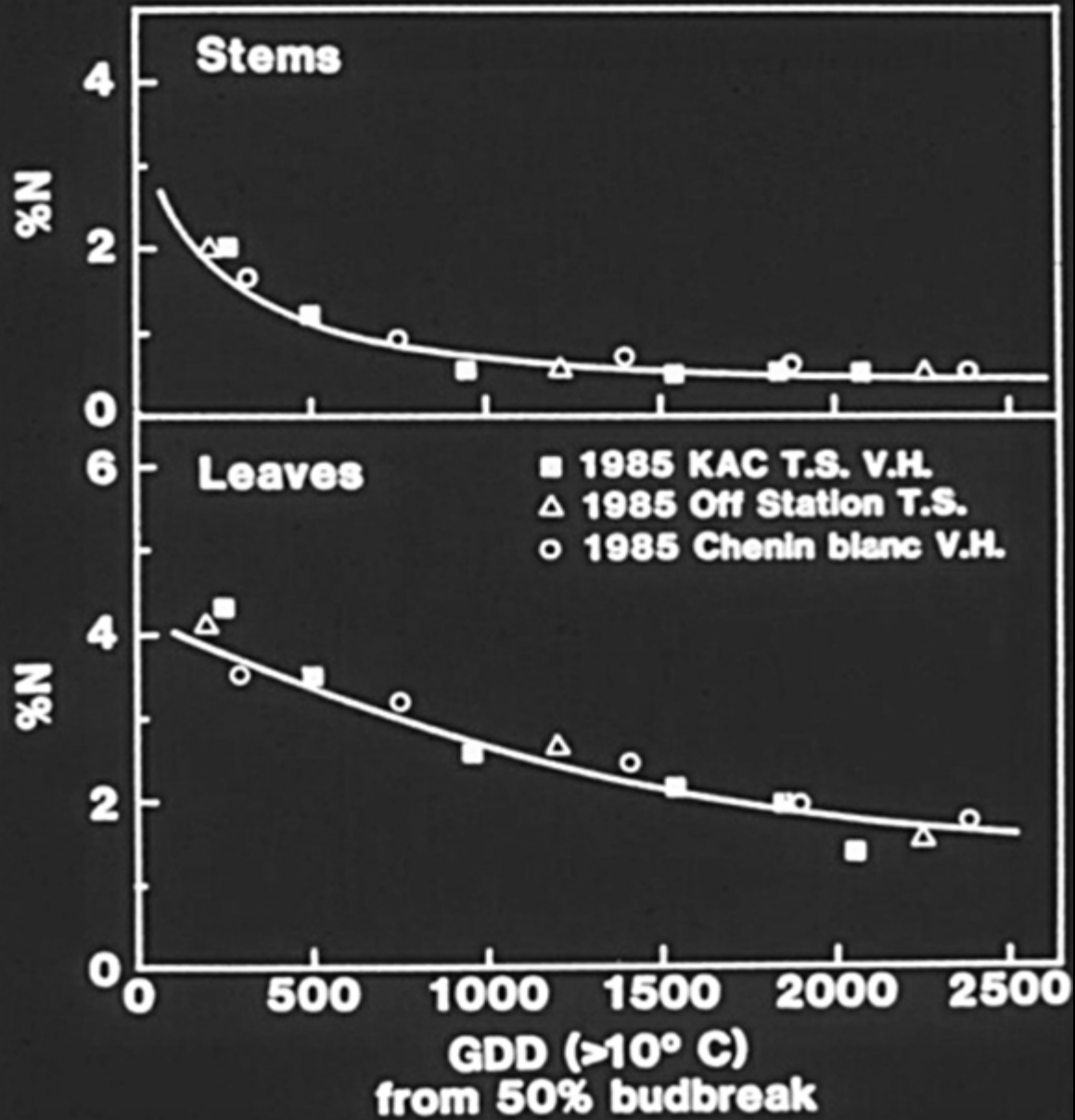


N and K Mineral Nutrition of Grapevines, Assessment of N and K Nutrient Status for Vines and Fertilization Guidelines

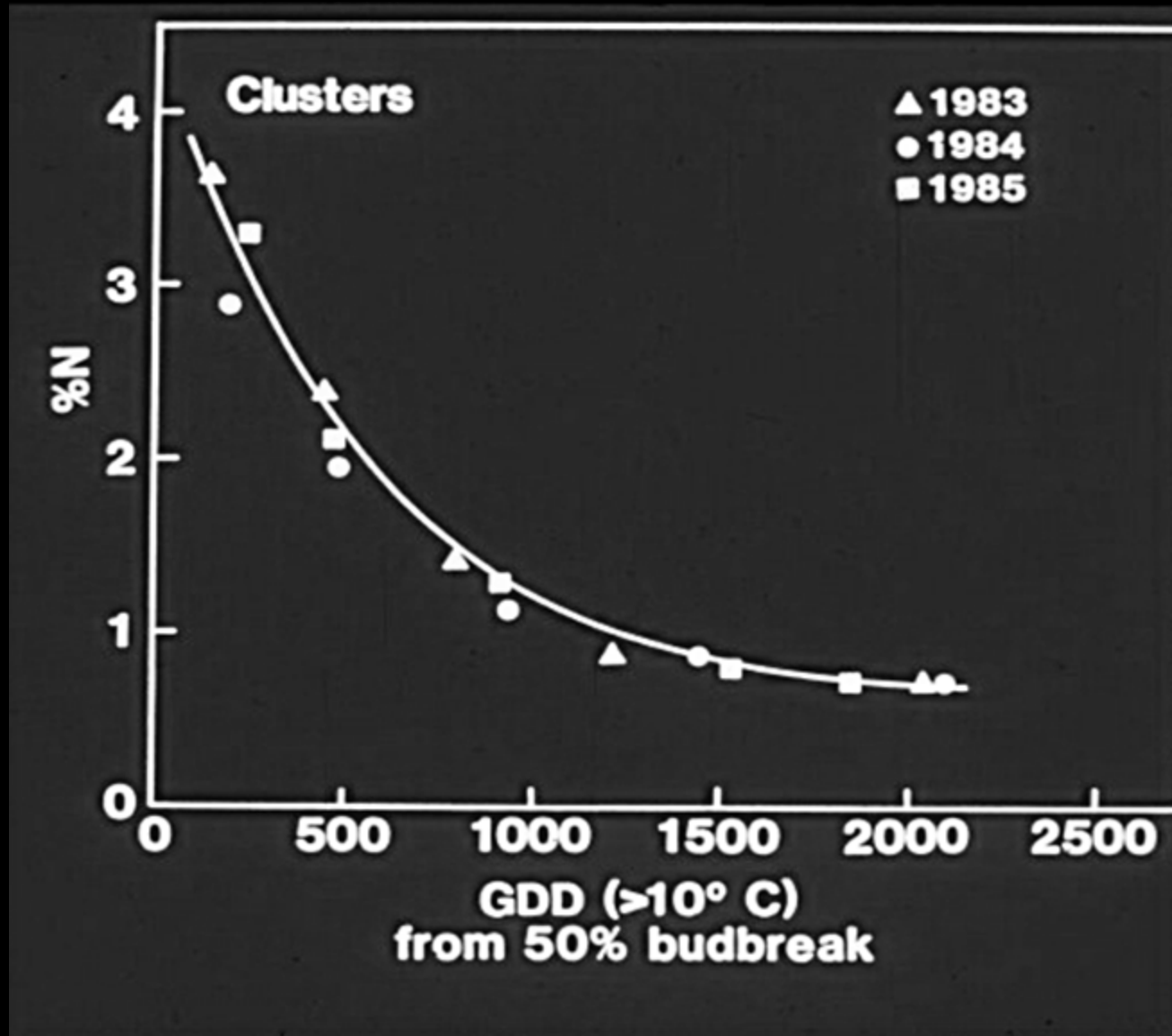
Larry E. Williams
Dept. Vit. and Enol.
UC-Davis
&
Kearney Ag Center

The following slides refer to the concentration of N (% dry weight basis) in the petioles, leaves, stems and clusters of grapevines.

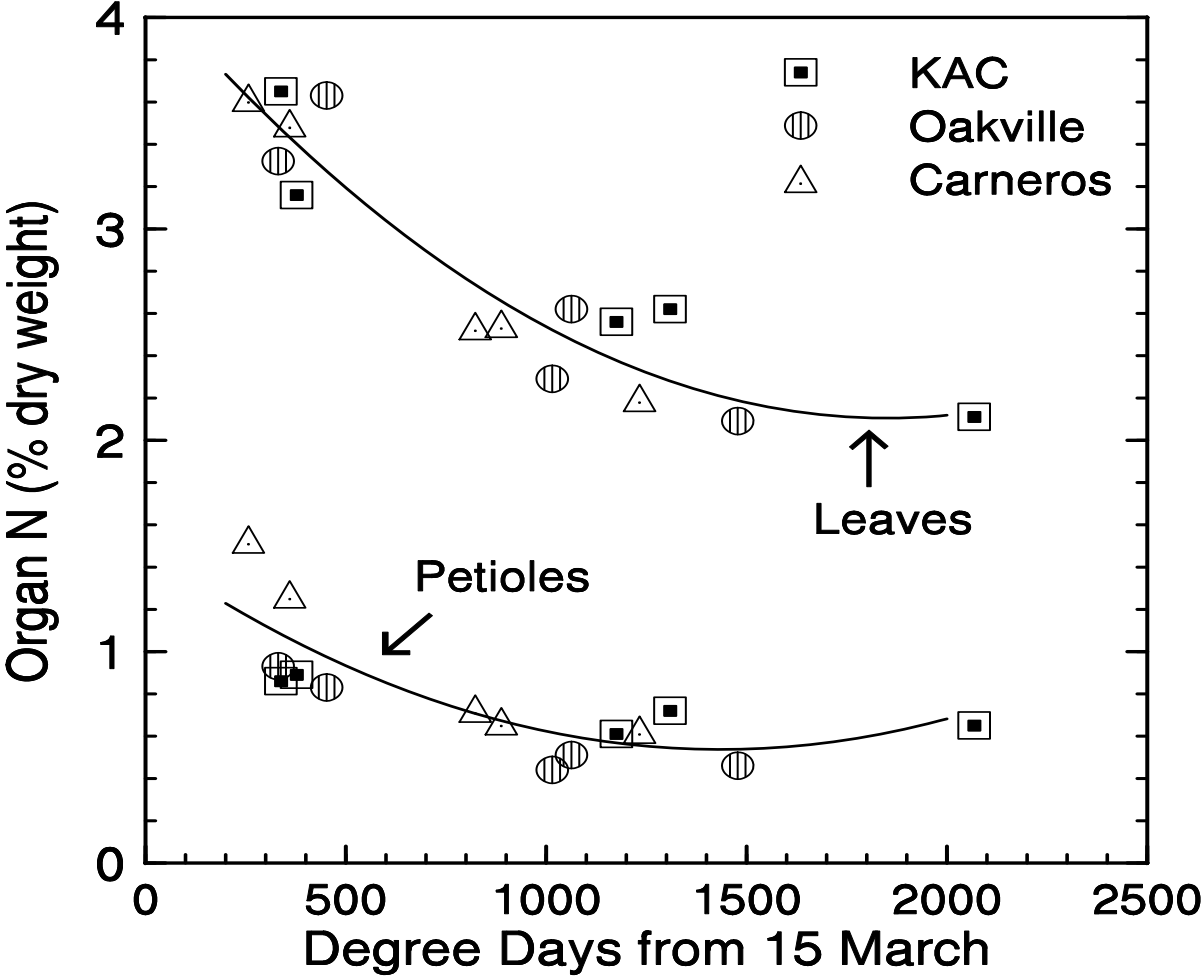
The concentration of N within the leaves and stems decreases throughout the season.

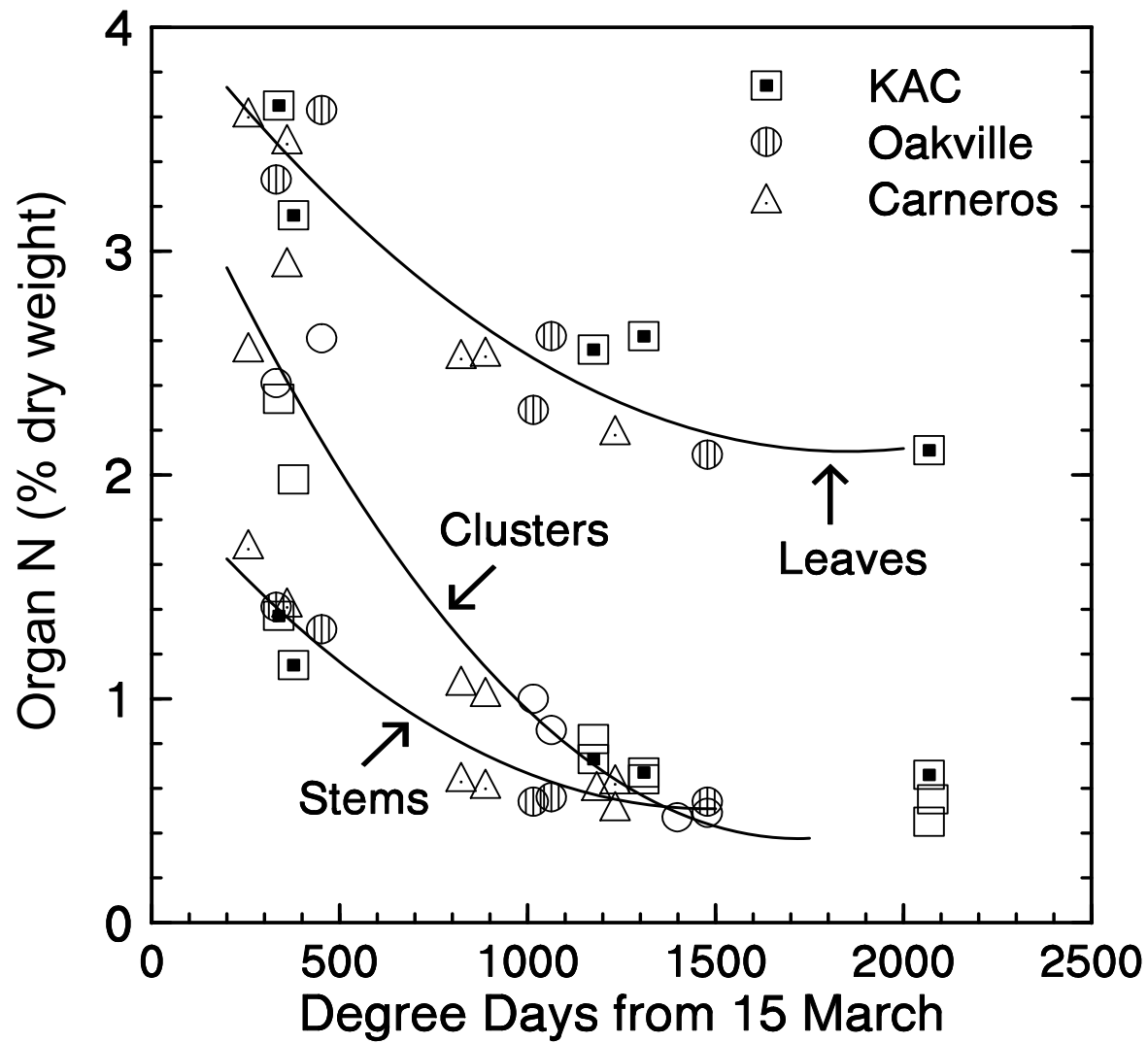


The concentration of N within the cluster decreases throughout the season.



KAC is Thompson Seedless, Oakville is Cabernet Sauvignon and Carneros is Chardonnay.





The previous slides demonstrate that the concentration of N in the various organs of the grapevine decrease throughout the growing season. This decrease is a function of degree-days, regardless where the vines are grown

The following slides refer to the production of vine biomass (leaves, stems and clusters) and the uptake of potassium (K) and N, in the above mentioned organs, as a function of whole vine water use. Biomass and N and K were also measured on the roots and trunks one year.

Background

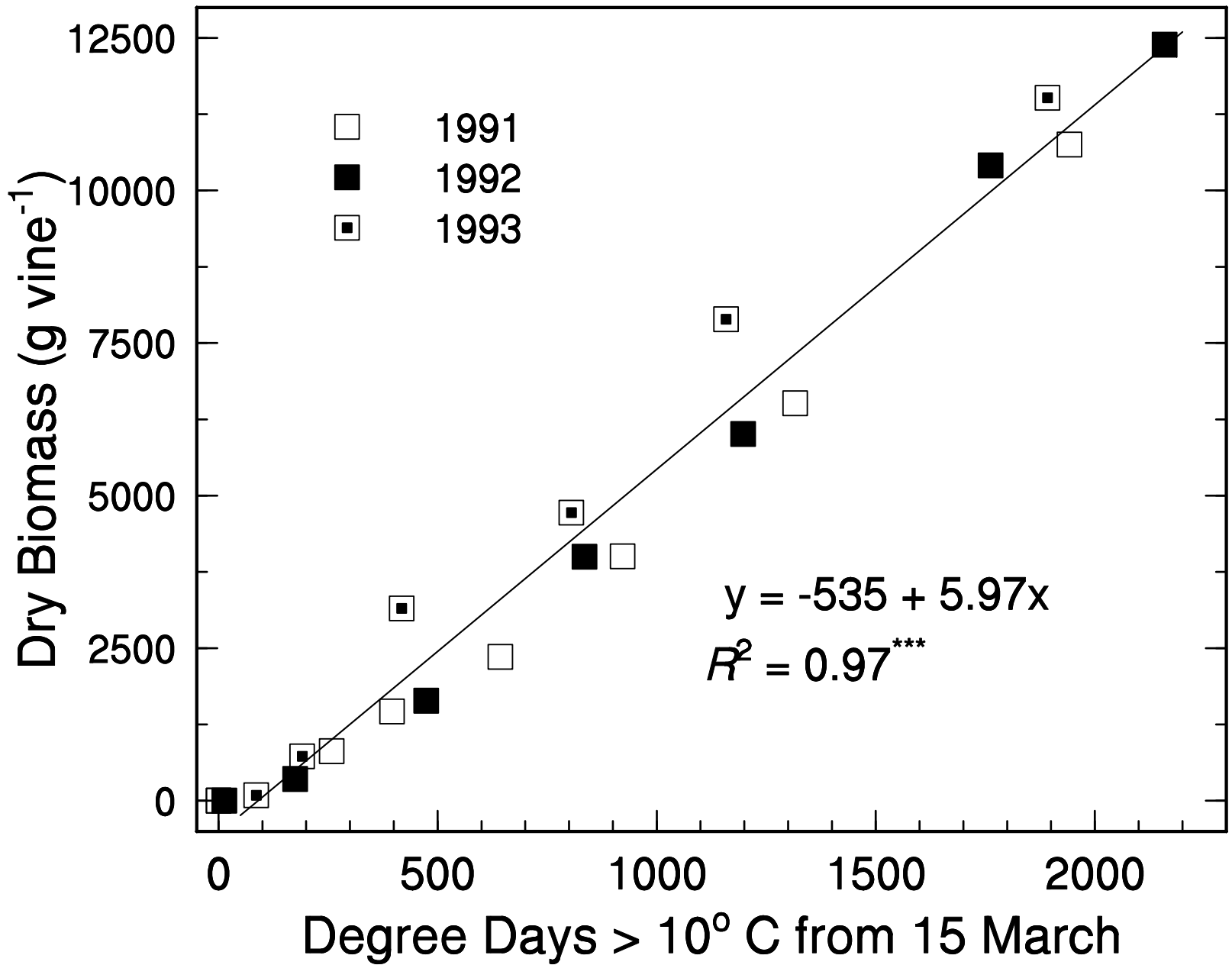
- Many have shown that there is a linear relationship between transpiration of plants and dry biomass production on a seasonal basis.
- This is due to the fact that CO₂ assimilation (photosynthesis) by the plant's canopy is highly correlated with transpiration, water vapor loss from the stomata.
- As far as I am aware, no such relationship has been demonstrated for grapevines (*Vitis vinifera* L.) grown in the field.

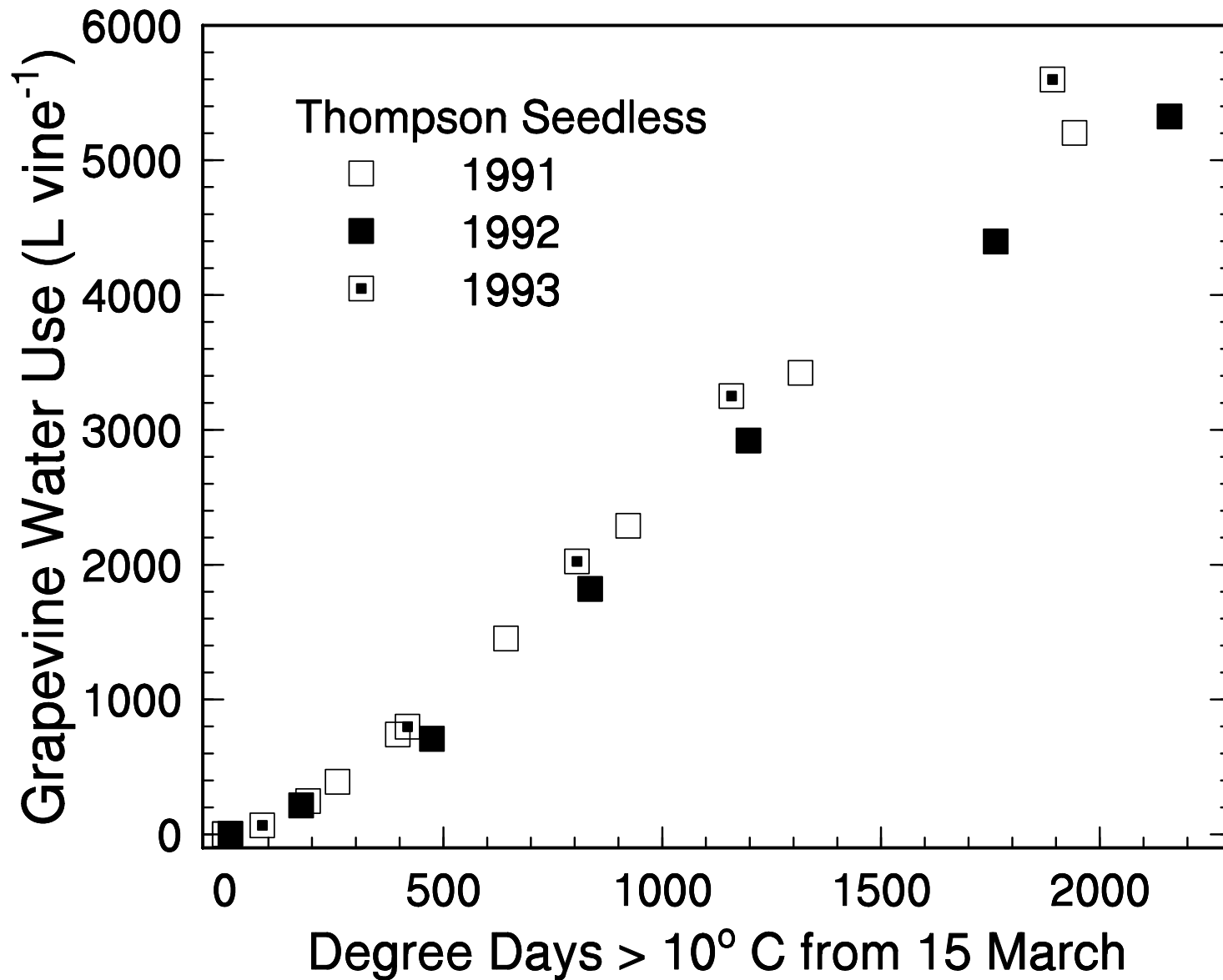
Background

- Several plant growth models have assumed that N uptake by plants is a linear function of transpiration. This would indicate that ion movement in the soil, ion uptake by the roots and distribution within the plant was due to mass flow.
- It has been demonstrated that transpiration is not necessary for the uptake of mineral nutrients by plants.
- Others have assumed that N (and perhaps K) uptake by plants is driven by growth under non-stress conditions.

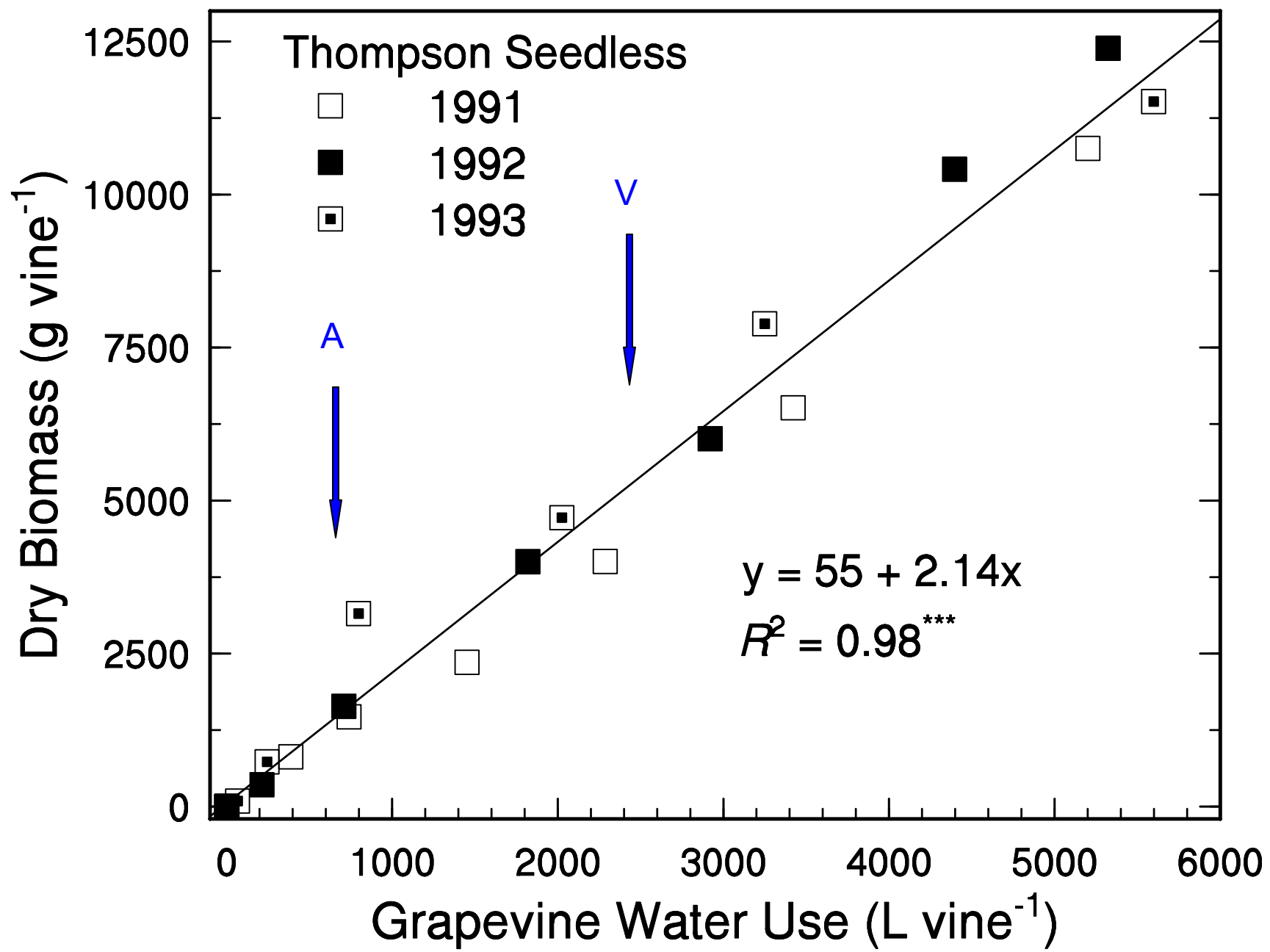
Objectives:

- Determine the relationship between grapevine ET and above-ground (leaves, stems and clusters) dry biomass production of field-grown Thompson Seedless grapevines.
- Determine whether N and K uptake were related with grapevine ET and/or biomass accumulation.
- Quantify the seasonal dynamics of N and K in the trunk and root system.



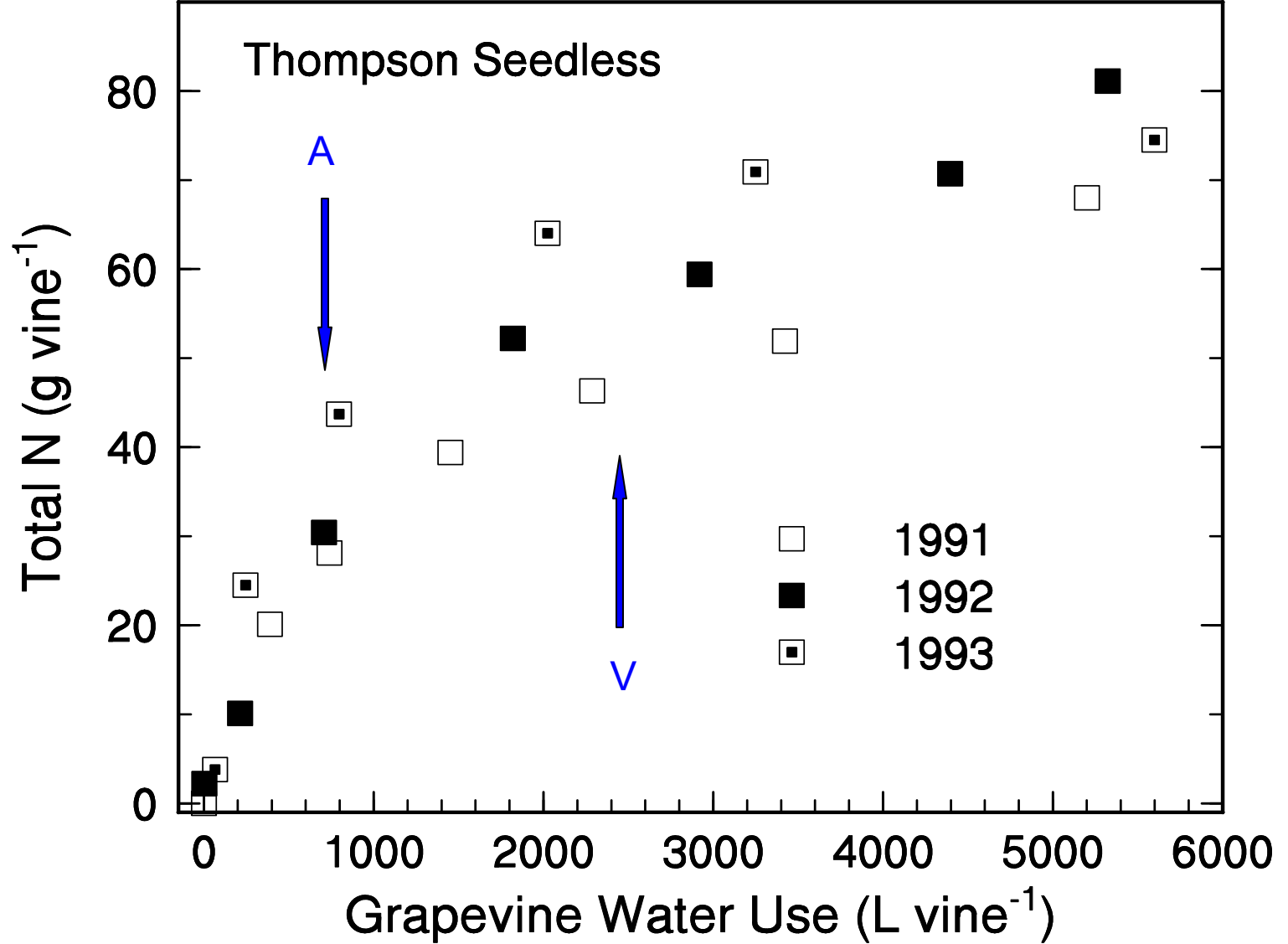


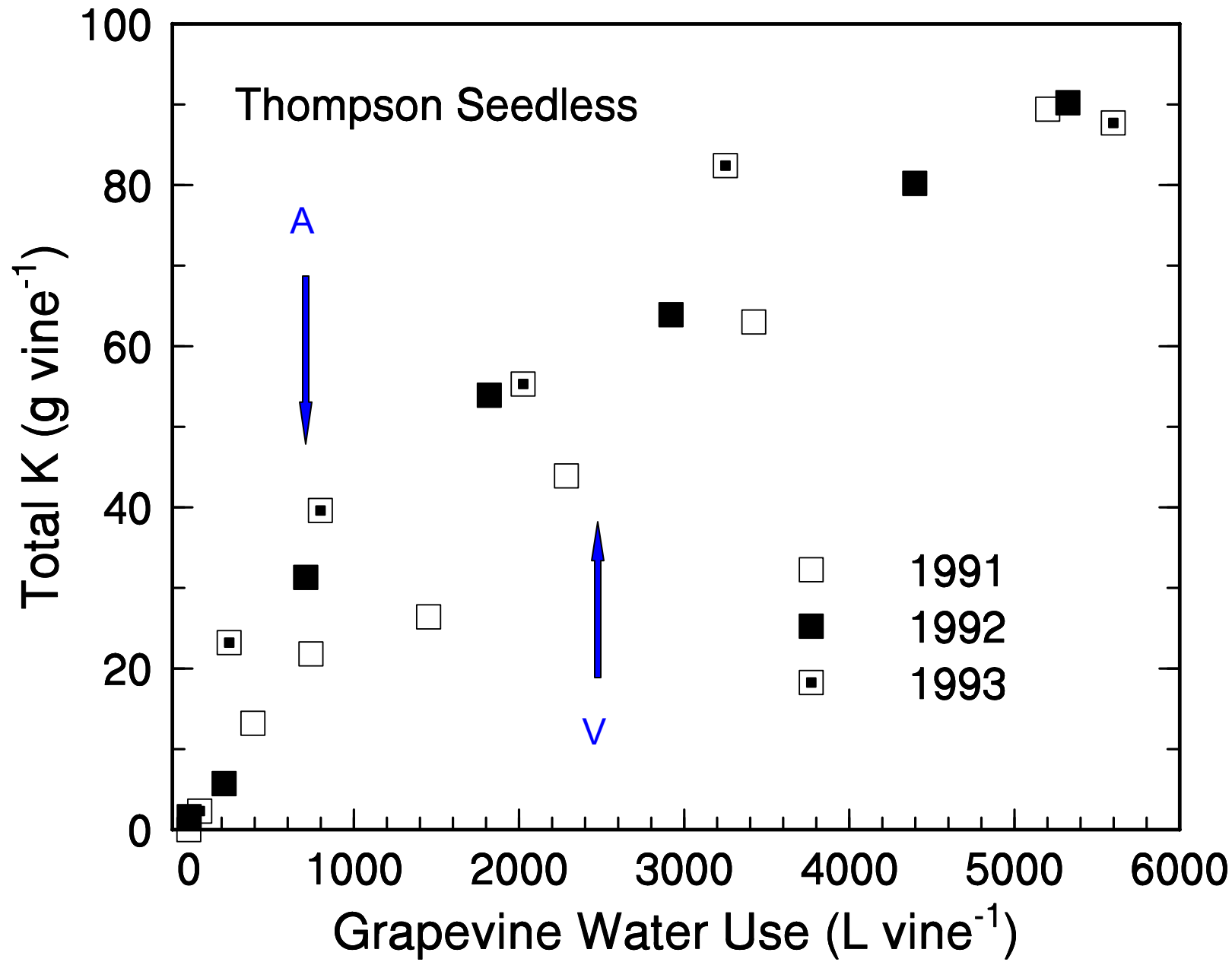
5,500 L = 728 mm or 28.6 inches of water

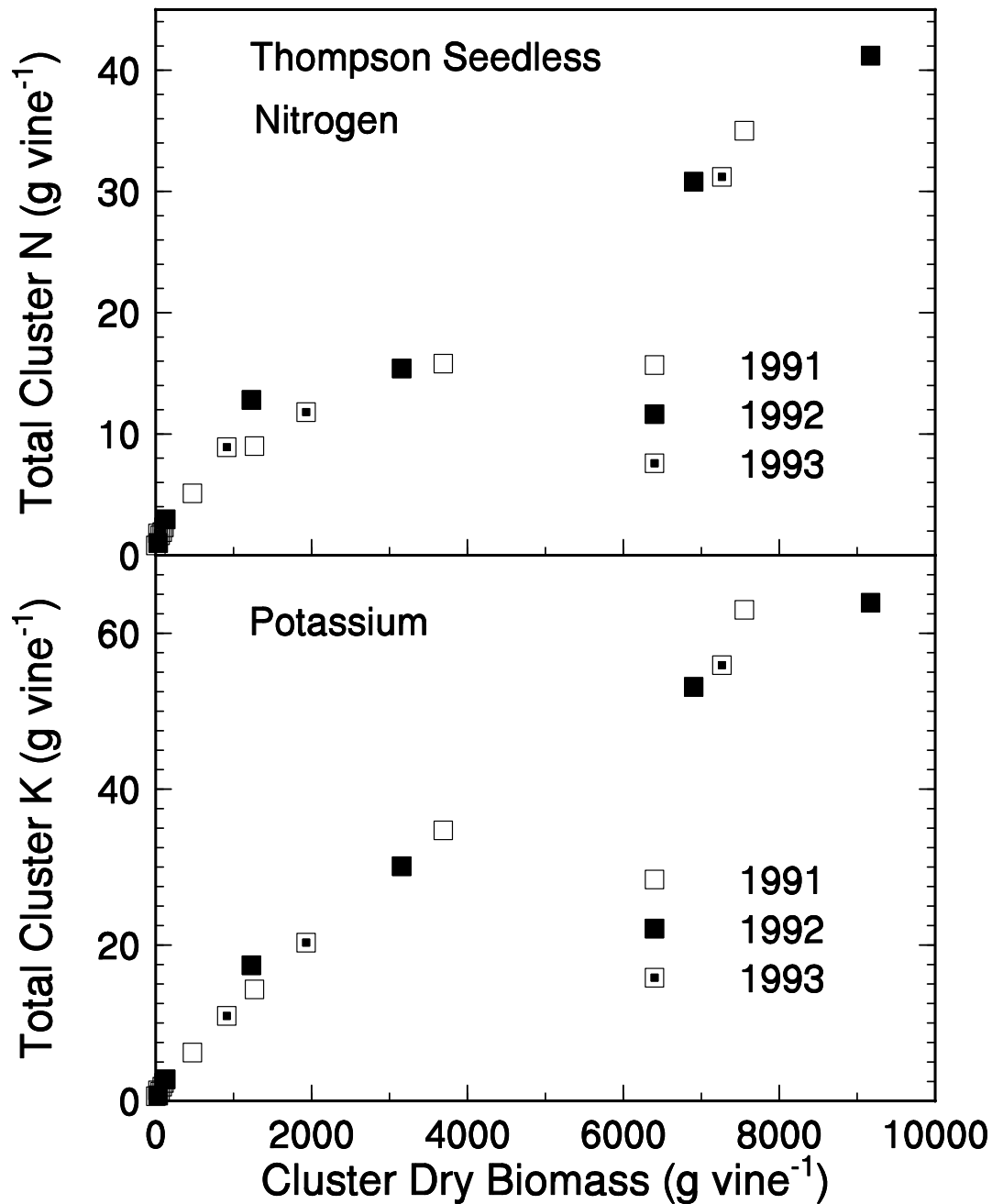


Summary:

- Dry biomass production of field-grown Thompson Seedless grapevines was a linear function of grapevine water use.
- Dry biomass production of field-grown Thompson Seedless was also a linear function of degree-days (temperature).
- Cluster dry weight accounted for ~ 70% of the total biomass produced in 1992.
- Only 7% of the current season's biomass production was allocated to the permanent structures of the vine under the conditions of this study.





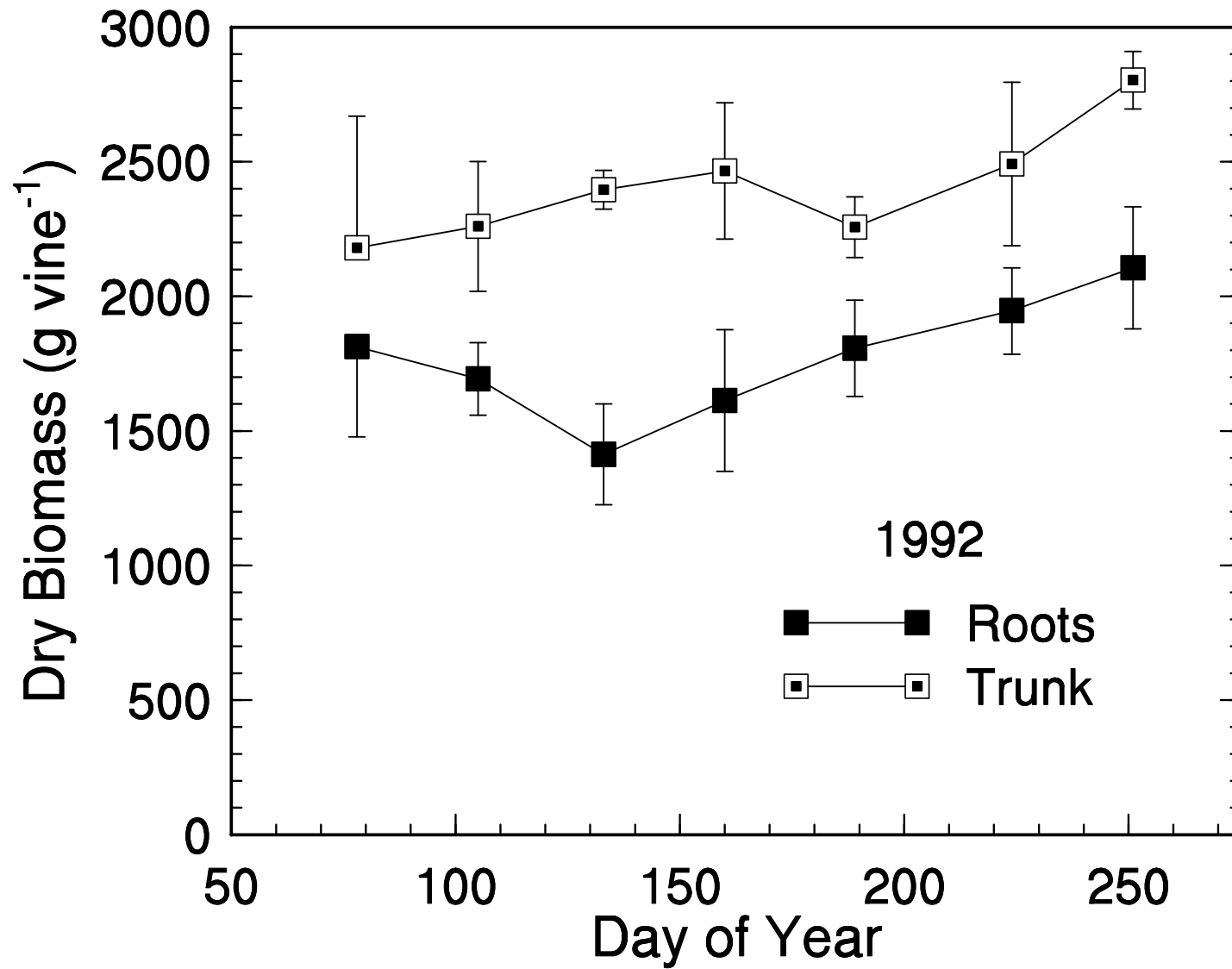


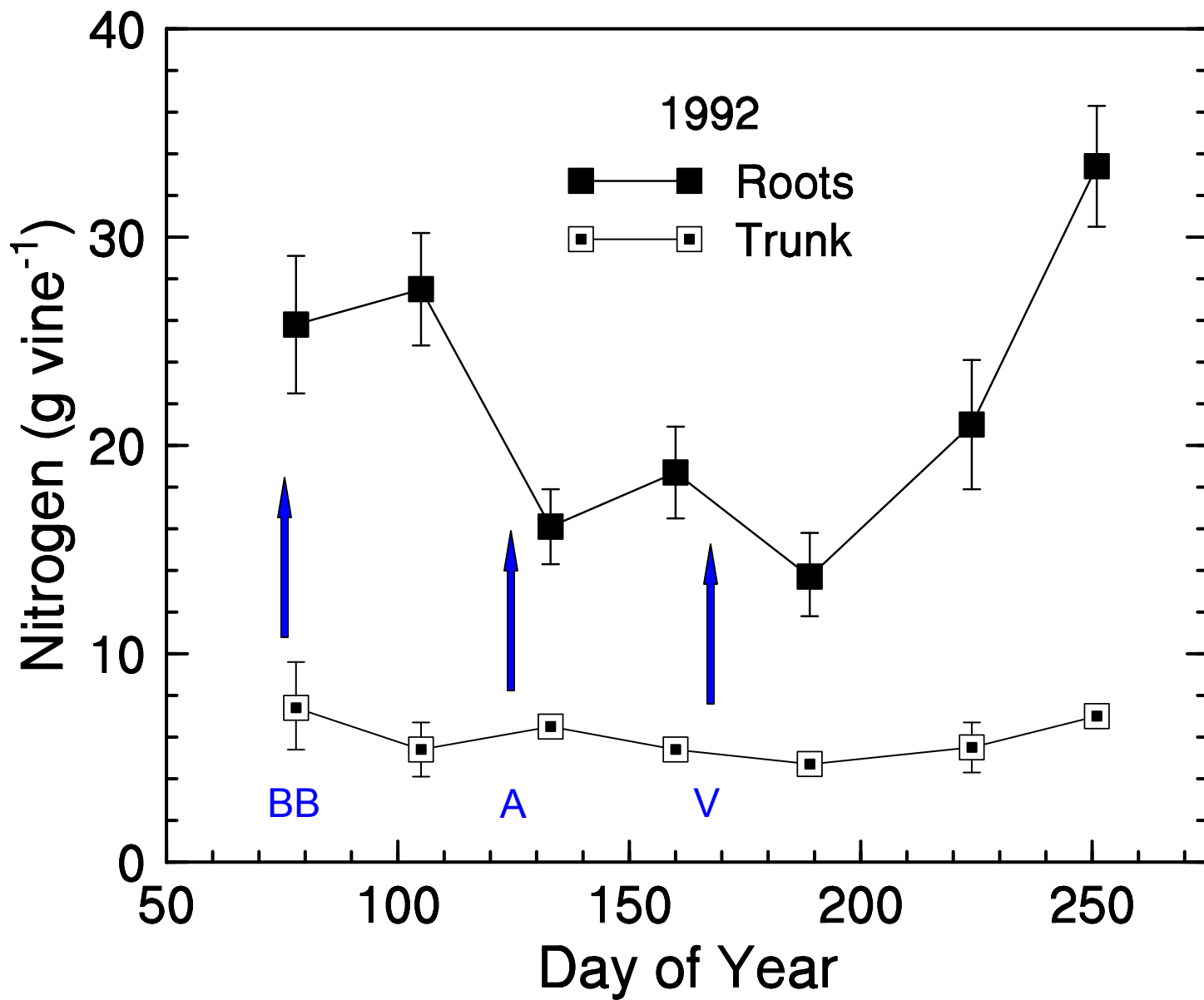
= 47 lbs N/acre

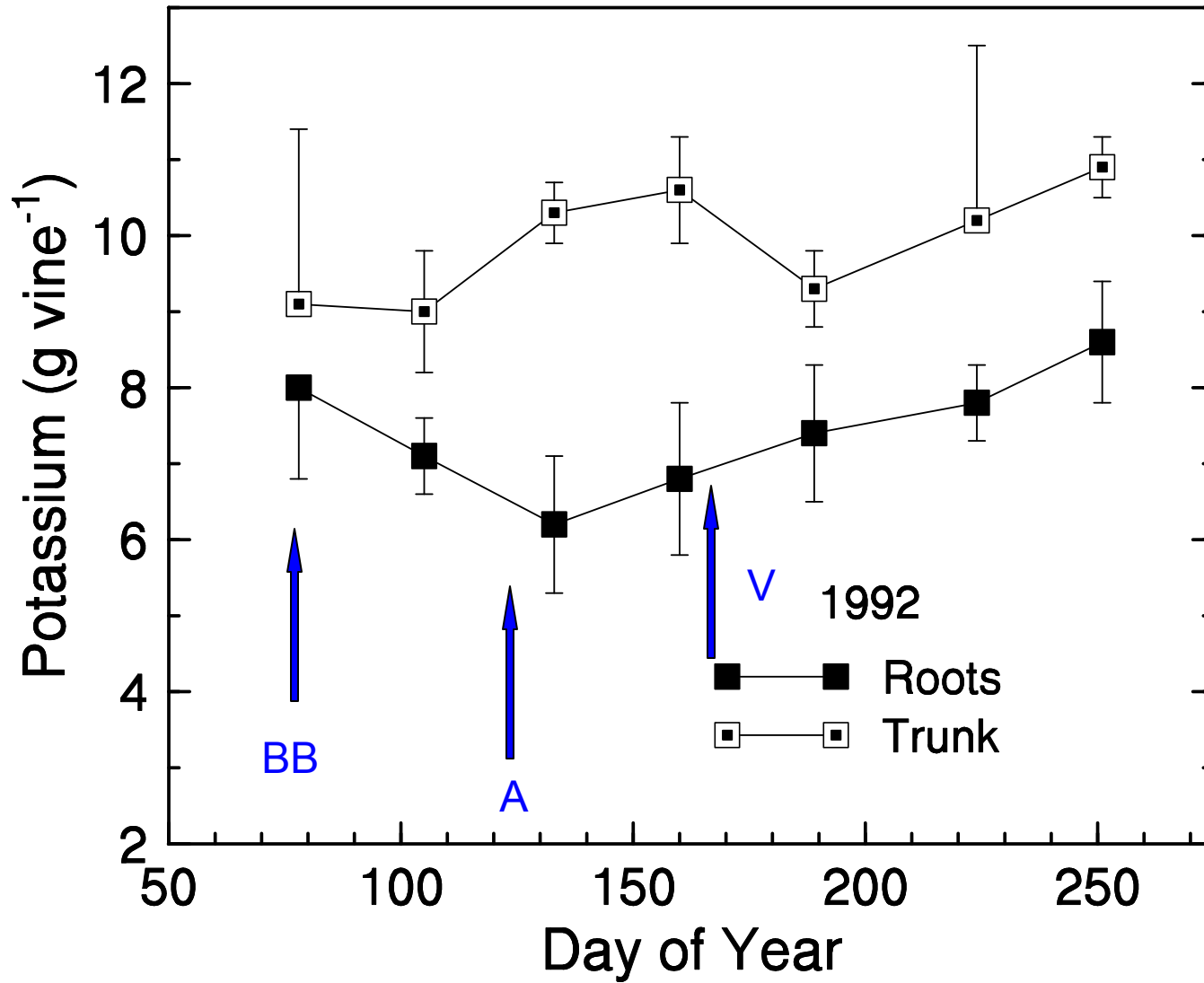
= 71 lbs K/acre

Summary:

- Nitrogen and K uptake by the vines were curvilinearly related to both seasonal vine water use and biomass accumulation of Thompson Seedless grapevines.
- The curvilinear relationship was due to the separation of vegetative and reproductive growth demands of N and K during the season.
- It is unknown whether the greater N and K uptake during the early portion of the growing season was due to an active uptake of both mineral nutrients or redistribution of N and K from the permanent structures of the vine.







Summary:

- Root biomass decreased from budbreak to shortly after anthesis and then increased thereafter until harvest.
- The K concentrations in the trunk and root system remained constant throughout the season. Therefore the differences in the amount of K in those two organs reflected seasonal variations in total root and trunk biomass. It would appear that no K was redistributed from those two permanent structures to the leaves, stems and clusters.
- This would indicate that under the conditions of the study, K used for growth of the leaves, stems and clusters was derived only from the soil.

Summary:

- Root N concentration and N content (g N vine^{-1}) varied throughout the season. The decrease in N concentration was due to both a reduction in total N content in the root and an increase in biomass accumulation.
- Based upon the metrics derived from the 1992 data, N stored in the root system was used to support shoot growth early in the growing season, from one month after budbreak to anthesis.
- The N content in the root system at harvest was similar to the amount found in the root system at budbreak.

N BUDGET OF THOMPSON SEEDLESS GRAPEVINES

Growth Period

Leaves	~35 g/vine
Shoots	~10 g/vine
Clusters	<u>~30 g/vine</u>
	75 g/vine

After Harvest

Fallen leaves	~20 g/vine
Prunings	~15 g/vine
Remolilization	<u>~ 5 g/vine</u>
	40 g/vine

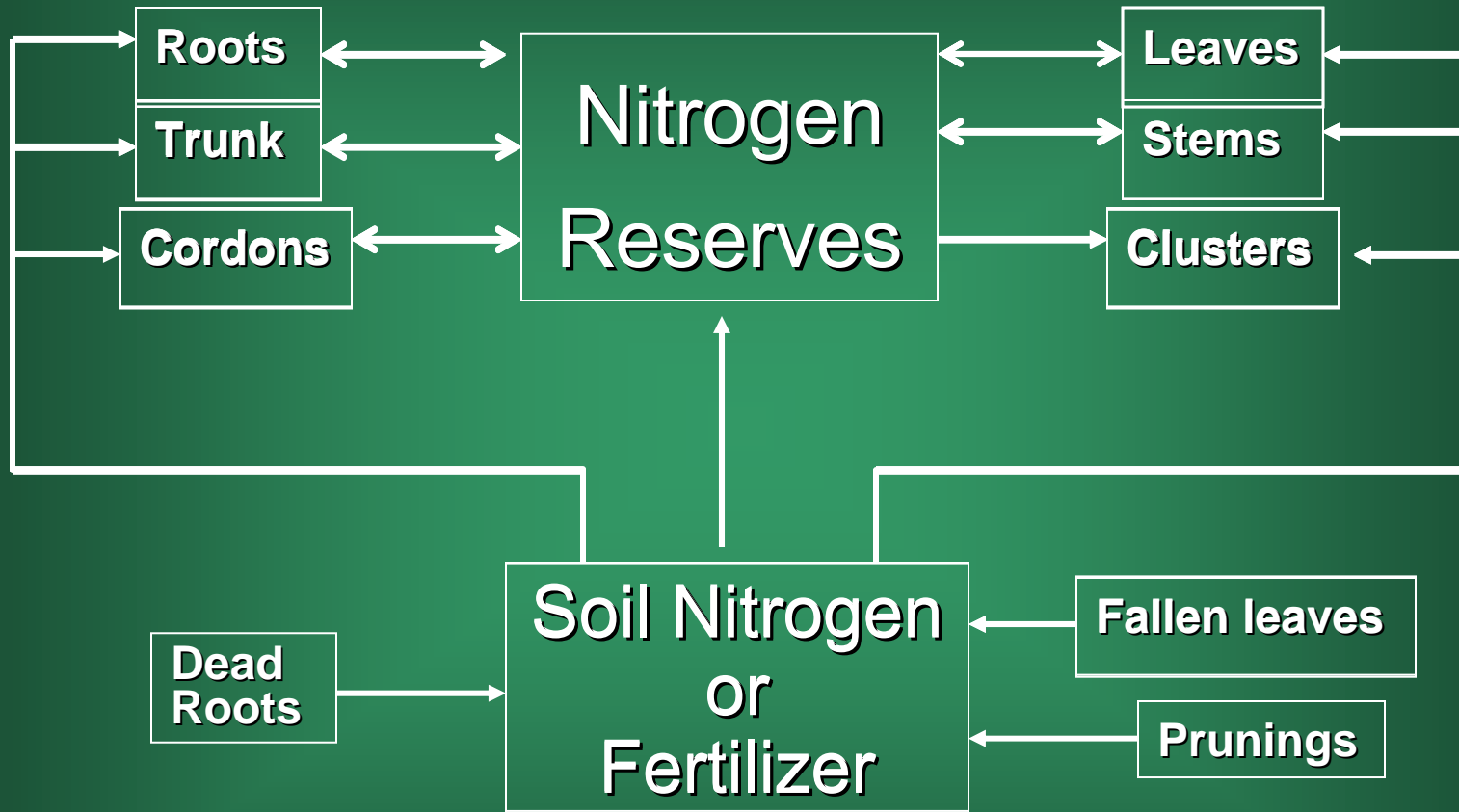
Potassium Budget of Thompson Seedless Grapevines (g/vine)

Requirements	Leaves	~12
	Stems	~26
	Clusters	<u>~43</u>
	Total	83
Losses	Shoot trimming	~5
	Fallen leaves	~8
	Prunings	~11
	Fruit harvest	<u>~45</u>
	Total	69

The average and high and low amounts of several mineral nutrients in one ton of fruit from grapevines.

Mineral Nutrient	Average	High	Low
	-----	(lbs / t)	-----
N	2.92	4.12	1.80
P	0.56	0.78	0.44
K	4.94	7.92	3.18
Ca	1.00	1.86	0.54
Mg	0.20	0.32	0.10

Nitrogen Cycling within a Vineyard



Grapevine N Fertilizer Program

- 1.) Assessing vineyard/vine N status
- 2.) Determination of N fertilizer amounts
- 3.) Kinds of N fertilizers
- 4.) Timing of fertilization events
- 5.) Effects of N on vegetative and reproductive growth

1.) Assessing vine nutrient status

a.) deficiency symptoms

b.) soil analysis

c.) tissue analysis

1.) Assessing vine nutrient status

- a.) deficiency symptoms –
by the time this is observed
vine growth may already be
adversely affected.

Nitrogen deficiency: Leaf symptoms



1.) Assessing vine nutrient status

b) Soil analysis

“Soil Analysis is of no value in determining N needs. This is due to the transient nature of its main available form (NO_3) in the soil profile and the unavailability of organic-N fraction until it is mineralized.”

L.P. Christensen, UCCE Specialist
Raisin Production Manual

1.) Assessing vine nutrient status

c.) Tissue Analysis – criteria for usefulness

- The tissue used and the mineral nutrient measured should be related to the mineral nutrient status or its concentration in other organs of the vine.
- The tissue used and the mineral nutrient measured should be related to vegetative and reproductive growth of the vine.
- A critical value or its range for the mineral nutrient in the organ measured should be robust enough to cover a wide range of vineyard or grapevine situations.

1.) Assessing vine nutrient status

c.) Tissue Analysis

- Time of Sampling
- Type of Tissue Sampled
- Form of Nitrogen

Time of Sampling

Bloom and/or Veraison

- Definite Growth Stage
- Repeatable
- Convenient

Type of Tissue Sampled

- Petioles opposite the cluster at bloom
- Petioles of mature leaves at veraison
- Leaf blades
- Fruit at harvest
- Canes during dormancy

Form of Nitrogen

Petioles – $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, total N

Leaf Blades – total N

Fruit – total N, arginine, yeast assimilable
nitrogen concentration (YANC)

Canes – total N, arginine

NITRATE-NITROGEN Bloom Petiole Levels (ppm)

	Nitrate-Nitrogen (ppm)
Deficient	Less than 350
Questionable	350 - 500
Adequate	500 – 1,200
Excessive	Over 2,000
Possibly toxic	Over 3,000

Other suggested critical values for N nutrient status

- Total N in petioles at bloom less than 0.8% indicates deficiency and those $> 0.8\%$ adequate
- In S. Africa, petiole total N at berry set less than 0.6% is deficient while sufficient ranges from 0.6 to 1.0%.
- Kliewer (1991) suggested that a total N value for leaf blades less than 1.5% is deficient while those from 1.5 to 3.0% is sufficient.
- Robinson (1992) suggests a leaf blade total N concentration of 2.9% at bloom and 1.6% at veraison is adequate

What factors may influence petiole values when analyzed for N or NO₃?

A. Time of day petioles are sampled – I have found that time of day may influence the concentrations of NO₃ and K in the petioles. I recommend that petioles should only be collected between 10 a.m. and 2 p.m. to minimize the effects of time of day on measured nutrient values.

Effect of time of day on nitrate-N of Perlette and nitrate-N and K of Flame Seedless petioles at bloom. Vines were growing in the Coachella Valley. Means within a column followed by a different letter are significantly different at $P < 0.05$.

	Perlette	---- Flame Seedless ----	
Time of Day	Nitrate - N	Nitrate - N	K
	-----ppm (dry wt) -----		% dry wt.
0800 h	890 b	825 b	2.51 b
1200 h	985 ab	968 ab	2.74 a
1600 h	1038 a	1025 a	2.65 ab

What factors may influence petiole values when analyzed for N or NO₃?

B. Location of the leaves where petioles are collected – I conducted a study where petioles were collected from leaves opposite a cluster, leaves in full sunlight and leaves growing in the shade. There were some minor differences, depending upon nutrient analyzed, among the leaf types selected. I am of the opinion that the leaf selected makes little difference as long as it is a mature, fully expanded leaf.

The effect of time of day and petiole location of leaves on nitrate-N of Chardonnay petioles sampled at bloom. Nitrate-N is expressed in ppm (dry weight basis). Leaf blades were exposed to direct sunlight (sun), shaded (shade) or located opposite a cluster at the time of sample.

Time of Day	Location of Leaves			Ave. Effect of Time of Day
	Sun	Shade	Opposite Cluster	
0800 h	1847	2411	1935	2064
1200 h	2121	2395	1893	2136
1600 h	<u>1970</u>	<u>2348</u>	<u>2135</u>	2151
Ave. Eff. Loc.	1979	2384	1988	
LSD _{0.05}	Time of Day = ns Location = 173 Interaction = ns			

What factors may influence petiole values when analyzed for N or NO_3 ?

- A. Cultivar
- B. Rootstock
- C. Time petioles sampled (during growing season)
- D. Irrigation/rainfall prior to sample
- E. Type of irrigation (flood or drip)
- F. Environment just prior to or the day of sample collection
- G. When last fertilized or fertility of soil in the vineyard

Bloom-time petiole analysis for NO₃ - nitrogen of four table grape cultivars over a four year period.

Vines were grown at the Kearney Ag. Center

Cultivar	-----Year-----			
	1990	1991	1992	1993
	----- NO ₃ (ppm) -----			
Flame Seedless	74	274	187	926
Perlette	66	215	49	703
Ruby Seedless	132	949	1088	1029
Thompson Seedless	316	1244	787	--

Effect of irrigation practices on petiole analysis of Thompson Seedless at bloom

Practice	NO ₃ -N (ppm)	K (%)
Irrigated	836	---
Not irrigated	217	---
Drip	383	3.3
Furrow	1465	2.3

Studies have measured petiole N, $\text{NO}_3\text{-N}$ and $\text{NH}_3\text{-N}$ and they are usually highly correlated with one another. However most studies have not compared petiole nutrient status with the nutrient status of other vegetative or reproductive organs within the vine at that time or at other phenological stages.

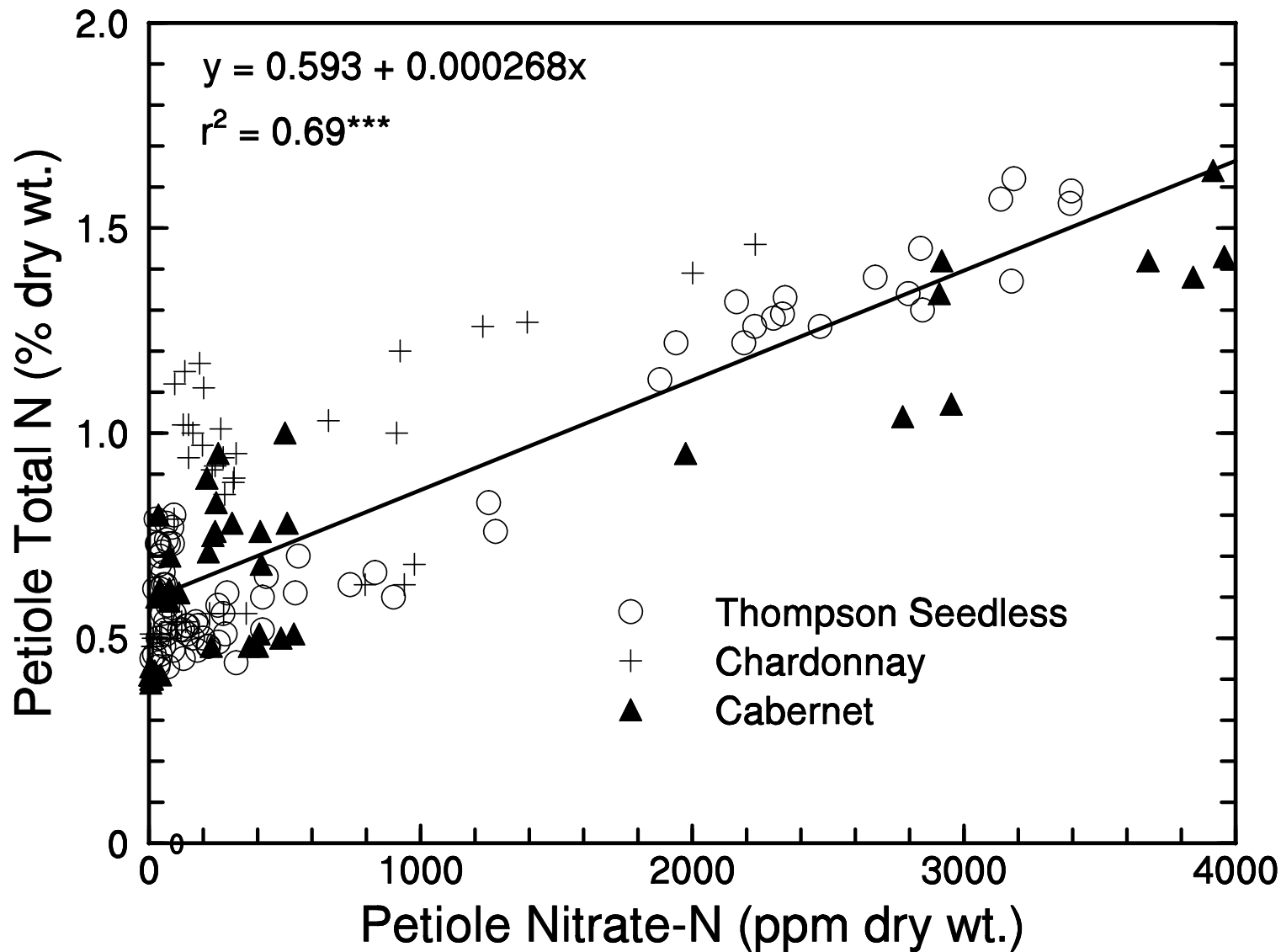
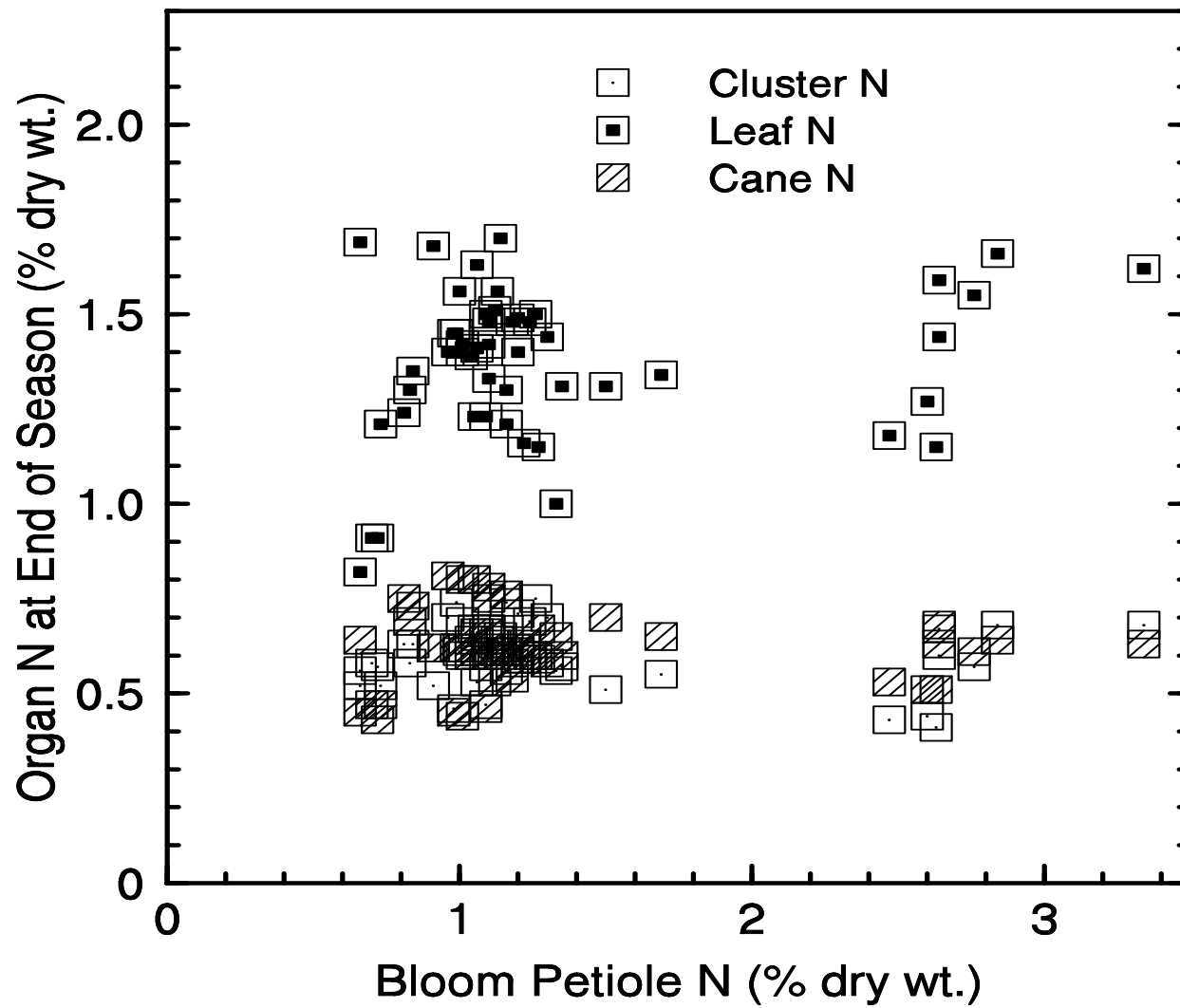
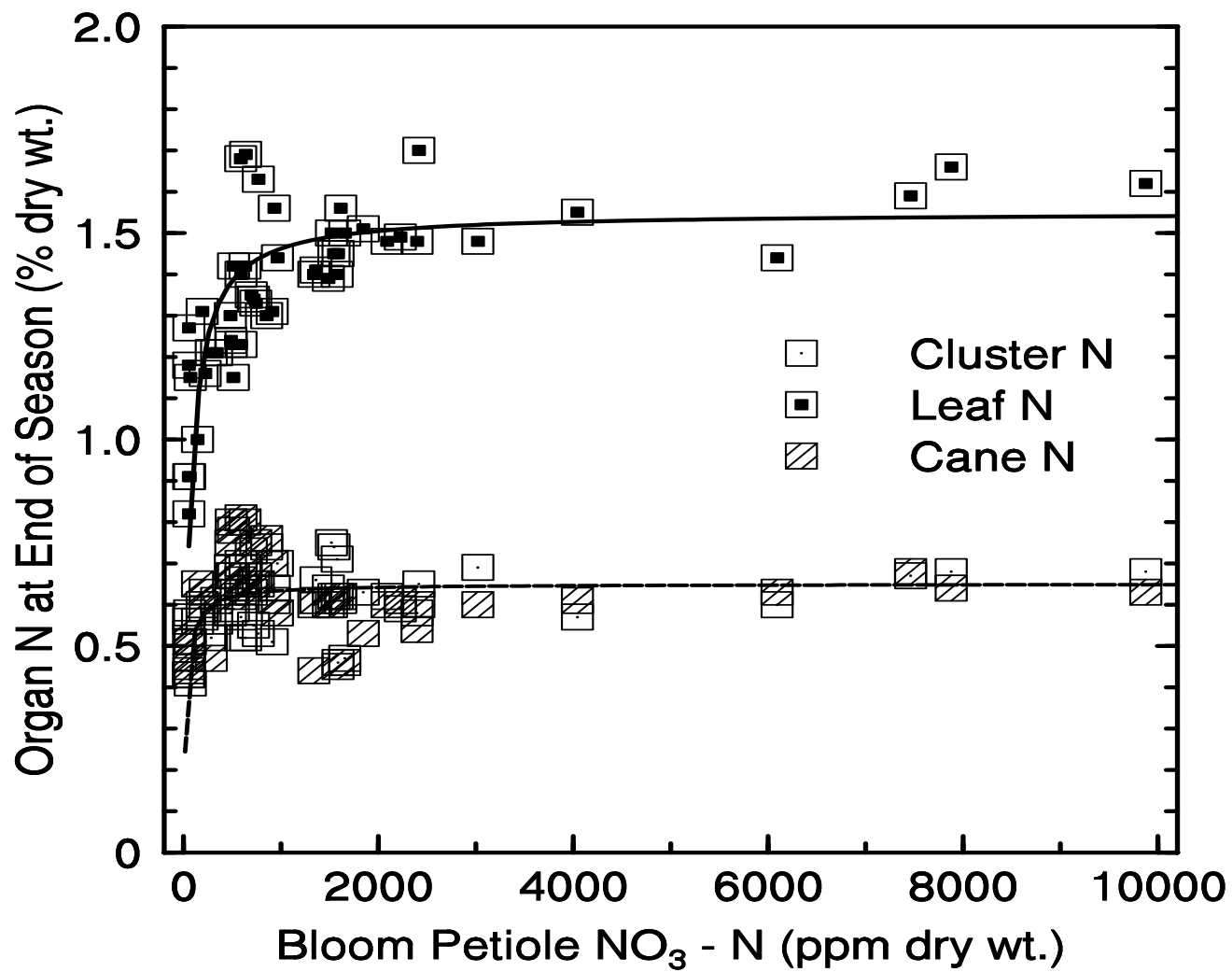
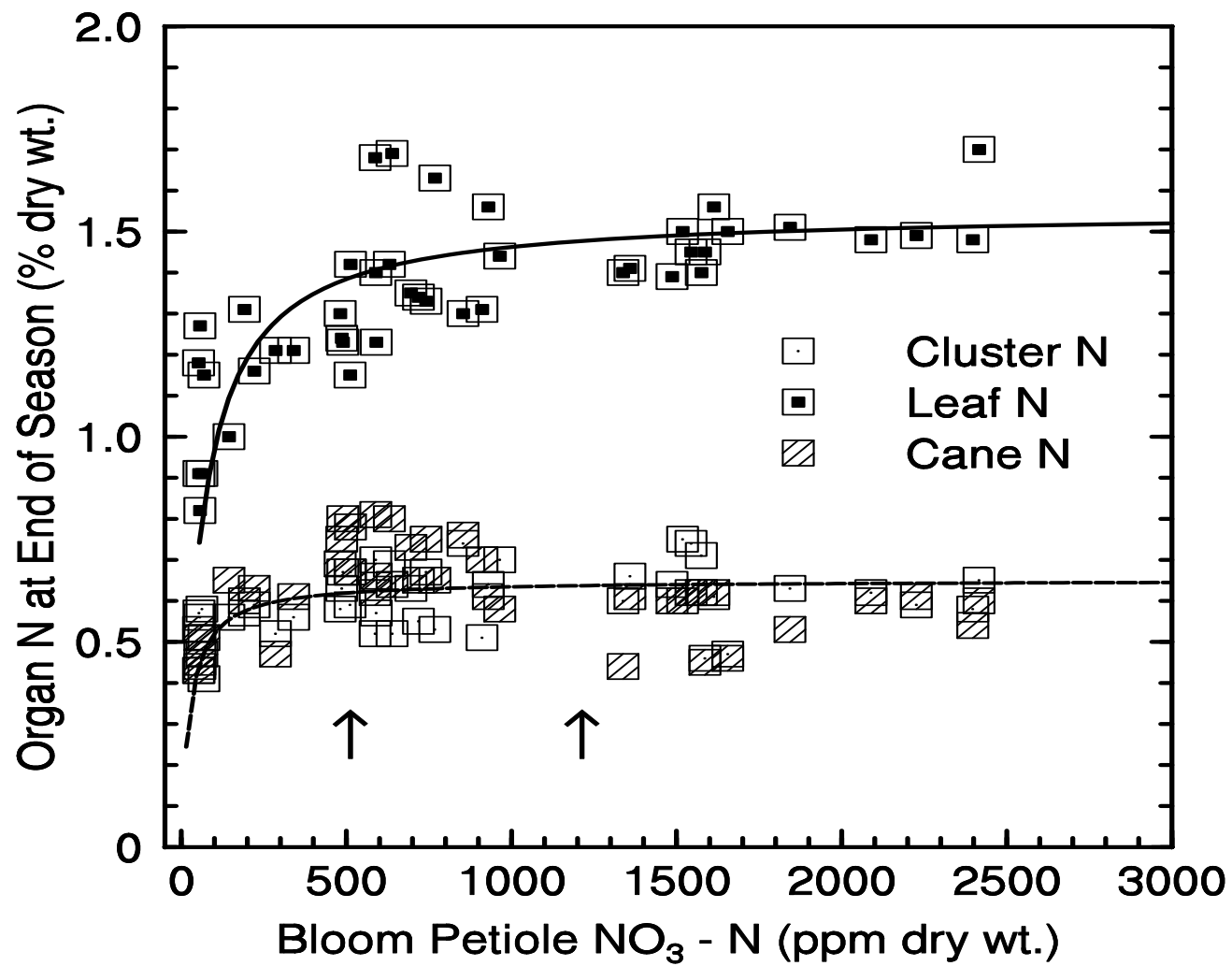


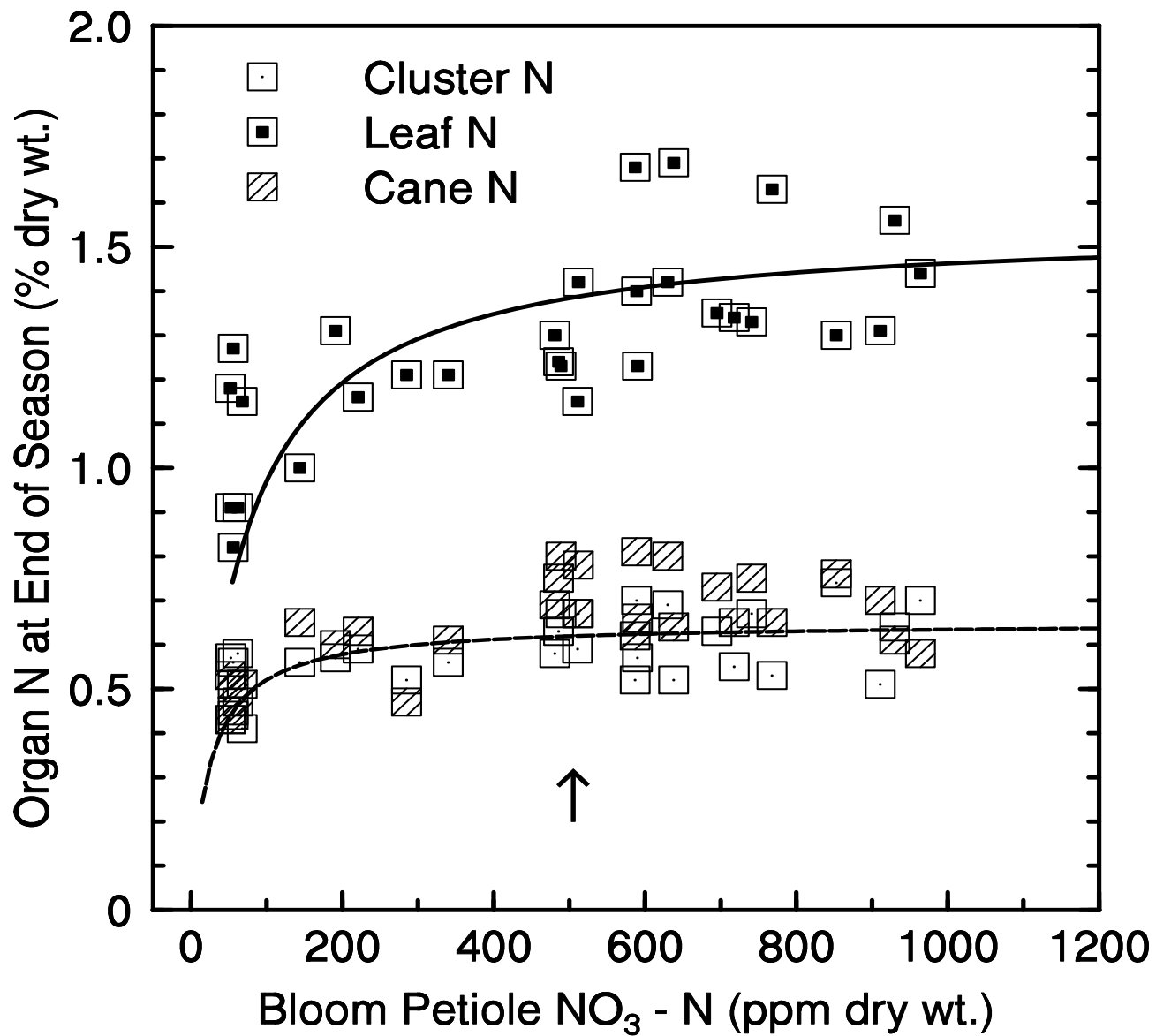
Figure 1. The relationship between petiole nitrate-N and petiole total N for three cultivars.

Relationships among bloom-time petiole N and K nutrient status and N and K nutrient status in the vine's other organs.

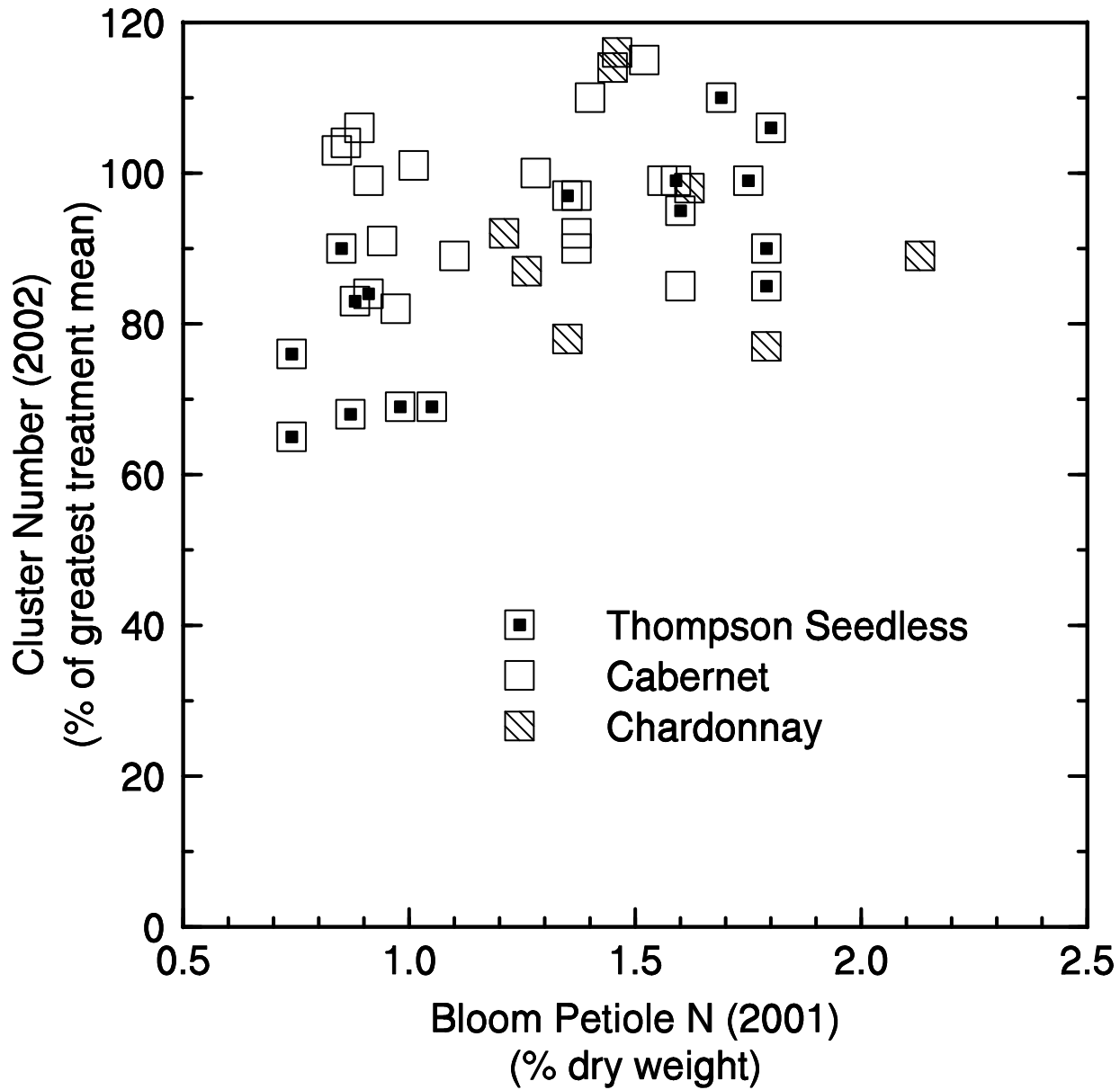


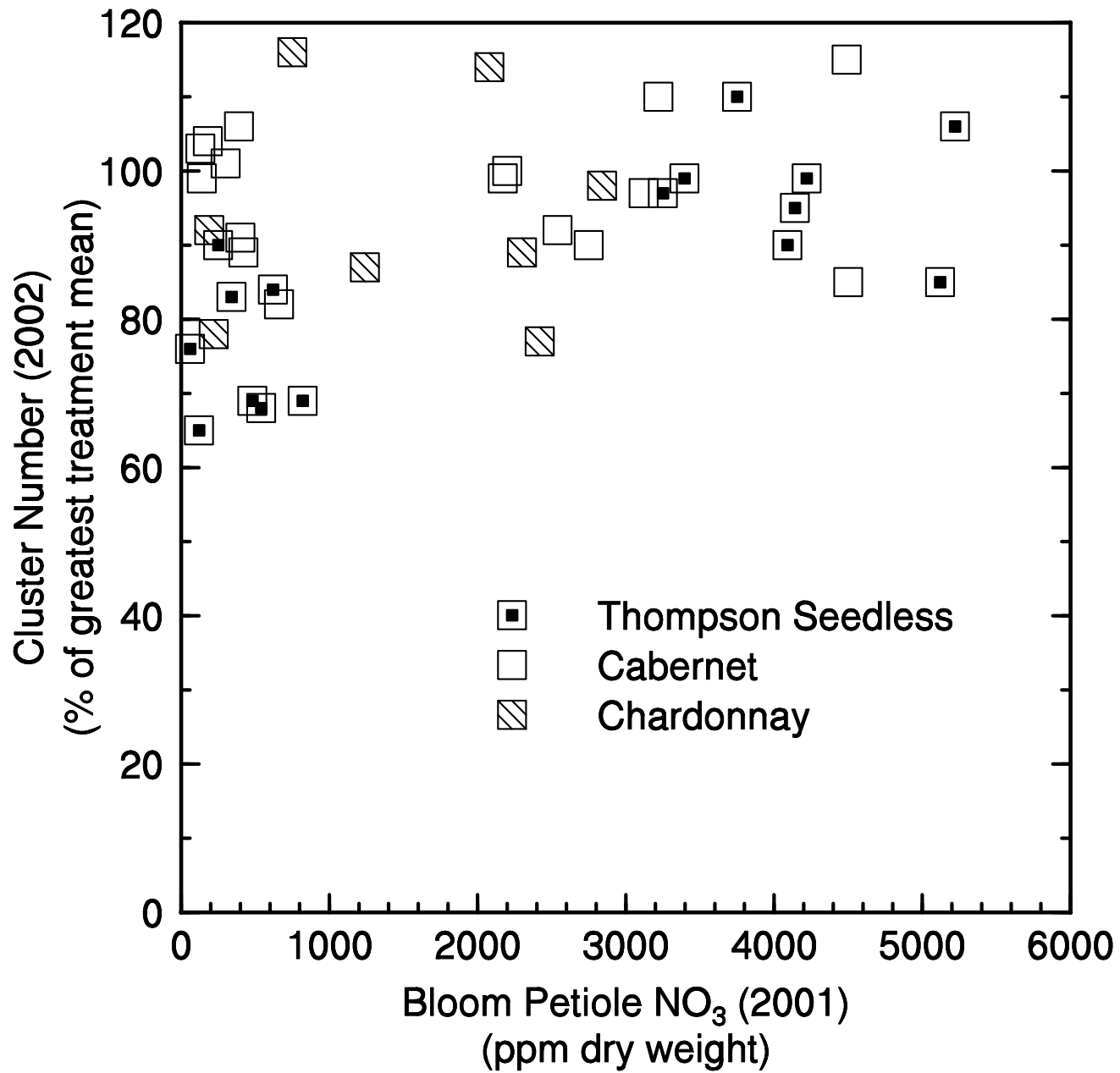


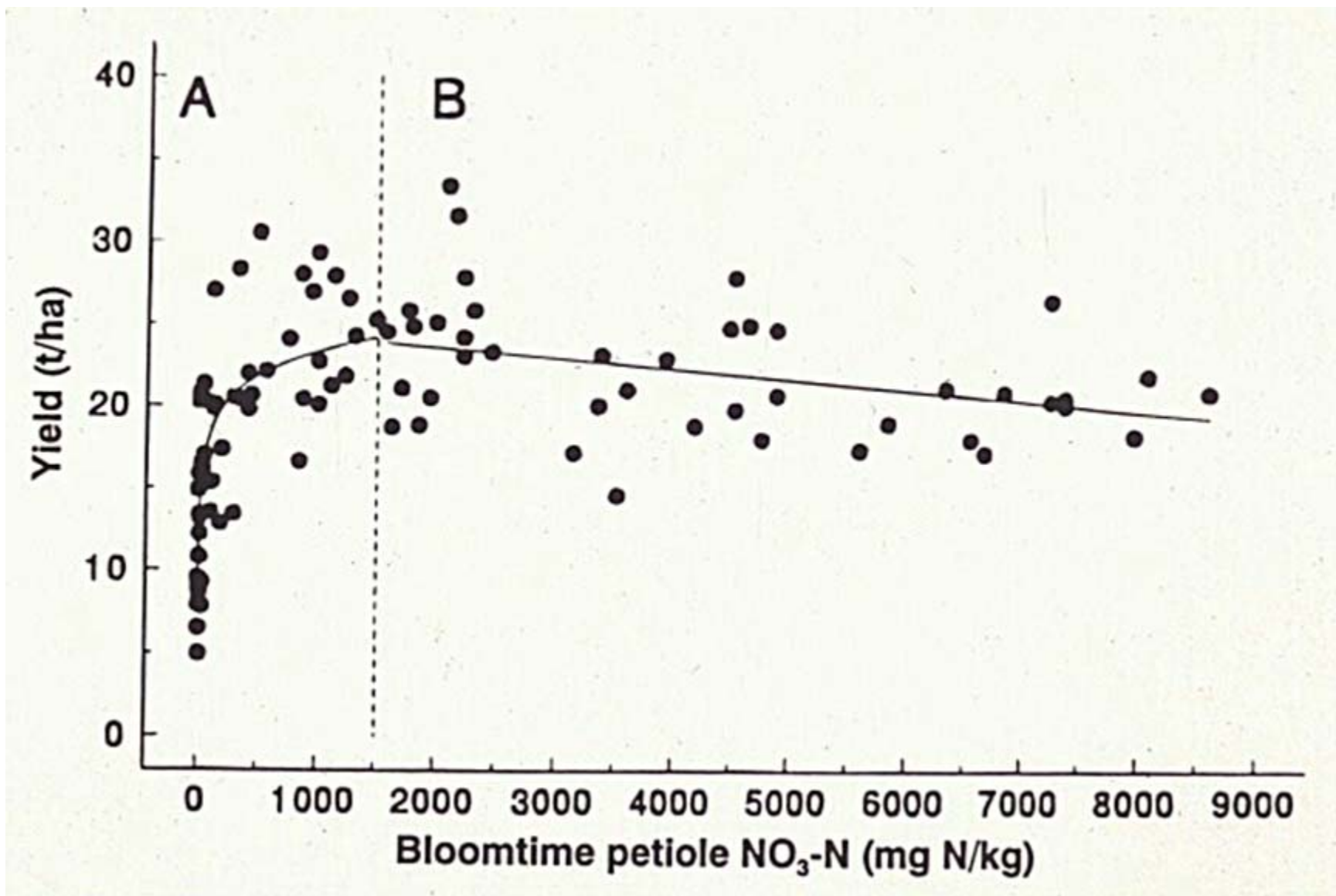




Relationships among bloom-time petiole nutrient status and return fruitfulness on three cultivars grown in CA and yield of grapes grown in Washington State.







It has always been assumed that rootstocks differ in their ability to take up mineral nutrients from the soil profile.

Bloom-time petiole nitrate concentration at four locations and rootstock/scion combinations for three years.

Location	Rootstock	----NO ₃ (ppm dry wt)----		
		1997	1998	1999
Carneros	5C	911	500	484
	110R	718	340	396
Gonzalez	5C	768	486	650
	110R	638	481	555
	Freedom	587	695	599
Oakville	5C	68	1655	47
	110R	56	1338	57
	3309C	52	1586	55
P. Robles	5C	6191	1359	2754
	110R	4042	964	1358
	Freedom	9876	1486	1387
	140Ru	7462	1518	1947
	1103P	7878	1575	1562

The amount of labeled N (N^{15}), total N, dry biomass and %N of the biomass accumulated by Chardonnay vines at two locations. Vines at Carneros and Gonzales were fertilized with 12 and 20 g N vine⁻¹, respectively, at berry set in 1997.

Location/ Rootstock	Total ¹⁵ N	Total N	Total Dry Wt.	Percent N
	----- (g vine ⁻¹) -----			% dry wt.
Carneros				
5C	0.066	44.1	6255	0.71
110R	0.078	52.7	7482	0.70
Gonzales				
5C	0.049	52.7	6694	0.79 a
110R	0.051	54.5	7591	0.72 b
Freedom	0.047	49.9	7889	0.73 b

The amount of labeled N (N^{15}), total N, dry biomass and %N of the biomass accumulated by Cabernet Sauvignon vines at Oakville. Vines were fertilized with 6 g N vine⁻¹ at berry set in 1997.

Location/ Rootstock	Total ¹⁵ N	Total N	Total Dry Wt.	Percent N
	----- (g vine ⁻¹) -----			% dry wt.
Oakville				
5C	0.039	26.6a	4480a	0.59 b
110R	0.043	24.0ab	3760 b	0.64a
3309	0.044	20.6 b	3761 b	0.62ab

Cultivar/Site: Cabernet at Paso Robles
 Data: ^{15}N , Total N and biomass for three years
 Applied Fertilizer: 17g N vine⁻¹

Rootstock	Total ^{15}N	Total N	Total Dry Wt.	%N
	-----(g vine^{-1})-----			
5C	0.035 c	65.3	8261	0.79 c
110R	0.049 b	67.5	8394	0.80 bc
Freedom	0.074a	69.7	8701	0.80 bc
1103P	0.072a	74.0	8949	0.83 b
140Ru	0.051 b	79.7	9171	0.87a

Conclusions:

- Bloom petiole analysis of N does not indicate that one rootstock is more efficient at taking up N than another under the conditions of this study.
- The relationship between petiole nitrate-nitrogen and N concentration in the leaves, fruit and canes in this study indicates that a bloom-time petiole value of 200 ppm NO_3 would be “adequate.” Nitrate values in the petioles at bloom below 100 ppm decreased percent N in those organs only slightly

Grapevine Fertilization Program

2.) Determination of fertilizer amounts

It will depend upon whether it is a maintenance program or one to correct a deficiency

- a.) for a maintenance program one needs to determine how much of the mineral nutrient is removed from the vineyard (i.e. develop a N budget)
- b.) determine the efficiency with which fertilizer is taken up.

The average and high and low amounts of several mineral nutrients in one ton of fruit from grapevines.

Mineral Nutrient	Average	High	Low
	-----	(lbs / t)	-----
N	2.92	4.12	1.80
P	0.56	0.78	0.44
K	4.94	7.92	3.18
Ca	1.00	1.86	0.54
Mg	0.20	0.32	0.10

Grapevine Fertilization Program

3.) Kinds of N fertilizers

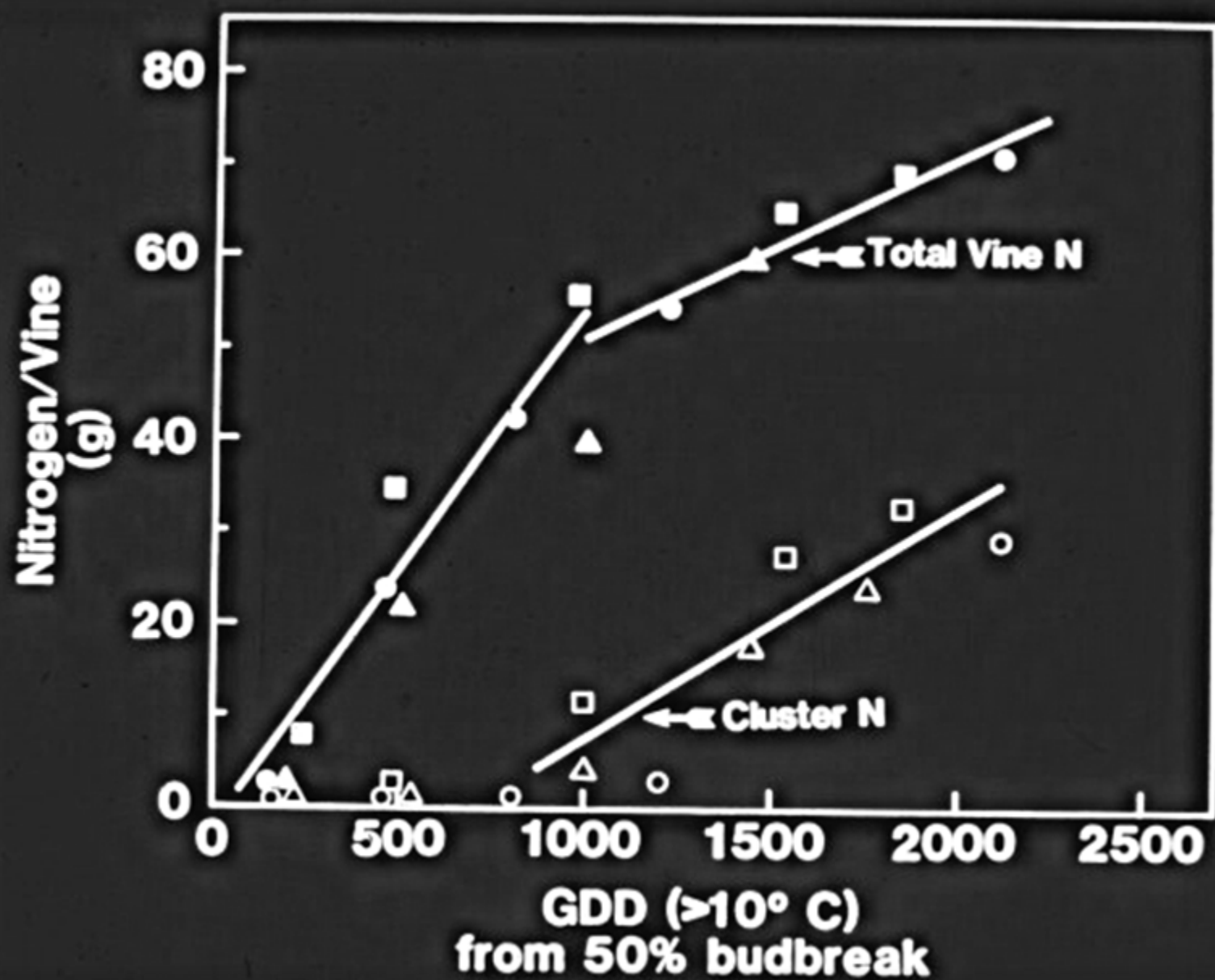
“Generally the choice of the formulation of nitrogen can be based mostly upon cost.”

L.P. Christensen, UCCE Specialist

Grapevine Fertilization Program

4.) **Timing of fertilization events**

One must know when the N is being utilized by the vine to choose the appropriate date to apply the fertilizer.



When do vines require the most N during the growing season?

- 1.) Approximately two thirds of the current season's above ground requirement goes to the leaves and stems (main axis of the shoot), the other third goes to the fruit.
- 2.) Approximately two thirds of the current season's N requirement is taken up between budbreak and sometime between berry set and veraison.
- 3.) Some of the nitrogen required by the current season's above ground growth may be obtained from N in the trunk (or cordons if present) and the root system

L.E. Williams' recommendation for N fertilization application timing

Split applications^a

1st application – one month after BB

2nd application – just after berry set.

^a apply one half the total fertilizer to be used each time.

When do you not want to apply a nitrogen fertilizer?

- 1.) Avoid applying N in winter/early spring if the fertilizer is susceptible to leaching during this season.
- 2.) An application of N fertilizer just prior to or at bloom will increase the amount of berries that fail to set.
- 3.) A post-harvest application of an N fertilizer is probably not as efficient as some thought. For one to consider this time as appropriate, one needs to assess vine health, length of season remaining and soil type.

Effect of irrigation type and form of N on nitrogen fertilizer use efficiency (FUE).

Treatment	FUE ¹
Drip NO ₃	42%
Drip NH ₄ ⁺	37%
Furrow (NO ₃)	14%
Furrow (NH ₄ ⁺)	10%
Drip (cont)	38%

¹ FUE = Total Fert. in Vine/Total Fert. N Applied.

Relative distribution of ^{15}N labeled fertilizer in the organs of Thompson Seedless grapevines.

Treatment	Clusters	Leaves	Pruned	Fruiting	Trunk	Roots
			Canes	Canes		
----- (^{15}N in organ/ ^{15}N taken up by vine) x 100 -----						
Drip Irr.						
NO_3	35.1 b	12.4	11.4 b	2.7	9.1	29.3 a
NH_3	46.9 a	12.6	10.1 b	2.0	10.0	18.4 b
NO_3/Cont	29.6 b	15.7	19.4 a	2.4	10.4	22.6 ab
Furrow Irr.						
NO_3	42.6	14.3	10.4	3.9	14.6	14.2
NH_3	35.9	13.8	11.7	5.4	14.6	18.6

Nitrogen derived from fertilizer (NDF) in the organs of Thompson Seedless grapevines.

Treatment	Clusters	Leaves	Pruned	Fruiting	Trunk	Roots
			Canes	Canes		
----- (^{15}N in organ / total N organ ⁻¹) x 100 -----						
Drip Irr.						
NO ₃	12.6	9.6 ab	11.1 ab	10.9	9.1	9.2 a
NH ₃	12.2	6.9 b	8.4 b	7.6	7.6	4.4 b
NO ₃ /Cont	12.7	10.5 a	15.6 a	11.5	11.0	10.8 a
Furrow Irr.						
NO ₃	6.9	4.8	6.8	4.6	4.4	2.6
NH ₃	3.9	3.0	4.0	4.8	3.2	2.3

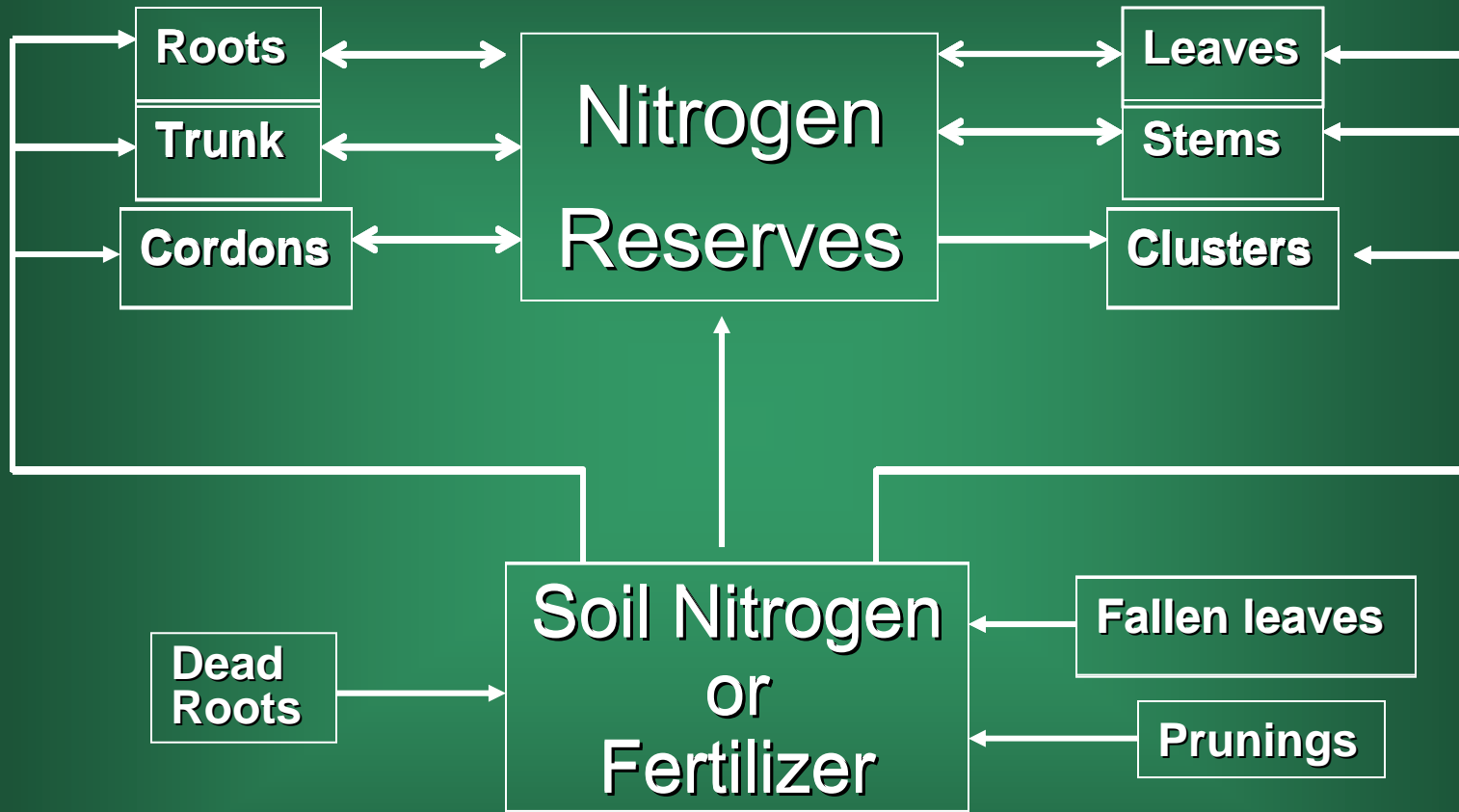
Distribution of fertilizer N in individual vine organs

Treatment	Year Harvested	-----Vine organs-----					Total
		Clusters	Leaves	Stems ²	Trunk	Roots	
----- (g N vine ⁻¹) -----							
Drip (cont)	1989	3.23	1.81	0.86	1.14	2.47	9.51
Drip (cont)	1990	1.78	1.40	0.78	0.58	2.32	6.86

¹ Vines fertilized with 15 N every two weeks during 1989 growing season for a total of 27.6 g N vine⁻¹.

² Stems include main axis of shoot and fruiting canes.

Nitrogen Cycling within a Vineyard



Grapevine Fertilization Program

5.) Effects of N on vegetative and reproductive growth

Effects of N Fertilization on Growth, Yield and Fruit Characteristics

Parameter	<u>Deficient Vineyards</u>	<u>Non-deficient vineyards</u>
Vegetative growth	↑	↑
Yield	↑	*
Berry Sugar	?	? or ↓
N Compounds in Fruit	↑	↑

↑ ↓ - increase and decrease respectively; * - no effect; ? :- may or may not have effect

San Joaquin Valley N and K Fertilizer Study: Objectives

- Determine the correlations among the various means to assess vine N nutrient status with nitrogenous compounds found in the fruit at harvest of Merlot and Thompson Seedless grapevines grown in the San Joaquin Valley.
- The nitrogenous compounds measured in the fruit are those used by yeast during fermentation. They include ammonia and α -amino acids.
- Determine the effects of K fertilizer on juice characteristics and correlations with vine K nutrient status.

San Joaquin Valley N and K Fertilizer Study: Materials and Methods – Fertilizer treatments

- Treatments consisted of N and K fertilizers being applied at berry set in 2004 using two rates (75 and 100 kg (N or K) ha⁻¹ and another treatment being applied at 75 kg (N or K) ha⁻¹ at veraison. The 75 kg rate was approximately 67 lbs of N or K per acre while the 150 rate was equivalent to 134 lbs of N or K per acre.
- The N fertilizer was ammonium nitrate and the K fertilizer was potassium sulfate.
- The control treatment received no fertilizer

San Joaquin Valley N and K Fertilizer Study: Materials and Methods – Samples

- The fruit of both cultivars were harvested at fruit maturity (except for T.S. in 2005).
- The fruit was transported to UC-Davis, grapes were separated from their stems and juice samples taken. Wine was made from the Merlot fruit in 2004.
- The juice and wine were analyzed for ammonia and α -Amino nitrogen content or nitrogen by OPA (NOPA).
- Ammonia + NOPA = yeast assimilable nitrogenous compounds or YANC

Critical values of YANC in grapes for wine production

Various studies have attempted to estimate the minimum concentration of juice N needed to achieve a satisfactory completion of fermentation as judged by low residual sugar, i.e. minimum concentration of N in juice at which the risk of slow or stuck fermentation is low. Estimates range from 70 – 267 mg/L YANC, with a value of ~ 140 mg N/L for clarified musts of moderate sugar concentration being considered a practical minimal limit.

Effects of applied **N** fertilizer at berry set (BS) or veraison (V) in 2004 on petiole N status of **Merlot** grapevines grown in Madera County.

N Treatment	Total N (% dry wt.)		--- NO₃-N --- ----- (ppm, dry wt.) -----		--- NH₄-N --- ----- (ppm, dry wt.) -----	
	Bloom	Veraison	Bloom	Veraison	Bloom	Veraison
2004						
N 0	1.02	0.61 b	660	185 c	260	75 b
N 75 BS	---	0.86 a	---	795 b	---	95 ab
N 150 BS	---	0.78 ab	---	1407 a	---	125 a
N 75 V	---	0.60 b	---	137 c	---	70 b
2005						
N 0	1.19	0.76	2022	1600	447 ab	112
N 75 BS	1.11	0.74	1777	1465	387 b	90
N 150 BS	1.16	0.82	2010	1952	445 ab	117
N 75 V	1.20	0.78	2070	1720	525 a	110

Effects of applied **N** fertilizer at berry set (BS) or veraison (V) in 2004 on must characteristics of **Merlot** grapevines grown in Madera County.

N	Soluble Solids		TA	NH ₄ ⁺	NOPA	YANC
Treatment	(°Brix)	pH	(g L ⁻¹)	----- (mg L ⁻¹) -----		-----
2004						
N 0	25.5	3.66	5.35 a	50 c	98 b	144 b
N 75 BS	26.0	3.67	5.32 a	67 b	123 a	181 ab
N 150 BS	25.5	3.63	5.45 a	79 a	115 a	184 a
N 75 V	25.3	3.71	4.65 b	63 b	118 a	188 a
2005						
N 0	22.4	3.46	3.47	62 b	143 b	205 b
N 75 BS	22.3	3.44	4.04	81 a	140 b	220 ab
N 150 BS	21.9	3.45	3.85	82 a	156 a	238 a
N 75 V	21.7	3.42	4.06	86 a	149 ab	235 a

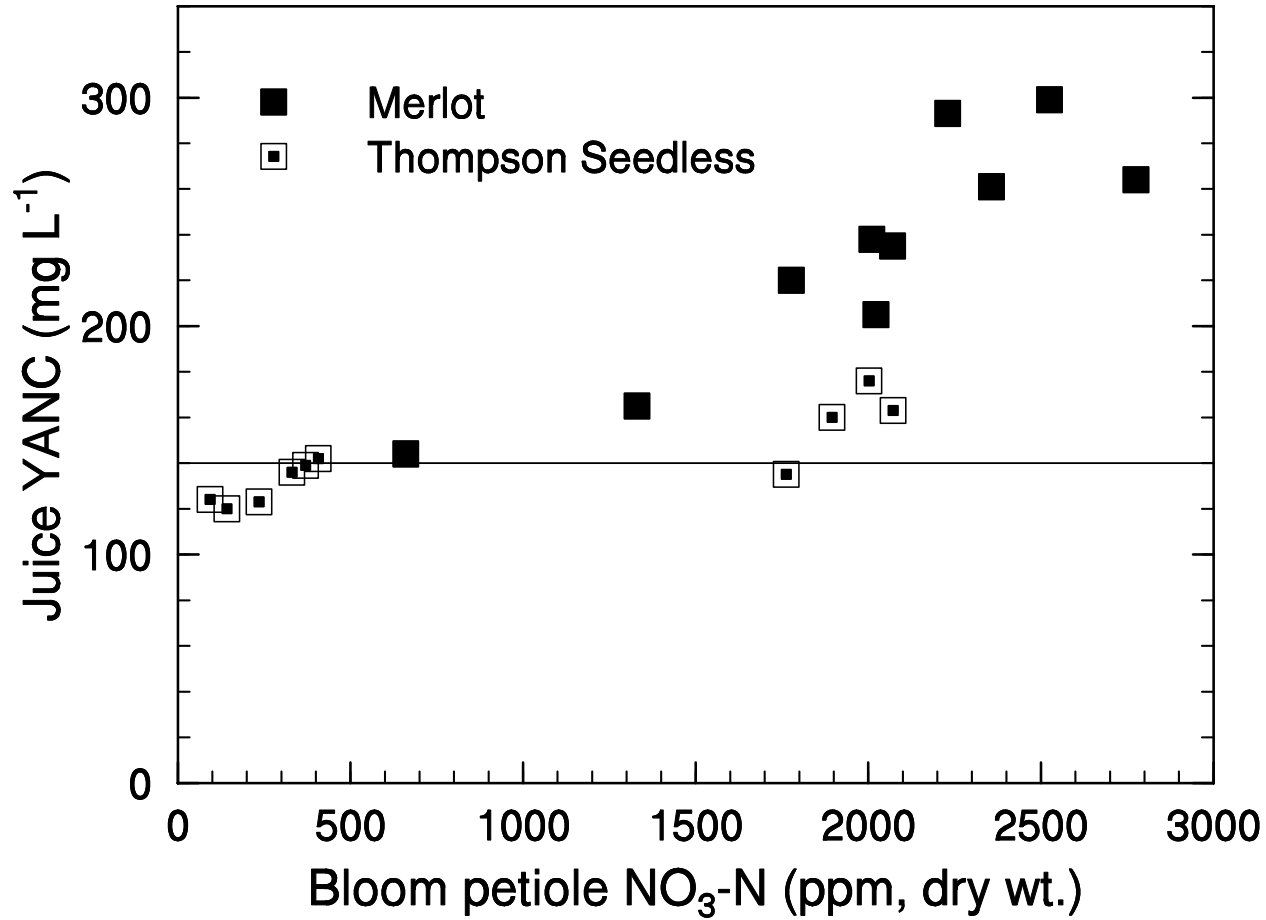
Effects of applied **N/K** fertilizer at berry set (BS) or veraison (V) in 2004 on wine characteristics of **Merlot** grapevines grown in Madera County.

N/K	Ethanol	pH	TA	NH₄⁺	NOPA	YANC
Treatment	(% v/v)		(g L ⁻¹)	-----	(mg L ⁻¹)	-----
2004						
N 0	14.1	3.98 b	5.63 a	5.9 b	34 b	40
N 75 BS	14.3	4.04 b	5.33 ab	4.5 b	40 a	44
N 150 BS	14.0	4.04 b	5.10 b	6.7 ab	39 a	46
N 75 V	13.9	4.11 a	4.93 b	9.4 a	40 a	49
2004						
K 0	14.4 a	4.02	5.60	7.1	36	43
K 75 BS	14.0 ab	3.98	5.74	9.8	39	49
K 150 BS	14.3 ab	3.99	5.78	6.8	35	42
K 75 V	13.7 b	4.00	5.46	6.4	34	40

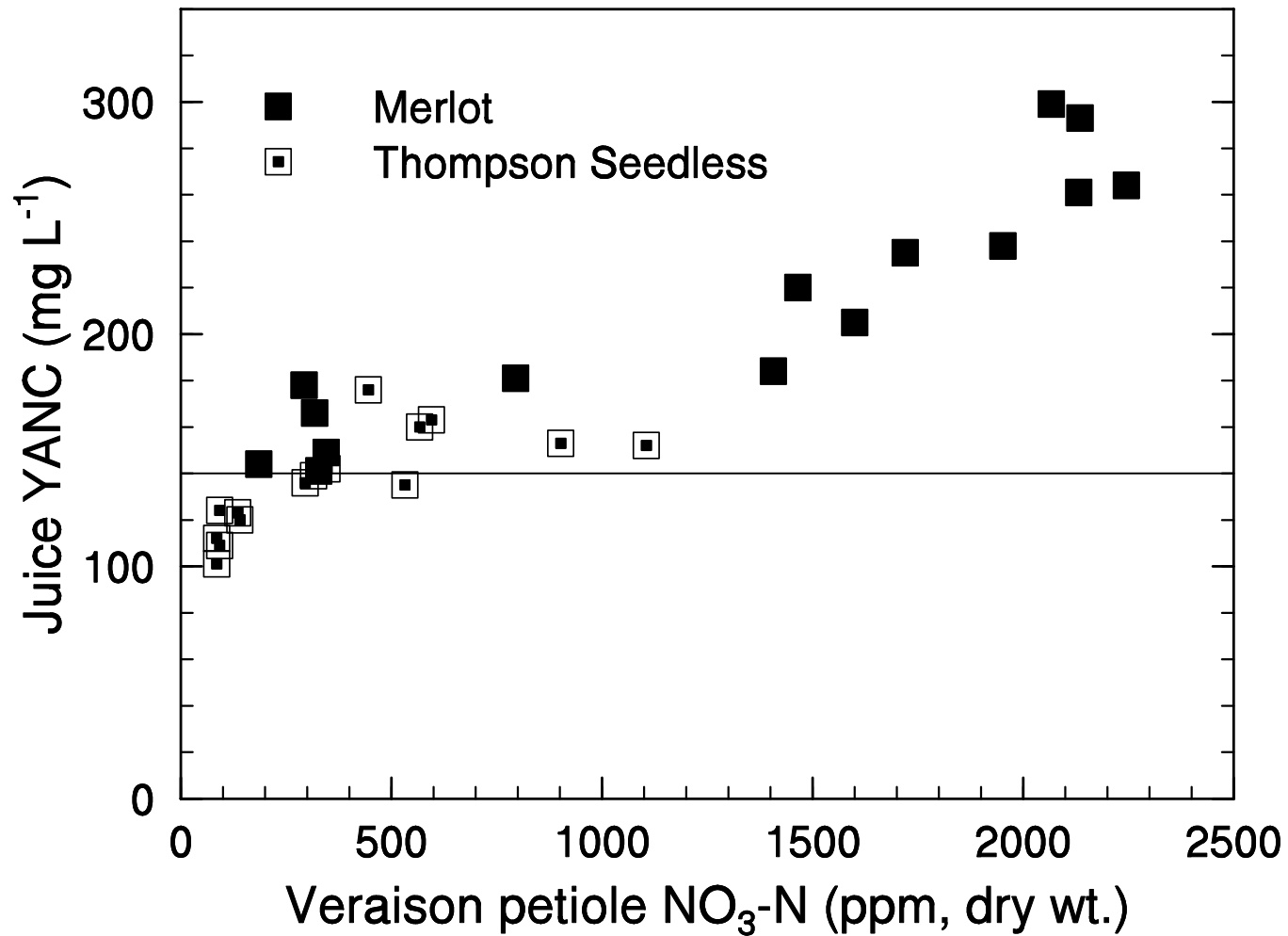
Effects of applied **N/K** fertilizer at berry set (BS) or veraison (V) in 2004 on must/wine nitrogenous compounds of **Merlot**.

N/K	----- Merlot Must -----			---- Merlot Wine ----		
Treatment	NH₄⁺	NOPA	YANC	NH₄⁺	NOPA	YANC
2004	----- (mg L ⁻¹) -----					
N 0	50	98	144	5.9	34	40
N 75 BS	67	123	181	4.5	40	44
N 150 BS	79	115	184	6.7	39	46
N 75 V	63	118	188	9.4	40	49
2004						
K 0	59	108	166	7.1	36	43
K 75 BS	62	106	178	9.8	39	49
K 150 BS	57	87	141	6.8	35	42
K 75 V	53	92	149	6.4	34	40

The line represents the minimal limit of YANC



The line represents the minimal limit of YANC



Grapevine K Fertilization Program

- 1.) Assessing vineyard/vine nutrient status
- 2.) Determination of fertilizer amounts
- 3.) Kinds of fertilizers
- 4.) Timing of fertilization events
- 5.) Effects of mineral nutrients on vegetative and reproductive growth.

POTASSIUM

Potassium (%)

Bloom Petiole Levels

Deficient

Less than 1.0

Questionable

1.0 to 1.5

Adequate

Over 1.5

Midsummer Petiole Levels

Deficient

Below 0.5

Adequate

Above 0.8

Bloom-time petiole analysis of K for four table grape cultivars over four year period. Vines were grown at the Kearney Ag. Center

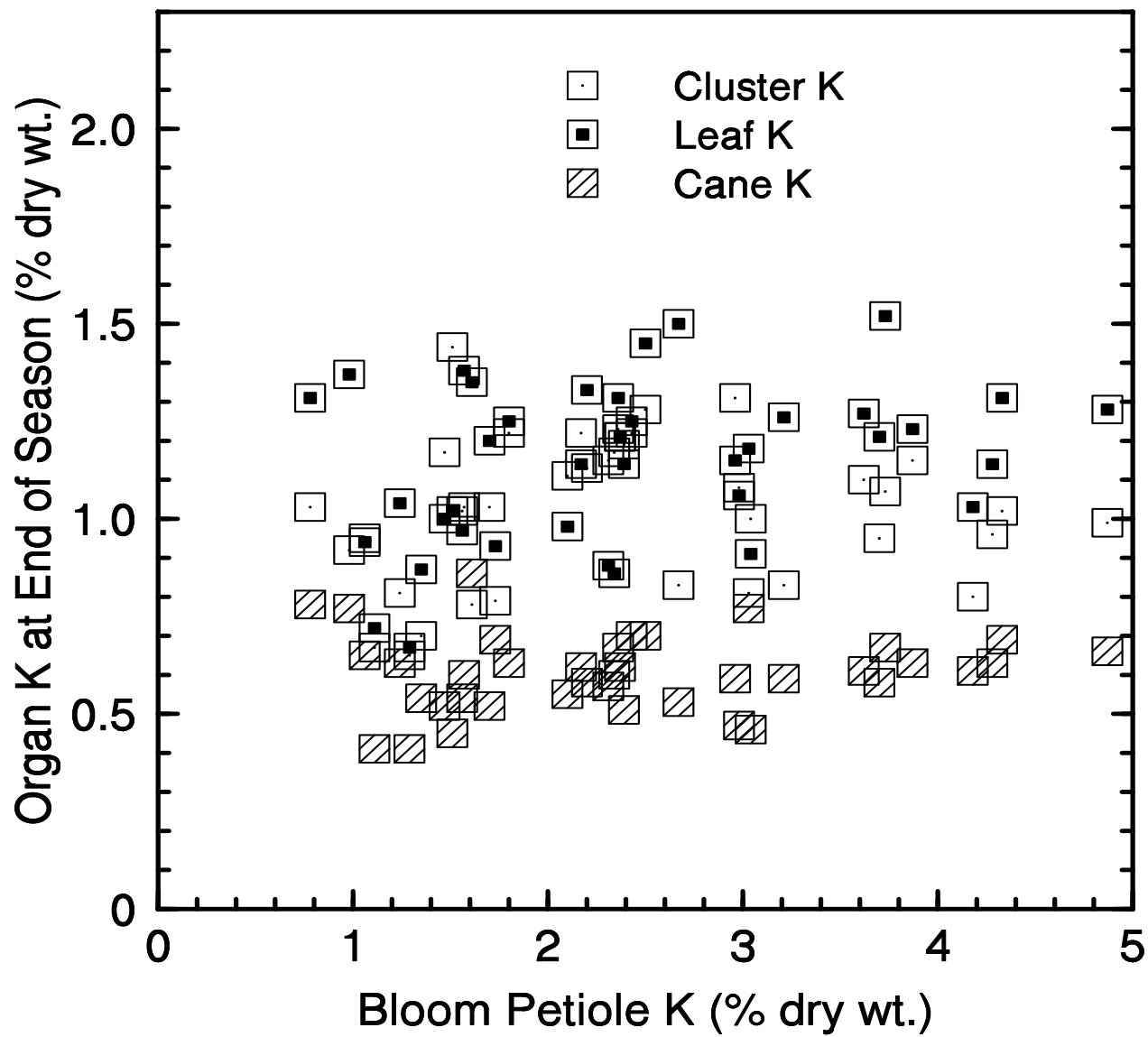
Cultivar	-----Year-----			
	1990	1991	1992	1993
	----- K (% dry wt) -----			
Flame	2.30	2.20	1.90	1.50
Perlette	2.90	2.50	2.30	2.50
Ruby Seedless	2.30	2.30	2.60	2.00
Thompson Seedless	2.30	2.10	1.50	---

The effect of irrigation treatments on bloom-time petiole analysis of furrow irrigation Thompson Seedless grapevines grown at KAC.

Year	Irrigation Treatment	-----Petiole analysis-----		
		NO ₃	K	P
		(ppm)	(% dry wt.)	(% dry wt.)
1990	Irrigated	836	1.53	--- ^a
	Non-irrigated	217	1.20	--- ^a
1991 ^b	Irrigated	304	1.83	0.54
	Non-Irrigated	871	1.40	0.21
1992 ^b	Irrigated	371	1.80	0.48
	Non-irrigated	--- ^a	--- ^a	--- ^a
1993 ^b	Irrigated	298	2.07	0.56
	Non-irrigated	837	1.30	0.29

^aNot sampled or analyzed.

^bIrrigation resumed in 1991 for the Non-irrigated treatments and continued for the 1992 and 1993 growing seasons.



Effects of applied **N and K** fertilizers at berry set (BS) or veraison (V) in 2004 on petiole **K** status of **Merlot** grapevines grown in Madera County

Treatment	----- K (% dry wt.) -----			Treatment	-- K (% dry wt.) --	
2004	Bloom	Veraison	Harvest	2005	Bloom	Veraison
N 0	4.53	3.97	2.13	N 0	3.76	3.31
N 75 BS	---	3.85	1.90	N 75 BS	3.71	3.37
N 150 BS	---	3.57	1.89	N 150 BS	3.63	3.16
N 75 V	---	3.85	1.91	N 75 V	3.70	3.07
2004				2005		
K 0	4.51	3.42	1.75 b	K 0	3.55	2.93 b
K 75 BS	---	3.51	1.90 ab	K 75 BS	3.72	3.12 ab
K 150 BS	---	3.77	2.19 a	K 150 BS	3.62	3.34 a
K 75 V	---	3.59	1.97 ab	K 75 V	3.73	3.26 ab

Effects of applied **N and K** fertilizers at berry set (BS) or veraison (V) in 2004 on juice or wine **K** status of **Merlot** grapevines grown in Madera County

Treatment	----- K (mg L ⁻¹) -----		Treatment	-- K (mg L ⁻¹) --
2004	Juice	Wine	2005	Juice
N 0	1922 ab	1694 c	N 0	1432
N 75 BS	2001 a	1951 b	N 75 BS	1409
N 150 BS	1727 b	2503 a	N 150 BS	1442
N 75 V	2006 a	1922 b	N 75 V	1353
2004			2005	
K 0	1913 b	1972	K 0	1406 b
K 75 BS	1908 b	1989	K 75 BS	1474 ab
K 150 BS	2364 a	2008	K 150 BS	1620 a
K 75 V	1887 b	1985	K 75 V	1363 b