The Crop Nutrient Removals project was developed to satisfy grower requests for greater understanding of the nutrient requirements of winegrapes grown under Murray Valley climatic conditions. The project started in 2012, developing eight regional chardonnay and shiraz sites for nutrient testing. It ran for three years and collected nutrient samples from each of the sites at flowering, veraison, harvest and pruning. Samples were divided into leaves, bunches and canes to examine nutrient content in the different vine organs. Samples were sent to Phosyn Analytical for nutrient content analysis.

Data was produced to demonstrate nutrient application as kg of nutrients applied per linear metre of trellis rather than the outdated use of kg of nutrients applied per Ha. Data was collected over the three-year project life from samples obtained during each of the different growth periods (flowering, veraison, harvest and pruning). The number of grams of nutrient accumulated by the vine per linear metre of trellis addressed the nutrition requirements of the vine and potential vineyard fertiliser requirements.
Nutrients are a vital part of everyday requirements in vineyards. Vines require nutrients to maintain growth, fruit production and build nutrient reserves in various parts of the plant for coming seasons. To understand the nutrients required each season and maintain a realistic fertilisation program, we first need to know what is removed. Vineyard nutrition is complex due to variability in vineyards. This variability either by slope, rootstock, irrigation and other factors can change the nutritional requirements, which generally growers learn as a matter of trial and error.

Conradie in the 1980's conducted research on Chenin Blanc grafted to 99R rootstock, to find out the levels of nutrients removed by the vine. This research examined the level of nutrients in the vines at critical phenological phases. This information provided an insight into nutrient concentrations at varying growth stages (Figure 1).

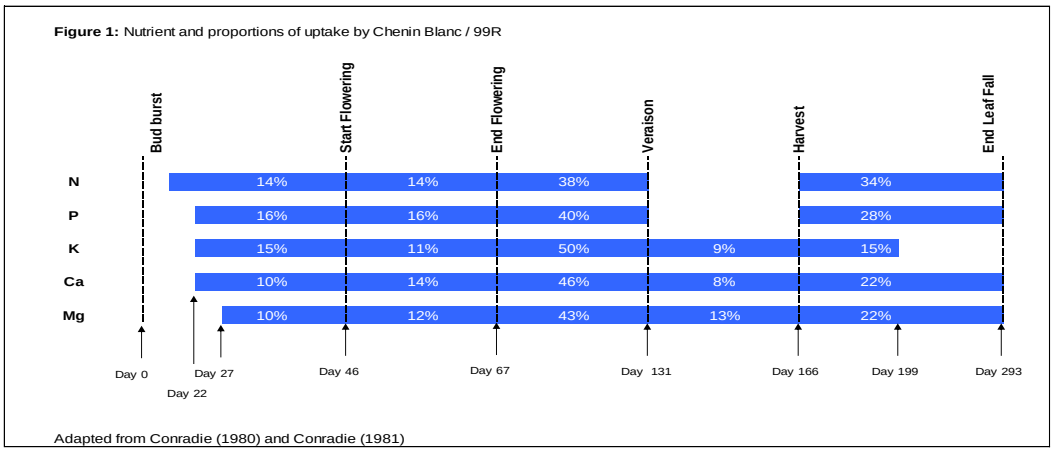

Figure 1: Nutrient percentages and uptake by Chenin blanc/99R during the growing season.

Conradie`s research has led to an understanding of the accumulation of nutrients from budburst to leaf fall, showing the ways in which the plant stores or moves nutrients around the system.

Results:

Hutton et al, conducted trials on chardonnay within the Riverina looking at matching nitrogen and other nutrients to maintain healthy growth and productivity. Measurements taken at harvest of the total nutrition accumulated within shoots and bunches shows the total nutrition lost when fruit is removed. Hutton et al, found that nitrogen (N) and potassium (K) in bunches were the nutrients found to be removed in the largest amounts at harvest. Sunraysia trials arrived at (Table 1) the same conclusion as Hutton et al i.e. N and K were reduced the most in bunches at harvest.
Table 1, also showed similar findings to the Riverina trial indicating that potassium (P) is found to be at relatively low levels within the bunches at harvest.
At the start of flowering, leaves have a high accumulation of N which slowly declines up until harvest. Bunch N accumulation starts off relatively low at flowering for both shiraz and chardonnay, then by veraison shows high levels within these structures. By harvest the N accumulation in the bunch has dropped in both shiraz and chardonnay.
K accumulation from flowering to harvest in leaves and canes is very stable. Bunch accumulation from flowering to veraison notes about 25X increase with a high accumulation in bunches taken away at harvest.
Canes show that they are a low area of accumulation of nutrients from flowering to pruning within the vine system. Further work needs to be done to see what part the roots and trunks play in nutrient re-positioning or movement pre flowering and post-harvest.

Conclusion

There is a direct correlation on yield increases with increased N in bunches around veraison. For both shiraz and chardonnay varieties, an increased N content showed an increase in yield. The shiraz vines in 2013 showed an average yield of 727kg/100m. This yield was the lowest recorded, directly correlating to the amount of N within bunches before harvest. In 2014, shiraz yields were averaging 1252kg/100m, with the highest N accumulation in bunches across the three years of data. K was also showing the same direct correlation as N within bunches and increases in yields over the three years. Chardonnay in 2014 had the highest yields across the three years, which also showed the highest nutrient accumulation in bunches (Table 1). K also showed the same trend.

As many farming enterprises undertake varying nutrient regimes, the data provided is a reference for local growers to look at their individual enterprises and make an assumption as to what they require. Each grower will need to look at the amount of grapes harvested (kg/100m) to calculate the amount of NPK fertiliser to return to the vine each year. Growers will then need to analyse their inputs of NPK throughout the season to give a replacement figure for each of the nutrients applied.

Overall, the difference in NPK nutrients did not change much across each variety for the three years of data captured. In 2013/2014 the trial sites all received some damage from frost early in the season, which may have impacted on the nutrient content of the vines.

Further work needs to be conducted as to timing of individual grower nutrient applications and the amount each grower applies per season. Growers would then be generate a basic template of nutrient applied each season and adjust according to yields harvested.

Table 1: NPK average nutrient accumulation in Shiraz and Chardonnay vine components (Leaves, Bunches and Canes) for three growing seasons across 9 Murray Valley vineyards.

Shiraz NPK Nutrient Accumulation kg/100m

2012 2013

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	2.40	2.02	1.31	
	P	0.19	0.17	0.13	
	K	1.09	1.31	0.83	
Bunches	N	0.35	4.67	2.50	
	P	0.04	1.07	0.55	
	K	0.31	7.42	3.94	
Canes	N	0.70	0.17	0.11	0.28
	P	0.16	0.06	0.04	0.06
	K	1.15	0.38	0.28	0.25

2013 2014

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	3.45	2.88	2.73	
	P	0.35	0.27	0.24	
	K	1.83	1.53	1.51	
Bunches	N	0.22	6.26	5.84	
	P	0.03	1.21	1.20	
	K	0.21	7.28	8.21	
Canes	N	1.11	0.34	0.11	0.30
	P	0.28	0.12	0.07	0.05
	K	1.89	0.66	0.39	0.21

2014 2015

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	2.34	1.68	2.83	
	P	0.20	0.16	0.25	
	K	1.51	0.90	1.57	
Bunches	N	0.57	3.88	3.58	
	P	0.07	0.89	0.78	
	K	0.50	6.16	5.64	
Canes	N	0.88	0.18	0.19	0.20
	P	0.20	0.06	0.07	0.03
	K	1.44	0.41	0.47	0.14

Chardonnay NPK Nutrient Accumulation kg/100m

2012 2013

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	2.50	2.36	1.70	
	P	0.26	0.20	0.17	
	K	1.26	1.53	1.08	
Bunches	N	0.49	5.81	3.88	
	P	0.06	1.33	0.85	
	K	0.43	9.24	6.12	
Canes	N	0.56	0.17	0.11	0.23
	P	0.12	0.06	0.04	0.05
	K	0.91	0.38	0.27	0.21

2013 2014

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	2.40	3.25	1.98	
	P	0.19	0.27	0.20	
	K	1.09	2.11	1.26	
Bunches	N	0.50	6.46	4.25	
	P	0.06	1.48	0.93	
	K	0.44	10.27	6.70	
Canes	N	0.49	0.18	0.12	0.26
	P	0.11	0.06	0.04	0.05
	K	0.80	0.42	0.31	0.23

2014 2015

Sampling	Nutrient	Flowering	Veraison	Harvest	Pruning
Leaves	N	3.89	2.01	1.75	
	P	0.31	0.17	0.18	
	K	1.78	1.30	1.12	
Bunches	N	0.70	4.55	3.09	
	P	0.08	1.04	0.68	
	K	0.61	7.23	4.87	
Canes	N	0.64	0.14	0.11	0.20
	P	0.14	0.05	0.04	0.04
	K	1.04	0.32	0.28	0.18

Table 2: Average yield (kg/100m) on Shiraz and Chardonnay vines for three growing seasons across 9 Murray Valley vineyards.

Shiraz

Year	Average Yield kg/100m
2013	727
2014	1252
2015	1040

Chardonnay

Year	Average Yield kg/100m
2013	1129
2014	1237
2015	898

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