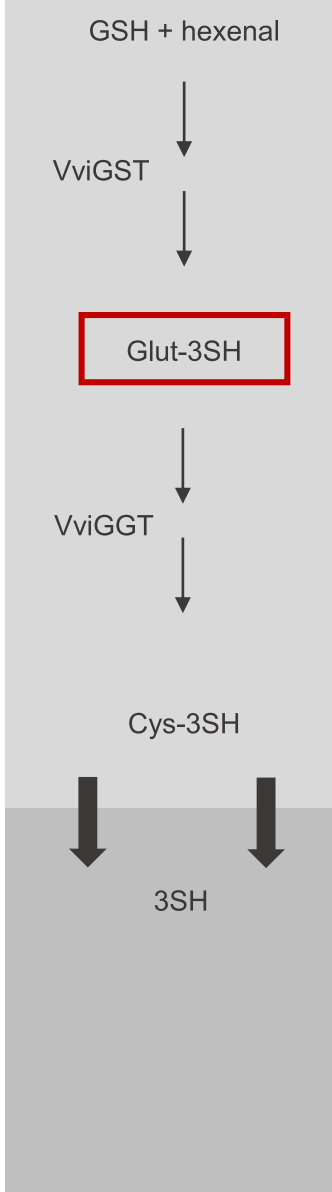




3SH and its Precursors

In grape berries

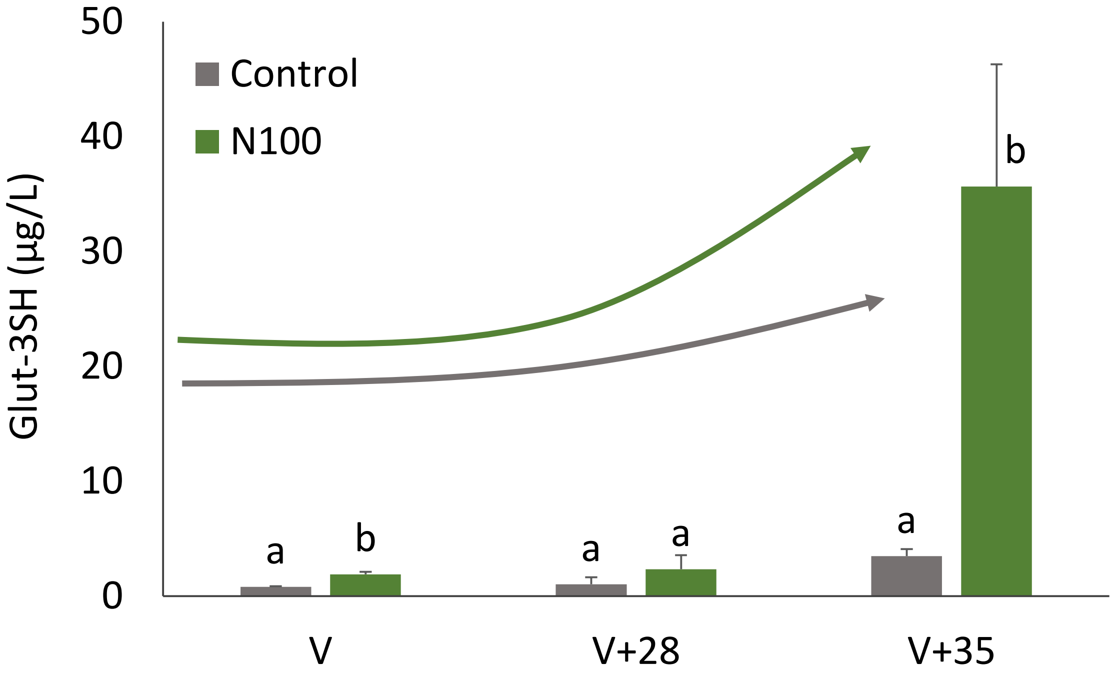


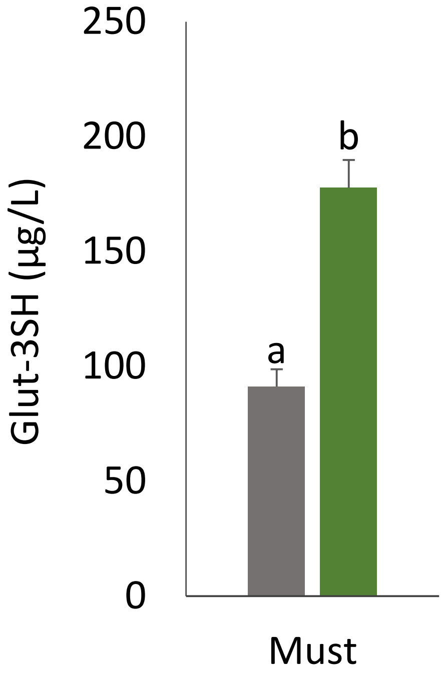


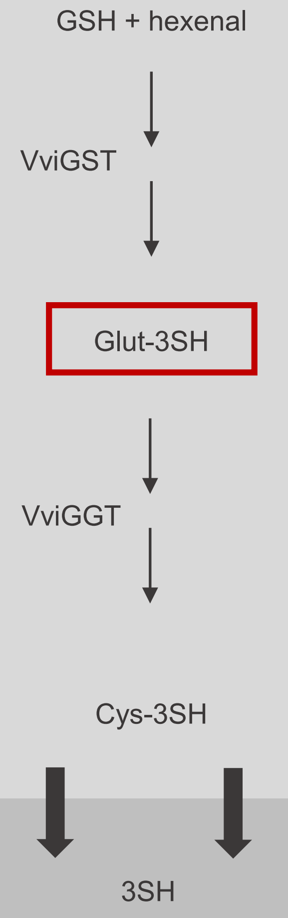
3SH and its Precursors

In grape berries

In must



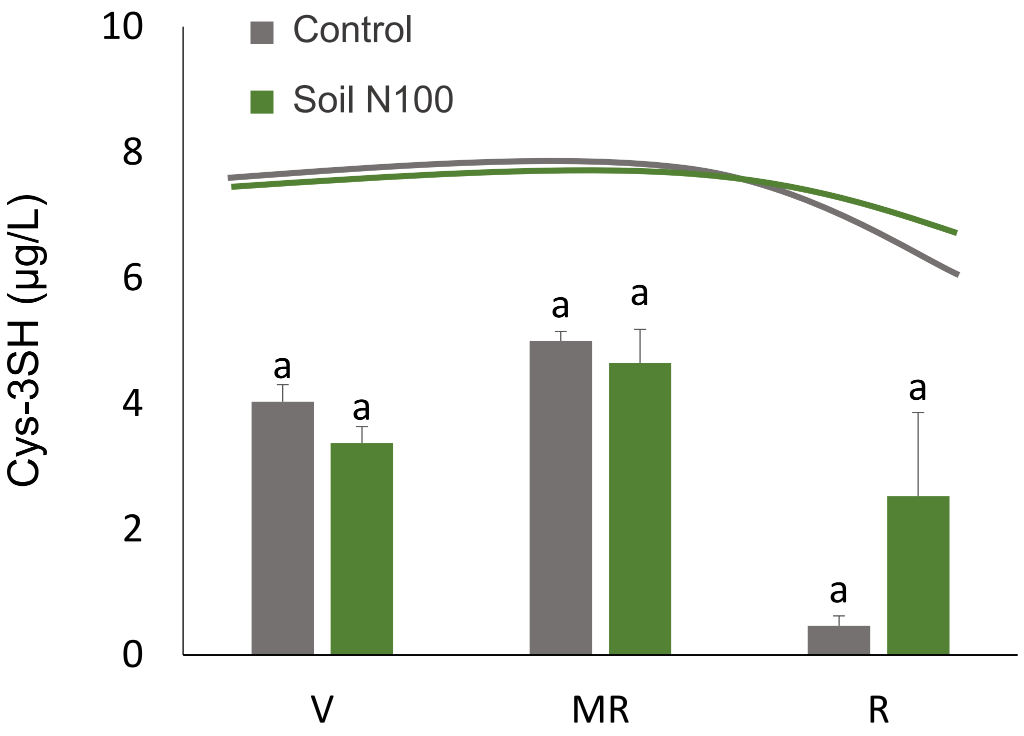




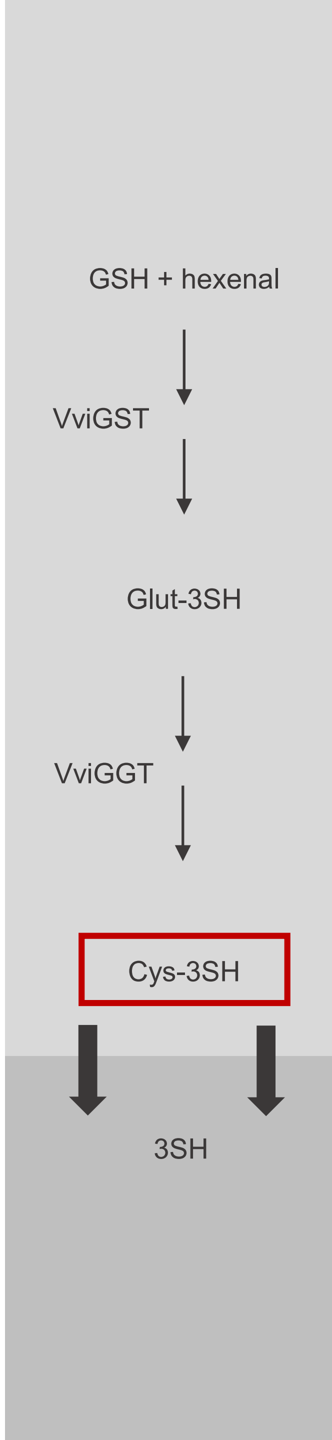
Positive effect of vine N status on Glut-3SH levels in berries and must

3SH and its Precursors

In grape berries

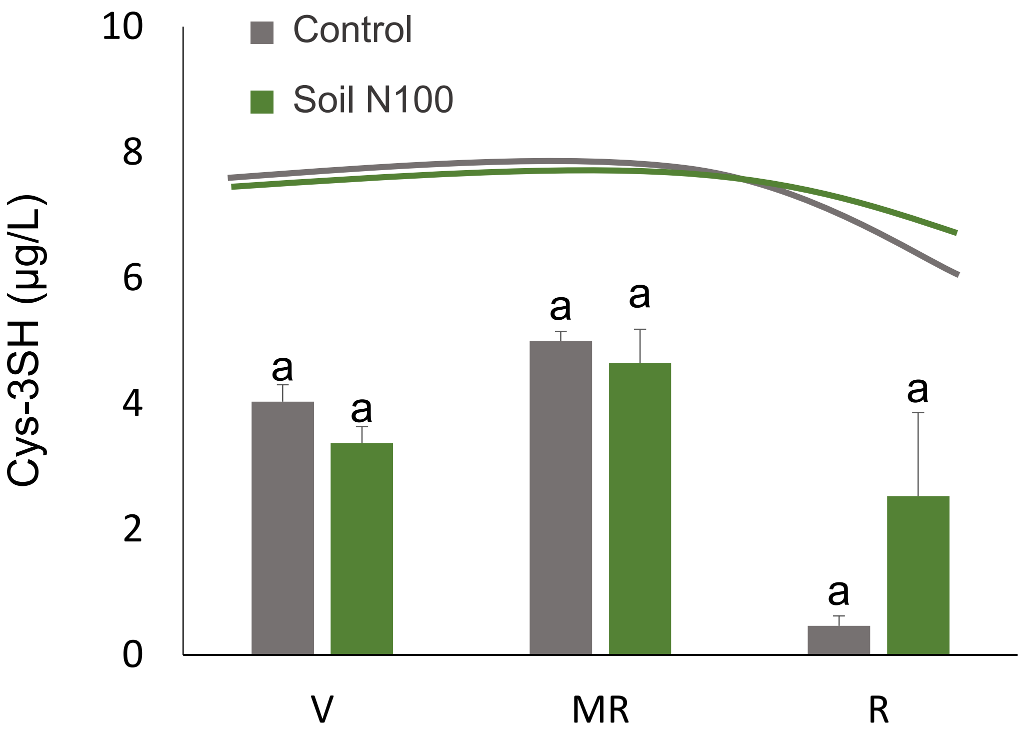


No effect of vine N status on Cys-3SH levels in berries and must

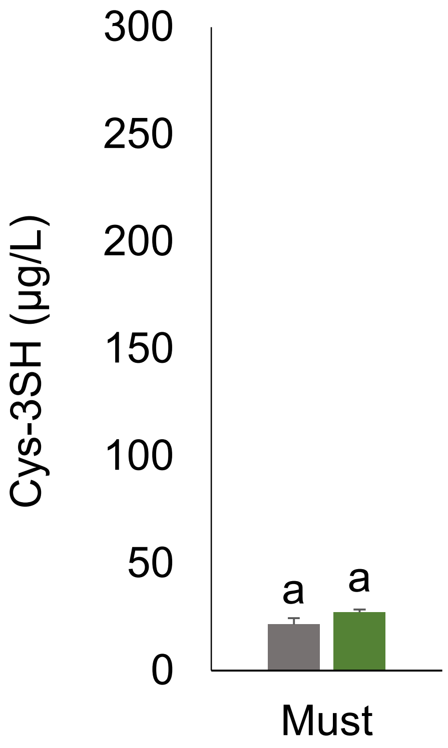


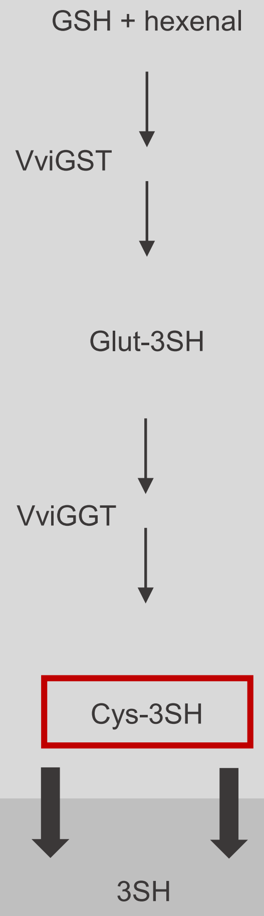
3SH and its Precursors

In grape berries



In must

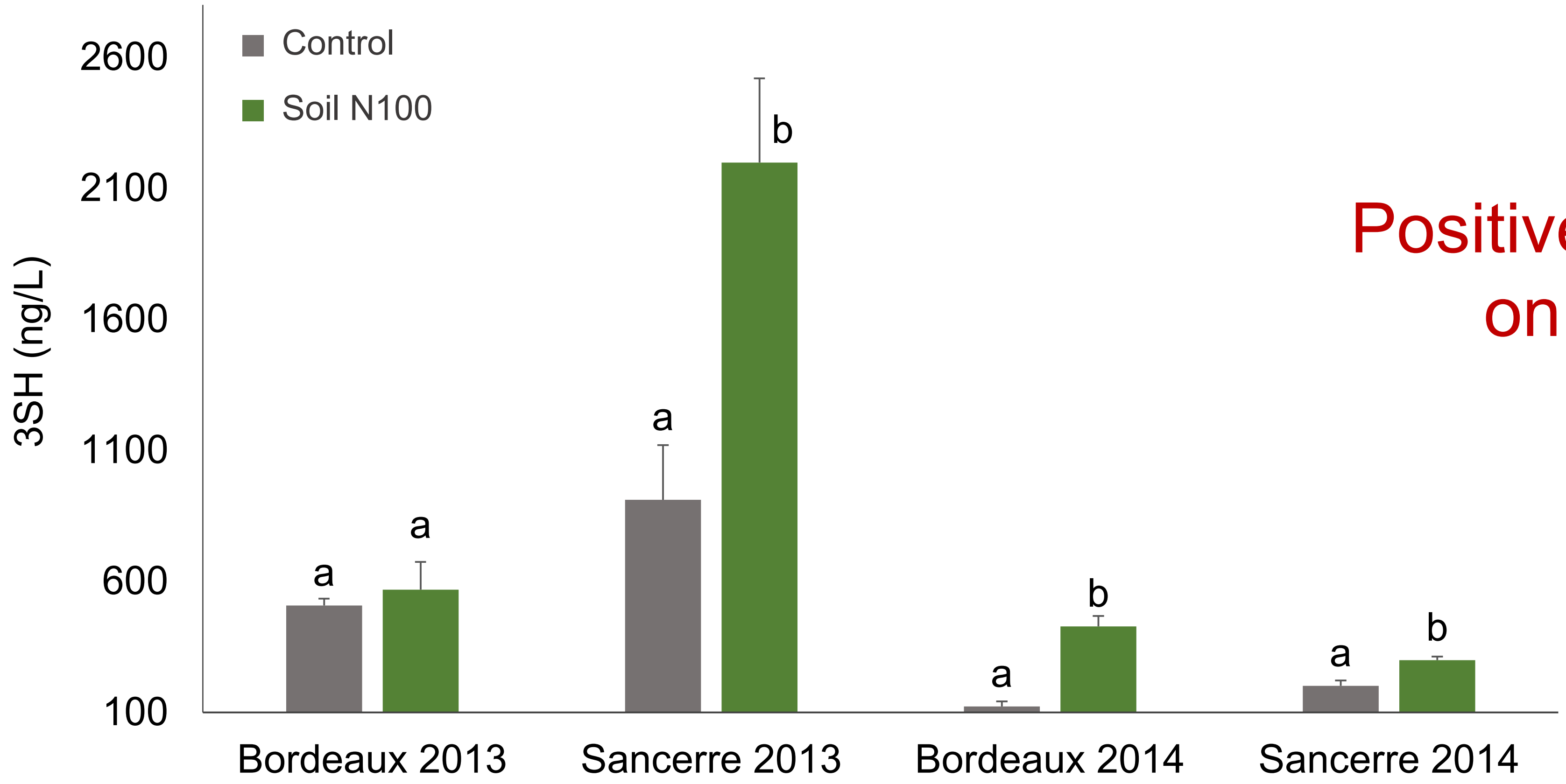




No effect of vine N status on Cys-3SH levels in berries and must

3SH and its Precursors

In wine



Positive effect of vine N status on 3SH levels in wine

Direct positive effect of vine nitrogen status on Glut-3SH level in berries & must and on 3SH level in wines

Independently from Cys-3SH

Vine nitrogen status and volatile thiols and their precursors from plot to transcriptome level
Helwi *et al.*, 2016, BMC Plant Biology

Conclusions

With N fertilization in the absence of water deficit and vigor variation :

IBMP	=		=

Vine nitrogen status does not have a direct impact on IBMP in grape berries and wines

Conclusions

With N fertilization in the absence of water deficit and vigor variation :

			
IBMP	=		=
3SH	▲		

Conclusions

With N fertilization in the absence of water deficit and vigor variation :



IBMP	=		=
3SH	▲		
Glut-3SH		▲	▲

Conclusions

With N fertilization in the absence of water deficit and vigor variation :

IBMP	=		=
3SH	▲		
Glut-3SH	▲	▲	▲
Cys-3SH		=	=

Vine nitrogen status impacts wine 3SH and Glut-3SH contents

Conclusions

With N fertilization in the absence of water deficit and vigor variation :

			
IBMP	=		=
3SH	▲		
Glut-3SH	▲	▲	▲
Cys-3SH		=	=

- Identification of *VviGSTU19* and *VviOPT,* candidate genes from 3SH precursors pathway

Articles

Vine nitrogen status and volatile thiols and their precursors from plot to transcriptome level

BMC Plant Biology, 2016

Effect of vine nitrogen status, grapevine variety and rootstock on berry S-glutathionylated and S-cysteinylated precursors of 3-sulfanylhexan-1-ol

Journal International des Sciences de la Vigne et du Vin, 2015

Vine nitrogen status does not have a direct impact on IBMP in grape berries and wines

Journal of Agriculture and Food Chemistry, 2015

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OENOLOGIE USC1366

UNITE DE RECHERCHE

Philippe Darriet
Cécile Thibon
Pascaline Redon
Warren Albertin
Sophie Tempère

SICAVAC

Sancerre

Bertrand Daulny
François Dal
Emeline Piton
Magali Darde
Anne-Lise Lapouge
Suzanne Balacey

UE viticole

INRA – Villenave d'Ornon

Dominique Forget
Matthieu Arroyo
Willy Goupil

THANK YOU!

pierre.helwi@ag.tamu.edu

Website: Aggie-horticulture.tamu.edu/vitwine
Facebook: Texas Viticulture & Enology
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SANCERRE
Les Baronnes
HB
HENRI BOURGEOIS

2018


20
18
KONO
WINE OF NEW ZEALAND
SAUVIGNON BLANC
Marlborough


LLANO
ESTACADO
2018
TEXAS
SAUVIGNON BLANC
wine-searcher.com

Sancerre, Loire Valley France

Soils

Hills and valleys.

3 types of soil: clay and limestone, limestone and siliceous clay.

Climate

Temperate with a continental influence.

Average temperatures range from 30°F in winter to 79°C in summer.

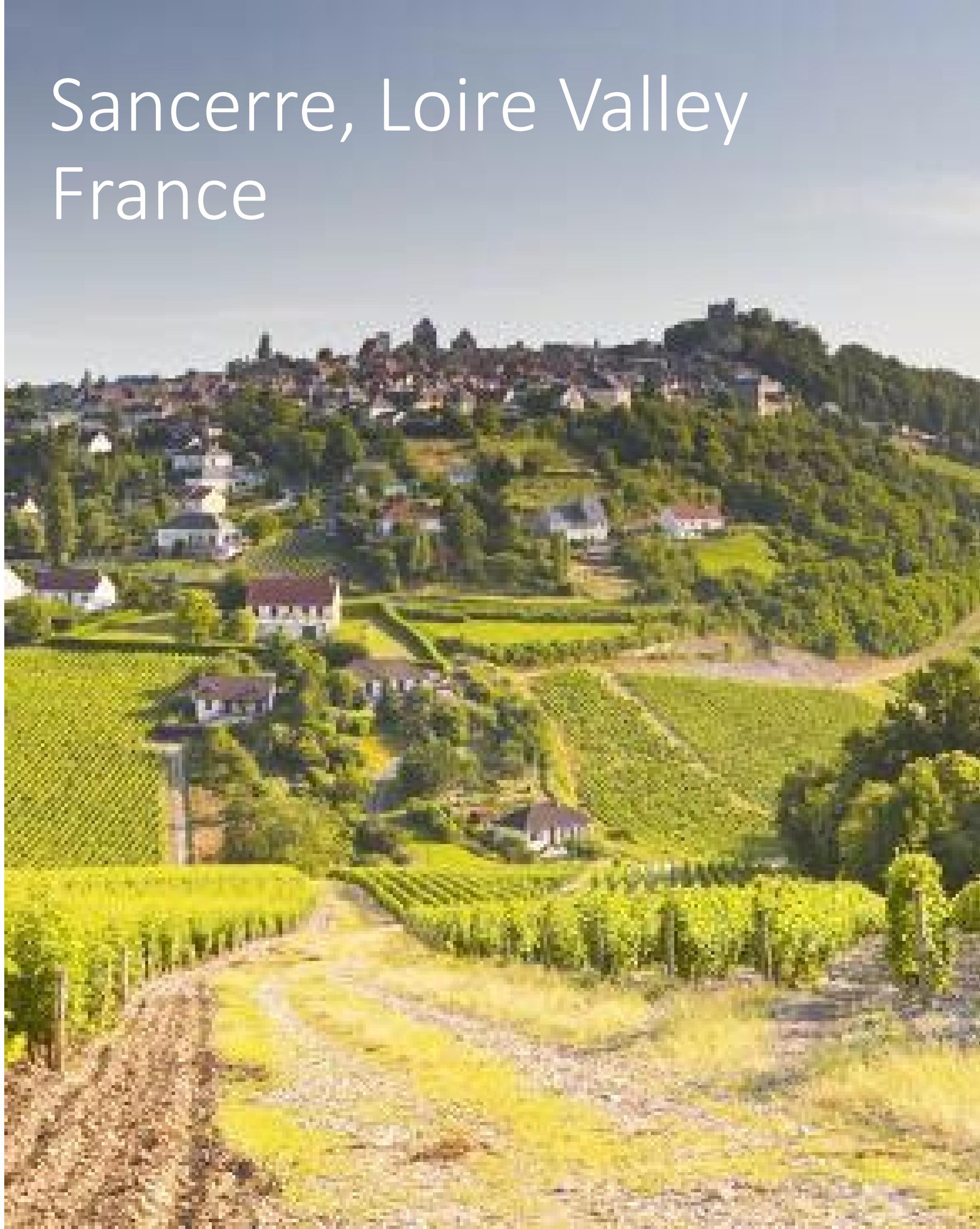
Average rainfall is 30’’/year, although the growing season is relatively dry.

Steep slopes promote good drainage.

Growing Practices

Minimum planting density: 2,300 vines per acre.

Pruning: Single or double guyot; cordon de royat.



Soils

Stony sandy loam over deep, stony gravels.

Climate

Semi-continental climate

Average temperatures range from 50°F in winter to 79°F in summer.

Low rainfall (~26’’/year).

Growing Practices

Pruning: cane and spur pruning.

Dell Valley Vineyard
Texas

Soils

Gravelly loamy sand

Deep and well drained

Rocky (calcareous) top soils

Climate

High desert-semi arid at 4,000’ elevation.

Hot days (95°F) during season and cool nights (60°F).

Very dry; less than 11’’/year.

Growing Practices

Flood and drip irrigation.

Spur pruning and bilateral cordon.

Sprawling canopy for sunlight protection.