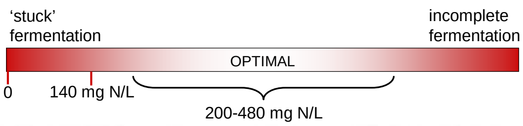
Activity 5: Overcoming critical plant nutrient limitations currently inhibiting healthy vine growth & production of high quality wine

Canada

Activity 5: Overcoming root zone limitations

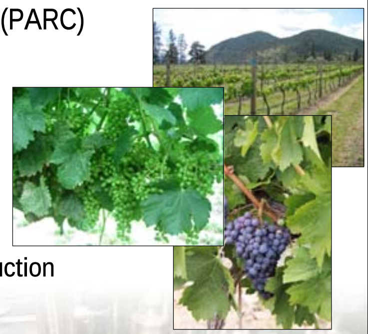
Gerry Neilsen – Soil & plant nutrition
Denise Neilsen – Water management & climate
Tom Forge – Nematodes & root health
Kirsten Hannam – Soil chemistry & biology (PDF)
Pete Millard – Plant eco-physiology (New Zealand)
Andy Midwood – Isotope analysis (Scotland)

1: Nitrogen (YANC)



Formol titration method (Zoecklein et al. 1999)

1a: Vineyard management practices affecting YANC (PARC)



- Deficit Irrigation
- N Fertilization
- Crop Load Reduction

Trial 1 (PARC): Irrigation x N Amendment

	Frequency		Evaporative Demand (%)	
	daily	3 days	100	50
Full	**X**		**X**	

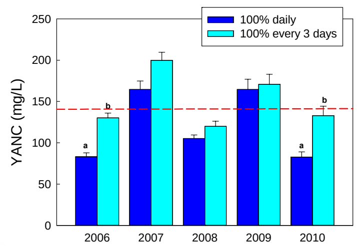
- applied throughout the growing season

Trial 1 (PARC): Irrigation x N Amendment

	Frequency		Evaporative Demand (%)	
	daily	3 days	100	50
Full	**X**		**X**	
Reduced Frequency		**X**	**X**	

- applied throughout the growing season

Trial 1 (PARC): Irrigation x N Amendment

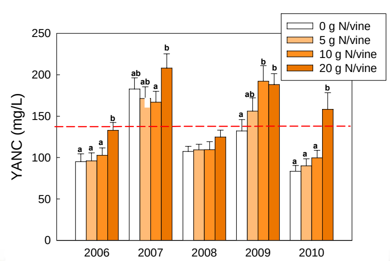


Trial 1 (PARC): Irrigation x N Amendment

Treatment (g urea-N/vine)	Equivalent to (kg urea-N/ha)
0	0
5	16.6
10	33.2
20	66.4

- applied twice (1/2 at bud break & 1/2 at full bloom)

Trial 1 (PARC): Irrigation x N Amendment



Trial 2 (PARC): Irrigation x Crop Load Reduction

	Frequency		Evaporative Demand (%)	
	daily	3 days	100	50
Full	X		X	

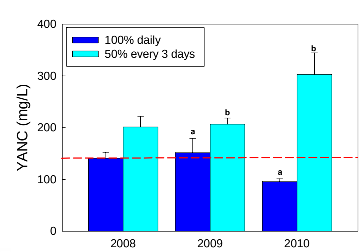
- applied from 2/3 full canopy through the growing season

Trial 2 (PARC): Irrigation x Crop Load Reduction

	Frequency		Evaporative Demand (%)	
	daily	3 days	100	50
Full	X		X	
Reduced Frequency & Intensity		X		X

- applied from 2/3 full canopy through the growing season

Trial 2 (PARC): Irrigation x Crop Load Reduction

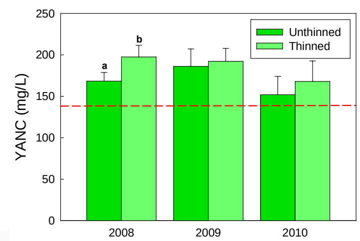


- fertigated with urea-N (5 g N/vine over 5 weeks)

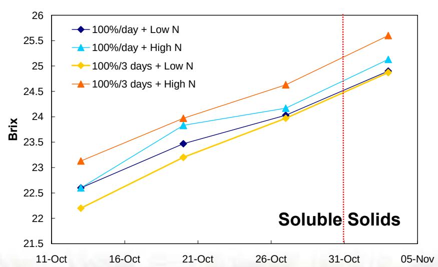
Trial 2 (PARC): Irrigation x Crop Load Reduction

- applied when grapes are pea-sized

Trial 2 (PARC): Irrigation x Crop Load Reduction



Trial 3 (PARC): Changes in YANC around harvest



1a: Vineyard management practices affecting YANC

	Effect on yeast assimilable N
Deficit Irrigation	- consistently increased (not always significant)
N amendment	- increased only with 66 kg N/ha (other quality issues?)
Crop load reduction	- slightly increased
Harvest timing	- TBD

1b: Strategies to increase YANC (7 industry sites)

VARIETY	mg N/L
Cabernet Sauvignon	70
Viognier	61
Merlot	48
Pinot Noir	58
Cabernet Sauvignon	72
Merlot	68
Pinot Gris	52

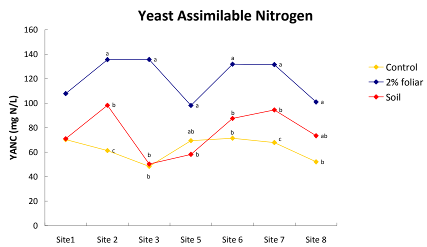
1b: Increasing YANC

Five treatments:

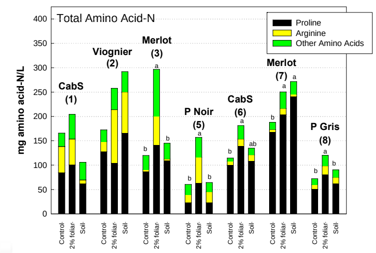
i. Control
ii. Foliar application of 1% urea
iii. Foliar application of 2% urea
iv. Soil application equivalent to 2% foliar urea
v. ½ foliar + ½ soil application of urea

- *applied three times, centred around veraison*

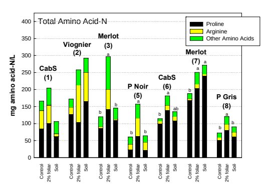
1b: Increasing YANC (2010)



Increasing YANC



Increasing YANC



	Site						
	1	2	3	5	6	7	8
Total Amino N			*	*	*	*	*
Assimilable Amino N		0.08	*	0.07	0.09	*	*

Increasing YANC

Crop load - yield, berry size, cluster size

Vine vigour - space, cluster exposure

Fruit quality - soluble solids, pH, titratable acidity

*- in most cases, treatment effects were **not** significant*

Increasing YANC

	Soluble Solids (%)		Crop Loads (kg/vine)	
	2010	2011	2010	2011
Site 1	24.0			
Site 2	24.0			
Site 3	26.1			
Site 5	22.5			
Site 6	25.6			
Site 7	27.6			
Site 8	24.6			

Increasing YANC

	Soluble Solids (%)		Crop Loads (kg/vine)	
	2010	2011	2010	2011
Site 1	24.0	21.5		
Site 2	24.0	20.2		
Site 3	26.1	24.8		
Site 5	22.5	21.8		
Site 6	25.6	22.8		
Site 7	27.6	24.5		
Site 8	24.6	22.5		

Increasing YANC

	Soluble Solids (%)		Crop Loads (kg/vine)	
	2010	2011	2010	2011
Site 1	24.0	21.5	2.9	
Site 2	24.0	20.2	2.4	
Site 3	26.1	24.8	3.2	
Site 5	22.5	21.8	4.0	
Site 6	25.6	22.8	-	
Site 7	27.6	24.5	2.5	
Site 8	24.6	22.5	3.0	

Increasing YANC

	Soluble Solids (%)		Crop Loads (kg/vine)	
	2010	2011	2010	2011
Site 1	24.0	21.5	2.9	4.1
Site 2	24.0	20.2	2.4	2.6
Site 3	26.1	24.8	3.2	4.1
Site 5	22.5	21.8	4.0	3.8
Site 6	25.6	22.8	-	3.8
Site 7	27.6	24.5	2.5	3.5
Site 8	24.6	22.5	3.0	4.2

1b: Increasing YANC (2011)

- 2011 samples, including ^{15}N analyses (4 sites)
- Added slow-release soil N treatment

10% ^{15}N-labelled urea - $5.75/g ($230k)
5% ^{15}N-labelled urea - $2.40/g ($46k)

2: Potassium (2 industry sites)

Cabernet Franc	Chardonnay
Control	Control
200 kg K/ha/yr	400 kg K/ha/yr
400 kg K/ha/yr	

2: Potassium (2011 - 1st year)

	Cabernet Franc	Chardonnay
pH - juice	3.5 - 3.7	3.4 - 3.6
Juice SS, TA, pH	- No treatment effects	
Fruit yield	- No treatment effects	
Canopy characteristics	- No treatment effects	
Soil nutrients	- To be analyzed	
Petiole nutrients	- To be analyzed	

2: Potassium - wine making (control & high K treatments)

2: Potassium (2012 – 2nd year)

- Re-fertilize and sample soil, petioles & fruit
- Complete wine-making (with Pat Bowen & Carl Bogdanoff)
- Examine effects of management practices on grapevine K nutrition at PARC sites

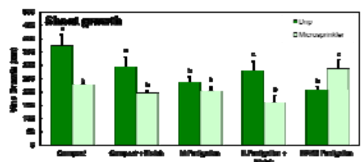
3: Conservative Soil Management (PARC)

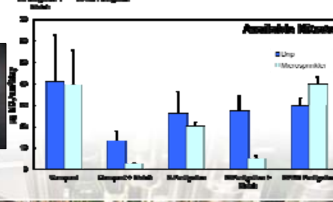
Irrigation Treatments:
- drip
- microsprinkler

Soil Amendments:
- composted grape pomace
- mulch
- fertigation with N or NPKB

3: Conservative Soil Management (PARC)

3: Conservative Soil Management (PARC)





Related Research -Conservative Soil Management (PARC)

- Measuring greenhouse gas emissions (nitrous oxide, carbon dioxide, ammonia) in wine grape, apple and raspberry
- New project (2012-2016)
- How do N inputs, high carbon mulches and different micro-irrigation systems affect
  - Soil nitrification, denitrification and ammonia and nitrous oxide emissions?
  - Root dynamics, soil carbon sequestration and carbon dioxide emissions?

Colleagues in NZ measuring CO_2 in the soil

3: Conservative Soil Management (PARC)

	Compost	Biochar
Control	0	0
Compost	2%	0
Biochar	0	1%
Compost + Biochar	2%	1%

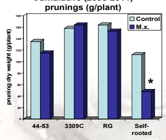
4: Nematodes & root health

2007 setup

4.1: Field microplot approach to assessing impacts of nematodes on vine growth

•Initiated with MII funding
•continuing microplot approach to assess effects on root turnover, carbon allocation and water stress

Ring nematodes reduce early vegetative growth of self-rooted Merlot, but not rootstocks

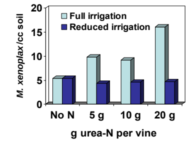


4: Nematodes & root health

4.2: Ecology of ring nematodes

Trial 1 (PARC): Irrigation x N Amendment

Ring nematode populations increase with water and N inputs



Ongoing covariance analyses to assess interaction effects on vine performance

4: Nematodes & root health

4.3: Comparative performance of rootstocks in presence of multiple nematode species

on-farm trial with Mission Hill, start 2011
-Ring nematodes (*Mesocriconema*)
-Root-lesion nematodes (*Pratylenchus*)
-Stubby root nematodes (*Paratrichodorus*)

Compost subplots

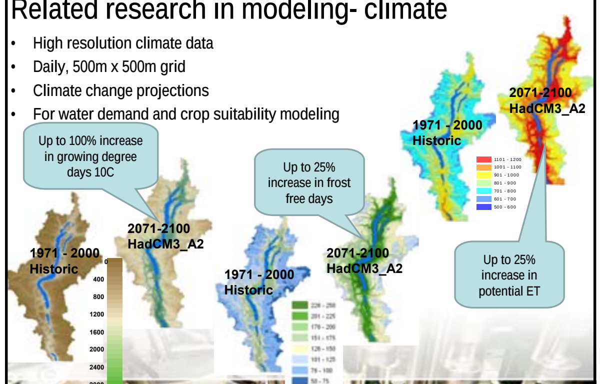
Replicate rows of each rootstock

Early observations: differences in rootstock biomass but not nematode population densities

Root biomass at end of first growing season (g dry roots per kg dry soil, cores taken 10 cm from stem)				
	Rootstock			
	SO-4	3309C	101-14	Schwartz.
Fine roots	0.86 a	0.73 ab	0.43 bc	0.58 c
Coarse roots	0.43	0.38	0.30	0.39

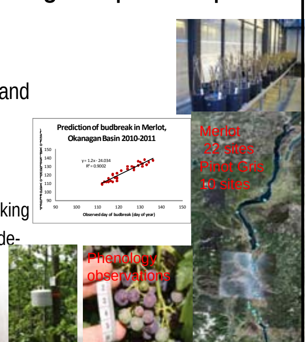
Related research in modeling- climate

- High resolution climate data
- Daily, 500m x 500m grid
- Climate change projections
- For water demand and crop suitability modeling



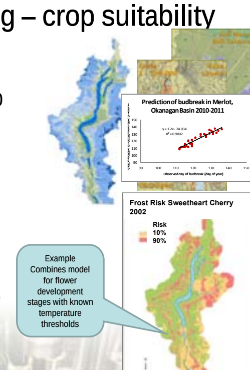
Related research in modeling –crop development

- Temperature based models for predicting crop dormancy, cold hardiness and in-season plant and fruit development
- Based on controlled laboratory studies
  - for dormancy induction and breaking
  - Cold hardiness acclimation and de-acclimation
- Field observations
  - Crop phenology
  - Site temperatures



Related research in modeling – crop suitability

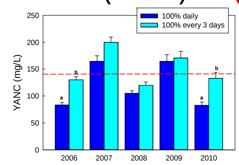
- Combine models for predicting dormancy, cold hardiness and crop phenological stages, with high resolution climate data and critical temperatures for crop risks.
- Combine crop risks with terrain analysis, detailed soil mapping to produce land suitability maps for perennial horticultural crops – wine grapes, sweet cherry and apple



Thank you!

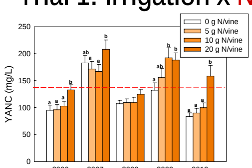
Canada

Trial 1 (PARC): Irrigation x N Amendment



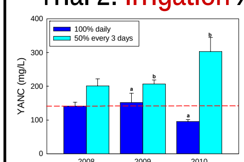
	2006	2007	2008	2009	2010
Yield	▼	▼			
Berry wt.	▼				▼
Sugars					
pH	▲	▲			▲

Trial 1: Irrigation x N Amendment



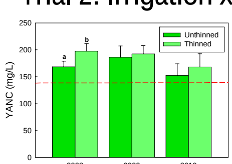
	2006	2007	2008	2009	2010
Yield					
Berry wt.			▼		
Sugars			*		▼
pH			▲	▲	▲

Trial 2: Irrigation x Crop Load Reduction



	2008	2009	2010
Yield	▼		*na*
Berry wt.	▼		▼
Sugars			▼
pH	▲		▲

Trial 2: Irrigation x Crop Load Reduction



	2008	2009	2010
Yield			*na*
Berry wt.			
Sugars	▲		▲
pH		▲	