

A photograph of a vineyard. The foreground shows a path covered in brown mulch, with a white plastic covering visible on the left. The background is filled with lush green grape leaves and vines, some showing signs of being pruned or trained. The lighting is bright, suggesting a sunny day.

Tissue Nutrient Standards for Irrigated PNW Wine Grapes

Joan Davenport
WSU-Prosser

Nutrient		Petioles			Leaves		
		Ref 1-B	Ref 2-B	Ref 3-B	Ref 4-B	Ref 4-V	Ref 5-V
Nitrogen	ppm or %	501-1199	500-1200	500-1200	3.0-5.0	2.2-4.0	2.2-2.4
Phosphorous	%	0.10-0.35	0.25-0.50	0.15-0.50	0.25-0.40	0.15-0.30	0.15-0.3
Potassium	%	1.01-3.00	1.8-3.0	1.50-2.00	1.0-1.8	0.8-1.6	0.8-1.6
Calcium	ppm	1.26-3.00	1.2-2.5	1.00-3.00	1.2-2.8 (%)	1.8-3.2 (%)	1.8-3.2
Magnesium	ppm	0.46-1.25	>0.4	0.30-1.50	0.3-0.6 (%)	NV	0.3-0.6
Sodium	ppm	NV	NV	NV	<0.1 (%)	<0.2 (%)	<0.1
Boron	ppm	26-99	30-75	30-100	30-200	30-100	35-100
Zinc	ppm	16-51	>26	25-100	35-60	30-60	30-60
Copper	ppm	5.1-20.9	6-11	5-50	10-100	10-300	10-300
Iron	ppm	30-100	NV	40-300	NV	NV	NV
Manganese	ppm	61-200	30-60	30-150	30-200	25-200	25-200

B = Full bloom sampling time

V = Verasion sample timing

Reference 1

Christensen, P. 1963, 1984

Reference 2

Reuter, J.D. and J.B. Robinson, Plant Analysis Manual, 1997

Reference 3

Mills, H.A. and J. Benton Jones, Jr., Plant Analysis Handbook II.

Reference 4

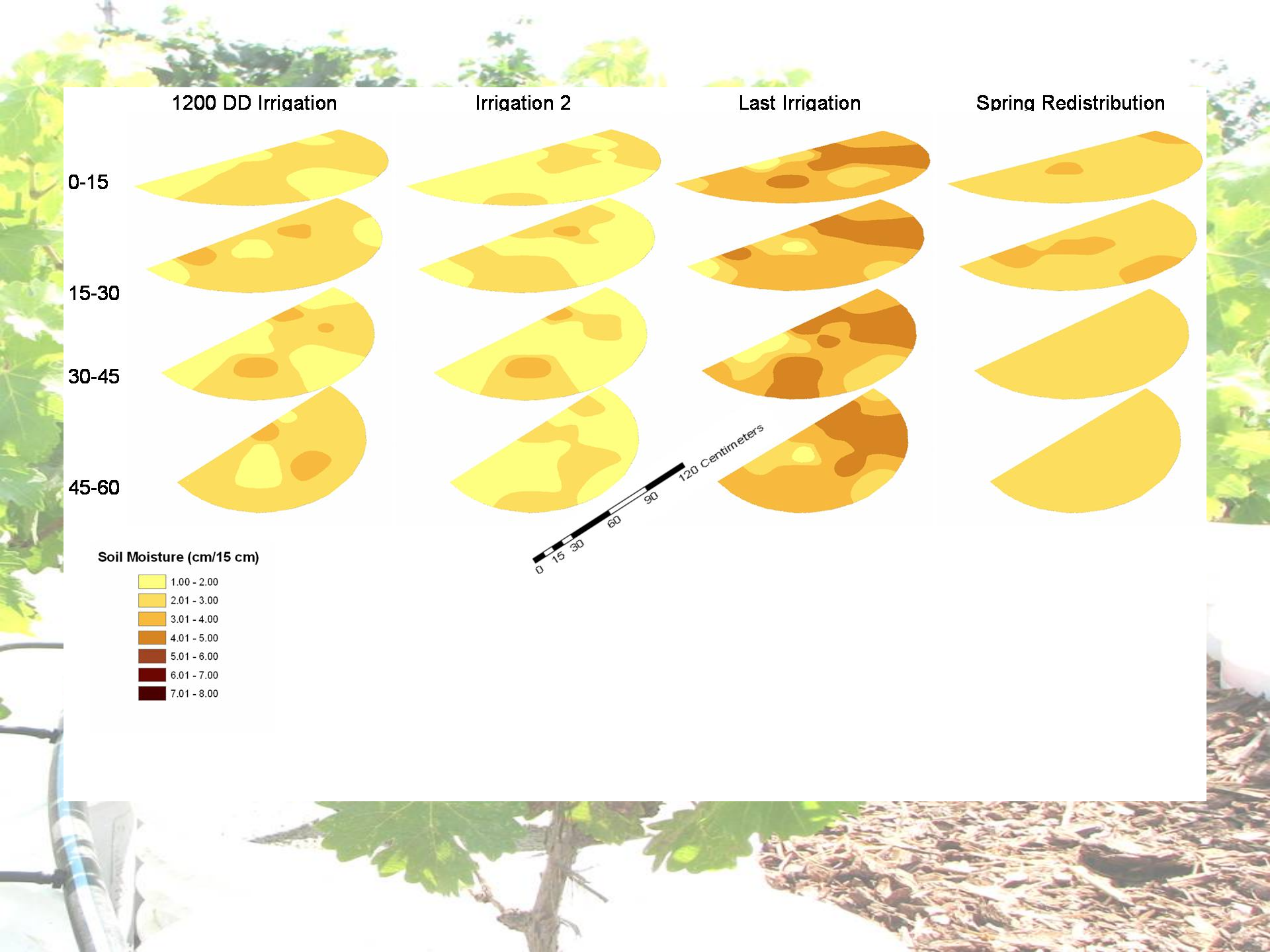
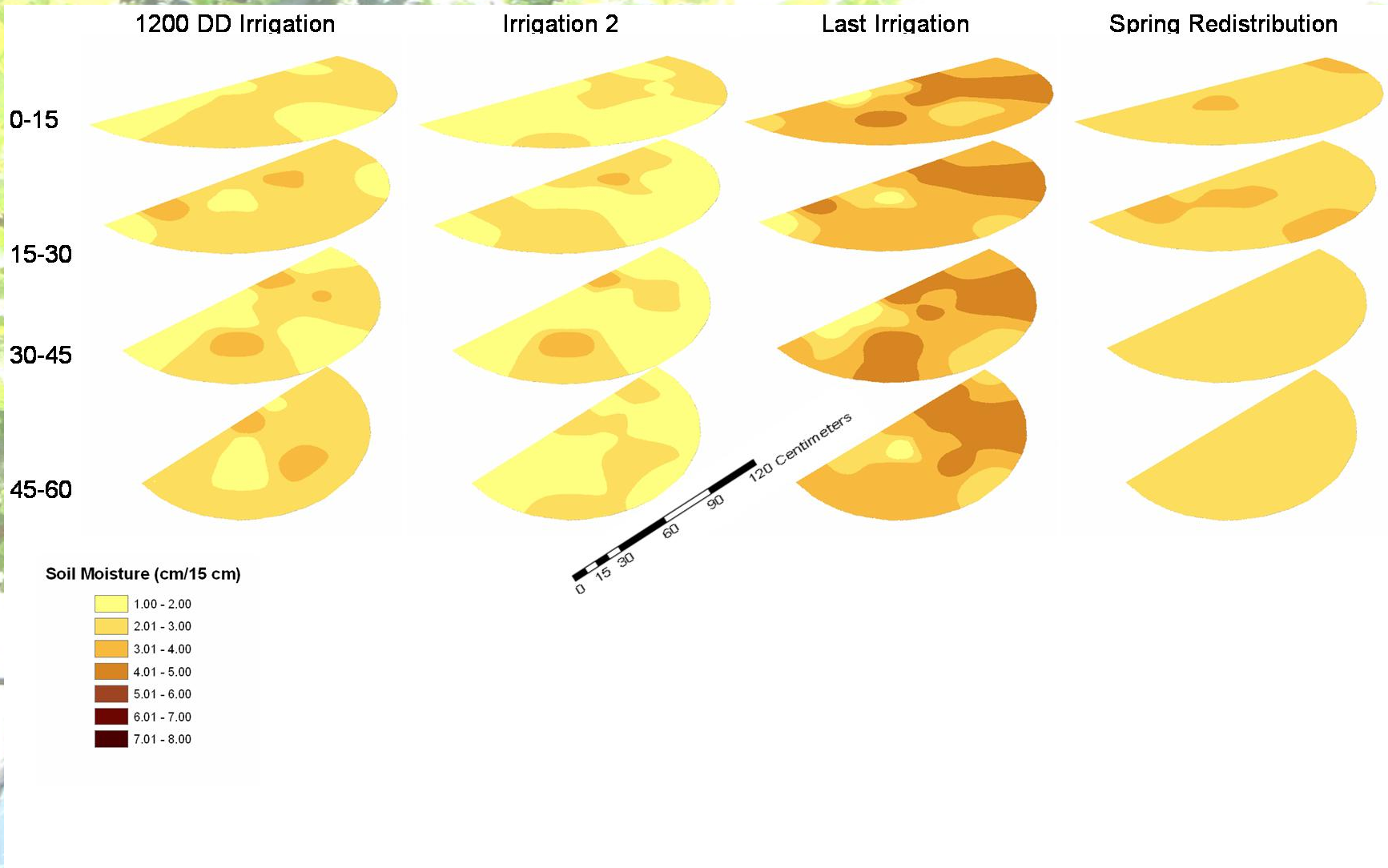
Weir, R.G. and G.C. Cresswell, Plant Nutrient Disorders 1: Temperate and Subtropical Fruit and Nut Crops, 1993

Reference 5

Coombe, B.G. and P.R. Dry, Viticulture Vol. 2

Why PNW Standards?

- Premium Wine Grape vs Thompson Seedless
- Regions
- It doesn't rain here
- Even though we irrigate, the soils are dry



Our Studies

- Tissue Testing Survey
- N Fertilizer Field Plots

Tissue Testing Survey

Leaf petiole and blade tissues:

leaf opposite the first fruit cluster at bloom
fifth fully expanded leaf position veraison

Collection (2004, 2006, 2007) sites (8 vineyards) located in:

South central Washington
Milton-Freewater Area, Oregon
Southwestern Idaho

Varieties (number of sites follow parenthetically)

Cabernet Sauvignon (8)	Chardonnay (6)
Merlot (7)	Pinot Noir (5)
White Riesling (5)	Syrah (5)

36 total sample sites

Information on yield and quality was gathered from the cooperating growers.

N Fertilizer Field Plots

Merlot and Riesling

10 Vines per plot, 4 non-treated spacer vines

Two vineyards per cultivar (Quincy sand, Warden silt loam)

4 N rates – none, low medium high

(silt loam 0, 11, 22, 34 kg/ha; sand 0, 22, 45, 67 kg/ha)

N split across 4 applications

bloom, 4 weeks later, veraison, post-harvest

Yield, Cluster number and weight

Juice Soluble Solids, Titratable acidity, pH measured

Tissue dried, ground and either:

Commercial laboratory for analysis for **P, K, Ca, Mg, Na, Cu, Zn, Mn, Fe and B**

Petiole water extracted and analyzed colorimetrically for **NO₃-N**

Blade analyzed for **total N** using dry combustion

Nutrient		Petioles			Leaves		
		Ref 1-B	Ref 2-B	Ref 3-B	Ref 4-B	Ref 4-V	Ref 5-V
Nitrogen	ppm or %	501-1199	500-1200	500-1200	3.0-5.0	2.2-4.0	2.2-2.4
Phosphorous	%	0.10-0.35	0.25-0.50	0.15-0.50	0.25-0.40	0.15-0.30	0.15-0.3
Potassium	%	1.01-3.00	1.8-3.0	1.50-2.00	1.0-1.8	0.8-1.6	0.8-1.6
Calcium	ppm	1.26-3.00	1.2-2.5	1.00-3.00	1.2-2.8 (%)	1.8-3.2 (%)	1.8-3.2
Magnesium	ppm	0.46-1.25	>0.4	0.30-1.50	0.3-0.6 (%)	NV	0.3-0.6
Sodium	ppm	NV	NV	NV	<0.1 (%)	<0.2 (%)	<0.1
Boron	ppm	26-99	30-75	30-100	30-200	30-100	35-100
Zinc	ppm	16-51	>26	25-100	35-60	30-60	30-60
Copper	ppm	5.1-20.9	6-11	5-50	10-100	10-300	10-300
Iron	ppm	30-100	NV	40-300	NV	NV	NV
Manganese	ppm	61-200	30-60	30-150	30-200	25-200	25-200

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A Table with Too Much on it!

Nutrient	Bloom						Veraison				
	Blade			Petiole			Blade			Petiole	
	Range	median	PIR	range	median	PIR	range	median	PIR	range	median
N	2.15-3.80	3.15	68	4 – 4448	145	8	2.13-3.61	2.91	97	12-2596	166
P	0.13-0.54	0.26	42	0.15-0.86	0.44	35	0.11-0.36	0.19	83	0.05-0.78	0.23
K	0.54-1.61	0.98	47	1.38-4.32	2.75	62	0.46-1.13	0.73	31	0.34-4.11	2.05
Ca	0.80-3.14	2.08	93	1.03-3.26	1.69	93	1.11-3.08	1.94	63	1.33-3.19	1.92
Mg	0.17-0.50	0.32	69	0.31-0.91	0.54	69	0.22-0.71	0.42		0.08-1.54	0.90
B	15-221	43	73	30-96	46	73	19-142	35	100	24-67	39
Zn	9-273	25	11	13-102	35	11	8-89	17	10	24-67	55
Fe	64-1090	124		17-223	31	46	66-307	117		20-70	37
Cu	4-22	10	59	3-18	9	87	3-15	7	18	2-9	5
Mn	21-208	90	96	9-81	31	9	33-125	59	100	24-156	65

Bloom – Macro Nutrients

Nutrient	Bloom					
	Blade			Petiole		
	Range	median	PIR	range	median	PIR
N	2.15-3.80	3.15	68	4 – 4448	145	8
P	0.13-0.54	0.26	42	0.15-0.86	0.44	35
K	0.54-1.61	0.98	47	1.38-4.32	2.75	62
Ca	0.80- 3.14	2.08	93	1.03- 3.26	1.69	93
Mg	0.17-0.50	0.32	69	0.31-0.91	0.54	69

Bloom – Micro Nutrients

Nutrient	Bloom					
	Blade			Petiole		
	Range	median	PIR	range	median	PIR
B	15-221	43	73	30-96	46	73
Zn	9-273	25	11	13-102	35	11
Fe	64-1090	124		17-223	31	46
Cu	4-22	10	59	3-18	9	87
Mn	21-208	90	96	9-81	31	9

Bloom

- Our values do not mesh well with published data
- Petiole $\text{NO}_3\text{-N}$ at this stage does not work

Veraison – Macro Nutrients

Nutrient	Veraison				
	Blade			Petiole	
	range	median	PIR	range	median
N	2.13-3.61	2.91	97	12-2596	166
P	0.11-0.36	0.19	83	0.05-0.78	0.23
K	0.46-1.13	0.73	31	0.34-4.11	2.05
Ca	1.11-3.08	1.94	63	1.33-3.19	1.92
Mg	0.22-0.71	0.42		0.08-1.54	0.90

Veraison – Micro Nutrients

Nutrient	Veraison				
	Blade			Petiole	
	range	median	PIR	range	median
B	19-142	35	100	24-67	39
Zn	8-89	17	10	24-67	55
Fe	66-307	117		20-70	37
Cu	3-15	7	18	2-9	5
Mn	33-125	59	100	24-156	65

Veraison

- Our blade values do mesh better with published data
- Petiole have some issues and are not typically used at veraison

Relationships with Yield

Nutrient	Bloom				Veraison			
	Blade		Petiole		Blade		Petiole	
	<i>P</i>	CC	<i>P</i>	CC	<i>P</i>	CC	<i>P</i>	CC
N	0.1328		0.0416	-0.004	0.4139		0.4852	
P	0.1112		0.3054		0.2638		0.3202	
K	0.9352		0.0179	-1.743	0.1481		0.0275	-3.551
Ca	0.0026	-1.401	0.0691		0.1619		0.2158	
Mg	0.0355	11.735	0.3338		0.4638		0.7730	
B	0.7769		0.0305	0.048	0.1264		0.0618	
Zn	0.8142		0.0006	0.131	0.6109		0.6626	
Fe	0.2328		0.5741		0.0688		0.4611	
Cu	0.9596		0.5407		0.3289		0.1209	
Mn	0.0019	-0.048	0.3598		0.3992		0.1582	

Relationships with Yield

Nutrient	Blade			Veraison		
	Blade	Petiole	CC	Blade	Petiole	CC
	<i>P</i>	<i>P</i>	CC	<i>P</i>	<i>P</i>	CC
N	0.1328	0.0416	-0.004	0.4852		
P	0.1112	0.3054	0.538	0.3202		
K	0.9352	0.0179	0.1481	0.0275	-3.551	
Ca	0.0026	0.0691	0.1619	0.2158		
Mg	0.0355	0.3	0.4638	0.7730		
B	0.7769		0.048	0.1264	0.0618	
Zn	0.8142		0.131	0.6626		
Fe	0.2328	0.41	0.6109	0.4611		
Cu	0.9596			0.1209		
Mn	0.0019	-0.048	0.52	0.1582		

Field Trial Results

Cultivar	Year	Parameter	N Fertilizer Level			
			None	Low	Medium	High
Riesling	2005	Bloom Bld Total N (%)	2.99 b	3.04 ab	3.06 a	3.06 a
		Veraison Pet NO ₃ -N (mg/kg)	90 b	232 b	444 b	860 a
	2007	Bloom Bld Total N (%)	2.72 b	2.79 ab	2.82 ab	2.88 a
		Yield (Mg/ha)	9.90 a	9.79 a	6.92 b	9.54 a

Merlot Part 1

Cultivar	Year	Parameter	N Fertilizer Level			
			None	Low	Medium	High
Merlot	2004	Veraison Pet NO ₃ -N (mg/kg)	57 b	41 b	40 b	96 a
		Veraison Bld Total N (%)	2.49 b	2.53 b	2.60 b	2.77 a
	2005	Veraison Pet NO ₃ -N (mg/kg)	56 b	34 b	96 b	380 a
		Veraison Bld Total N (%)	2.61 b	2.81 ab	2.86 ab	3.01 a

Merlot Part 2

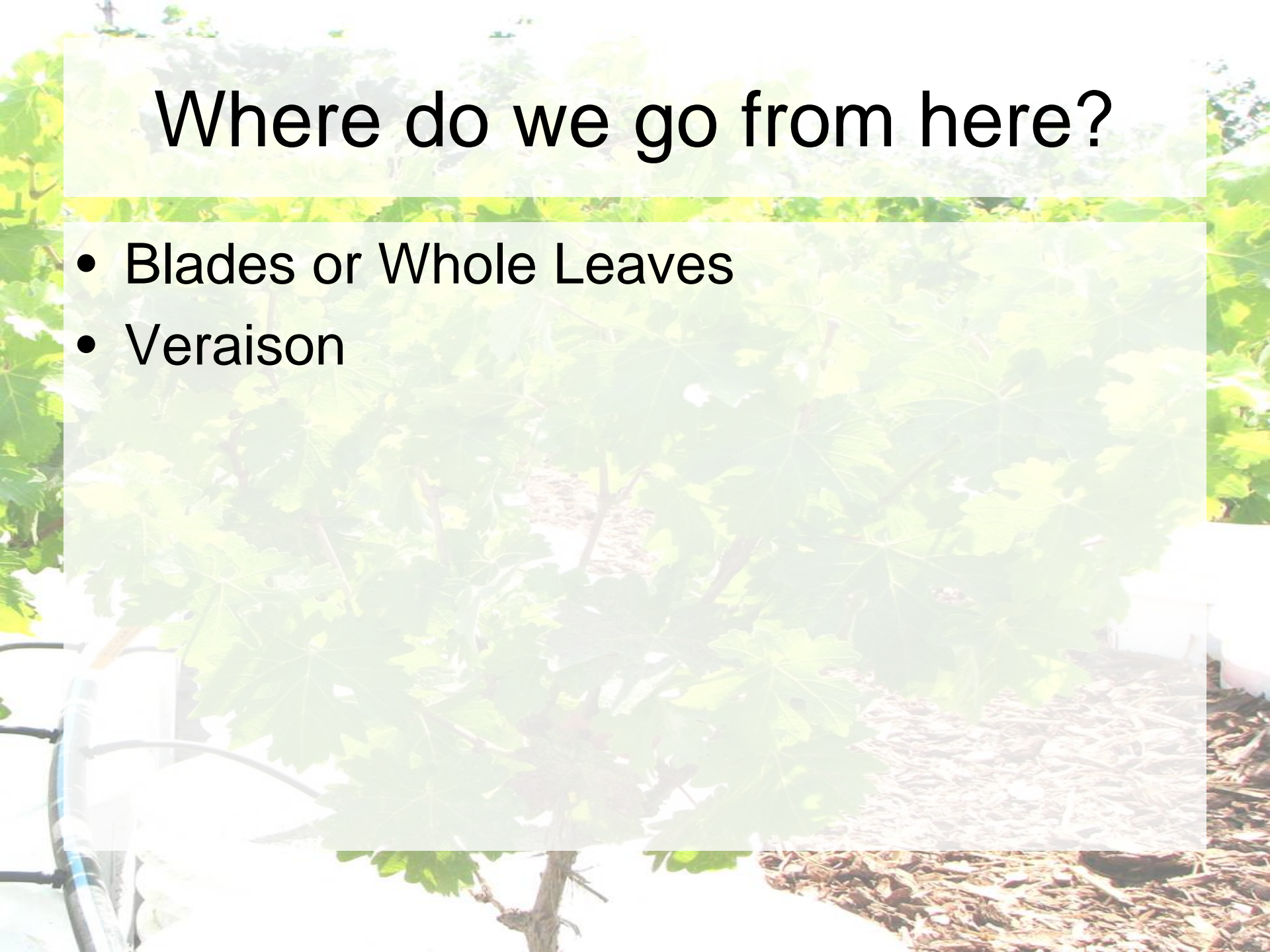
Cultivar	Year	Parameter	N Fertilizer Level			
			None	Low	Medium	High
Merlot	2006	Veraison Pet NO ₃ -N (mg/kg)	40 b	49 b	64 b	166 a
	2007	Veraison Bld Total N (%)	2.57 b	2.71 ab	2.79 ab	2.93 a
		Cluster Weight (g/cluster)	70 b	81 ab	88 a	95 a
		Yield (Mg/ha)	9.59 b	11.09 ab	12.72 a	12.54 a

Field Trial

- Not too much from Riesling
- Blades at Veraison were most responsive to N rates in Merlot
- Merlot yield and quality showed N rate response by year 5

Where do we go from here?

- Blades or Whole Leaves
- Veraison



Proposed Tissue Standards

Nutrient	Blades or Whole Leaves	
	Bloom	Veraison
Total N (%)	2.5 – 3.5	2.25 – 3.25
P (%)	0.15 – 0.45	0.12 – 0.30
K (%)	0.75 – 1.50	0.50 – 1.00
Ca (%)	1.00 – 3.00	1.00 – 3.00
Mg (%)	0.25 – 0.50	0.25 – 0.50
B (ppm)	30 – 100	30 – 100
Zn (ppm)	25 – 100	15 - 50
Fe (ppm)	>75	>75
Cu (ppm)	6 – 20	6 – 20
Mn (ppm)	30 - 100	30 - 100

Acknowledgements

- Wine Advisory Committee
- NW Center for Small Fruits Research
- Kelly Whitley and Jaimi Marden
- WSU-ARC
- Many leaf pickers!