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Nuriootpa Viticultural Centre, Nuriootpa, South Australia

Minimal pruning effects on the performance of selections of four *Vitis vinifera* cultivars

by

M. G. McCarthy and R. M. Cirami

Der Einfluß des Minimalschnittes auf die Leistung der Klone von vier *Vitis-vinifera*-Sorten

Zusammenfassung: Eine Reihe von Klonen der Sorte Shiraz, Riesling, Malbec und Semillon wurde dem Minimalschnitt unterzogen, um zu prüfen, ob der Ertrag durch die Schnittmethode begrenzt wird. Minimalschnitt hatte bei Riesling, Malbec und Semillon, nicht jedoch bei Shiraz, höhere Erträge zur Folge. Bezüglich des Ertrags bestanden signifikante Interaktionen zwischen einigen Riesling- und Malbec-Klonen und der Schnittmethode.

Key words: pruning, yield, must quality, variety of vine, clone, selection, Australia.

Introduction

That reproducible yield differences exist between clones of cultivars of *Vitis vinifera* in Australia has been well documented (Antcliff 1965; Woodham and Alexander 1966, Antcliff *et al.* 1979). An intensive search in other major grape-growing regions of the world for higher yield and improved wine quality has resulted in the selection of a number of superior clones.

The goal of clonal selection is to find clones with desirable genetic characteristics, such as yield, suited to particular environments. Grape yield is influenced by many factors; May (1972) summarized the factors as genetic, pathological, environmental and management. The level and method of pruning in clonal evaluation trials may significantly influence yields. Some buds may not burst, some may produce more than one shoot while others may be less fruitful. Other workers have used a range of pruning methods in clonal evaluation trials ranging from a set number of buds on all clones to a balanced pruning system using the weight of annual growth removed as a guide to the number of buds retained. As all systems rely to some degree on a subjective assessment there is the possibility of masking the true productive potential of individual clones by restrictive pruning. The minimal pruning concept developed by Clingeleffer (1983) offers a vine management technique which permits each individual vine to perform to its true productive potential. Clingeleffer (1988) demonstrated that yield differences between four Riesling clones were masked by pruning method when assessed under the hot irrigated conditions of the Australian Murray Valley.

To determine if the cropping potential of a number of clones under long term assessment in the Barossa Valley, South Australia was being masked by traditional pruning methods minimal pruning was imposed on four winegrape varieties. This paper reports on the effects of minimal pruning on the performance of clones of Shiraz, Riesling, Malbec and Semillon.

Materials and methods

Preliminary

The four clonal trials used were planted on the Nuriootpa Viticultural Centre, situated in the Barossa Valley, South Australia. Trials were located in four adjacent rows on a Light Pass fine sandy loam, Dr 2.23 (Northcote *et al.* 1954; Northcote 1965). Vines growing on their own roots were planted 2.1 m apart in rows 3.6 m wide and drip irrigated at about 90 l/week during the growing season (about 20 % of weekly Class A pan evaporation). Canes were attached to a trellis of about 1.1 m height and uniform bud numbers were used in each year for each variety. The number of buds retained on cane pruned vines was increased by 4—6 buds/vine by either leaving longer canes or additional replacement spurs in each year for the years preceding the imposition of the minimal pruning treatments in Winter 1982. Minimal pruned vines were trained to a higher cordon wire at about 1.4 m; annual pruning consisted of removing only those shoots which had grown horizontally or downwards, vertical shoots were not pruned. The weight of prunings removed was recorded in each year. Pruning weight of cane pruned vines comprised 1 year old wood while on minimal pruned vines both 1 year old

Table 1

Identification and source of clones

Bezeichnung und Herkunft der Klone

Local identification	Source	Australian Accession Number (if applicable)
Shiraz		
SA.1654	Barossa Valley	A.S.70.2271
BVRC 33	Barossa Valley	—
BVRC 30	Barossa Valley	—
BVRC 12	Barossa Valley	—
Riesling		
SA.140	Barossa Valley	A.S.70.2352
BVRC 8	Barossa Valley	—
BVRC 17	Barossa Valley	—
GM 198	Germany	I.S.74.8052
GM 110	Germany	I.S.65.2056
Malbec		
K.1	Barossa Valley	—
K.2	Barossa Valley	—
K.3	Barossa Valley	—
K.4	Barossa Valley	—
1056	France	I.S.70.8125
C6V11	California	I.S.75.2314
ex. WA	Western Australia	—
Semillon		
F4V1	California	I.S.76.2099
BVRC 14	Barossa Valley	—
BVRC 32	Barossa Valley	—
SA.143	Barossa Valley	A.S.70.2354

and some older wood would have been weighed. After pruning in 1984 all buds retained on cane and minimal pruned vines were recorded. Prior to harvest in each year a 50 berry sample, taken from 10 bunches chosen at random on each vine was collected for the determination of berry weight, pH, titratable acid and °Brix. At harvest the total weight of fruit and the number of bunches per vine were recorded.

Shiraz and Riesling

The trials were planted in 1974 as randomized complete block designs comprising single vine plots of 16 replicates. 4 high yielding Shiraz and 5 Riesling selections (Table 1) from other clonal evaluation trials were used. Minimal pruning was imposed on 4 replicates. In winter 1982 cane pruned Shiraz vines were pruned to 62 buds/vine, Riesling to 48 buds. Yield and maturity components were recorded for harvest years 1984—1986.

Malbec and Semillon

Randomized block designs of 12 single vine plot replicates of 7 Malbec selections (Table 1) and 16 single vine plot replicates of 4 Semillon selections were planted in 1977. Cane pruned Malbec vines were pruned to 44 buds/vine, Semillon to 36 buds in winter 1982. Minimal pruning was imposed on 3 replicates of Malbec and 8 Semillon replicates. Yield and maturity were recorded as for Shiraz and Riesling but for harvest years 1985—1987.

Data analysis

At the completion of each trial harvest data from the 3 years was analysed as a year/pruning/clone split-split plot design with an uneven (or even for Semillon) number of plots. Although there were significant seasonal effects (year effects) they are not presented here and means for the 3 years are reported. Pruning is reported as the main-plot treatment, clone as sub-plot. The uneven number of pruning treatment replicates for 3 varieties resulted in an additional set of LSD values where there were pruning × clone interactions and a skewed value when the mean of cane and minimal pruning for each clone are computed.

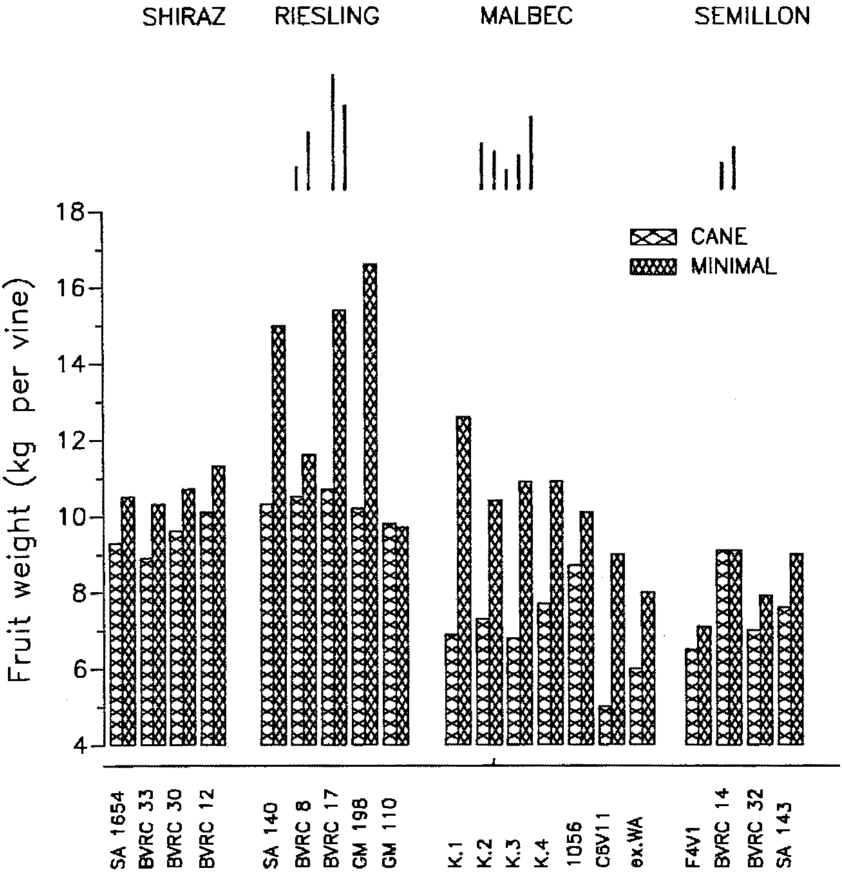
Results

CIRAMI *et al.* (1988) reported the local selections used in this experiment to be free of the major virus diseases leafroll, corkybark, fanleaf and stem pitting.

Shiraz

There were no significant differences in fruit weight between the 4 clones when either cane or minimal pruned (Fig.). Minimal pruning had no significant effect on fruit weight compared with cane pruned vines but there were about 3 times more bunches (Table 2) on minimal pruned vines compared with cane pruned; average bunch weight was significantly lower. Minimally pruned vines had significantly smaller berries and fewer berries per bunch. The weight of prunings from cane pruned vines was nearly 3 times more than that from minimal pruned vines. There was no significant difference between clones in the number of buds retained for either pruning method but minimal pruned vines had nearly 6 times more buds retained (Table 6). There was no significant difference in pruning weight between clones (Table 2).

Minimal pruning resulted in a 1.8 °Brix depression, higher titratable acidity and lower pH (Table 2) compared with cane pruned vines. BVRC 12 was significantly lower in °Brix compared with BVRC 33 when pruning treatments were combined and lower in °Brix than BVRC 30 and 33 for cane pruning; there were no differences in °Brix between clones with minimal pruning. Differences in pH and titratable acid between clones were caused by differences in °Brix.



Yield response in kg per vine of clones of Shiraz, Riesling, Malbec and Semillon to minimal pruning. Vertical bars indicate least significant difference (LSD) (P = 0.05) for each variety. No bar = non-significant difference. 1st bar = LSD for main-plot (pruning), 2nd bar = LSD for subplot (clone), 3rd bar = LSD for between clones with cane pruning, 4th bar = LSD for between clones with minimal pruning, 5th bar = LSD for between pruning methods for each clone. Bars 3, 4 and 5 only shown where significant interactions between pruning and clone were present.

Traubenertrag (kg je Rebe) bei Klonen von Shiraz, Riesling, Malbec und Semillon unter dem Einfluß des Minimalschnittes. Die senkrechten Balken zeigen die Grenzdifferenzen (LSD bei P = 0.05) für die einzelnen Sorten. Kein Balken = keine signifikante Differenz. 1. Balken = LSD zwischen den Schnittmethoden, 2. Balken = LSD zwischen den Klonen, 3. Balken = LSD zwischen den Klonen mit Bogenschnitt, 4. Balken = LSD zwischen den Klonen mit Minimalschnitt. 5. Balken = LSD zwischen den Schnittmethoden für die einzelnen Klone. Die Balken 3, 4 und 5 sind nur beim Vorliegen signifikanter Interaktionen zwischen Rebschnitt und Klon eingezeichnet.

Table 2

Yield and maturity components of 4 Shiraz clones

Ertrags- und Qualitätskomponenten bei 4 Shiraz-Klonen

	SA.1654	BVRC 33	BVRC 30	BVRC 12	Mean	Least significant differences			
						Main-plot (pruning)	Sub-plot (clones)	Between clones within each pruning trt.	Between pruning trt. for each clone
Number of bunches									
Canes	116	113	119	122	118	23			
Minimal	348	328	364	386	357				
Mean	174	167	180	188					
Bunch weight (g)									
Canes	80.0	77.9	80.8	82.5	80.3	8.2			
Minimal	31.7	31.7	30.4	30.7	31.1				
Mean	67.9	66.4	68.2	69.6					
Berry weight (g)									
Canes	0.91	0.95	0.94	0.93	0.93	0.04			
Minimal	0.69	0.63	0.66	0.63	0.65				
Mean	0.85	0.87	0.87	0.86					
Berries per bunch									
Canes	89	83	87	89	87	6			
Minimal	44	50	46	49	47				
Mean	78	75	77	79					
Pruning weight (kg/vine)									
Canes	2.1	2.2	2.1	2.2	2.1	0.2			
Minimal	0.7	0.8	0.8	0.8	0.8				
Mean	1.7	1.8	1.8	1.8					
° Brix									
Canes	24.2	24.7	24.3	23.9	24.3	0.3	0.3	0.4	0.5
Minimal	22.7	22.2	22.3	22.6	22.5			0.6	
Mean	23.8	24.0	23.8	23.5					
Acid (g/l as tartaric)									
Canes	6.3	5.9	6.2	6.3	6.2	0.2	0.2	0.2	0.3
Minimal	7.0	7.4	7.0	7.4	7.2			0.3	
Mean	6.4	6.3	6.4	6.6					
pH									
Canes	3.33	3.37	3.35	3.33	3.35	0.03	0.02	0.03	0.04
Minimal	3.30	3.26	3.26	3.25	3.27			0.05	
Mean	3.33	3.35	3.33	3.31					

Table 3

Yield and maturity components of 5 Riesling clones

Ertrags- und Qualitätskomponenten bei 5 Riesling-Klonen

	SA.140	BVRC 8	BVRC 17	GM 198	GM 110	Mean	Least significant differences: Main-plot (pruning)	Sub-plot (clones)	Between clones within each pruning trt.	Between pruning trt. for each clone
Number of bunches										
Canes	106	108	100	105	102	104	12			38
Minimal	302	250	285	348	217	280			50	
Mean	155	143	146	166	131					
Bunch weight (g)										
Canes	97.8	97.9	109.2	98.2	95.3	99.7	4	5.9		
Minimal	53.2	46.7	58.1	50.8	48.7	51.5				
Mean	86.7	85.1	96.4	86.4	83.7					
Berry weight (g)										
Canes	1.08	1.11	1.14	1.07	1.09	1.10	0.05			
Minimal	0.85	0.81	0.86	0.85	0.86	0.85				
Mean	1.03	1.03	1.07	1.02	1.03					
Berries per bunch										
Canes	91	89	96	92	88	91	4	5		
Minimal	62	58	65	59	57	60				
Mean	84	82	88	84	80					
Pruning weight (kg/vine)										
Canes	1.3	1.3	1.5	1.3	1.2	1.3	0.1	0.2		
Minimal	0.7	0.4	0.7	0.7	0.5	0.6				
Mean	1.2	1.1	1.3	1.1	1.1					
° Brix										
Canes	21.5	21.4	21.8	21.6	21.4	21.6	0.3			
Minimal	20.5	20.2	20.1	20.2	20.7	20.3				
Mean	21.3	21.1	21.3	21.3	21.2					
Acid (g/l as tartaric)										
Canes	6.1	6.2	5.9	6.1	6.0	6.1	0.2	0.2		
Minimal	7.1	7.3	7.2	7.1	6.8	7.1				
Mean	6.4	6.5	6.2	6.4	6.2					
pH										
Canes	3.23	3.20	3.23	3.21	3.24	3.22	0.03			
Minimal	3.13	3.14	3.09	3.13	3.15	3.13				
Mean	3.21	3.19	3.20	3.19	3.22					

R i e s l i n g

Minimal pruning resulted in more fruit, more but lighter bunches (Table 3), smaller berries and fewer berries per bunch. There was a significant interaction between pruning due to a non-significant increase in fruit weight of GM 110 with minimal pruning. In comparison minimal pruning on GM 198 increased fruit weight by about 60 %. The poor response of GM 110 to minimal pruning was caused by only a 2-fold increase in the bunch number compared with other clones which showed about a 3-fold increase. There was no significant difference in yield between clones when cane pruned but there were when minimal pruned. GM 198 was the highest yielding with minimal pruning.

There were no significant differences in °Brix (Table 3) between clones however minimal pruning resulted in a significantly lower °Brix for all clones. BVRC 8 was significantly higher in acidity than BVRC 17 and GM 110. The small but significant differences in pH and acidity between pruning treatments were caused by differences in °Brix.

Minimal pruning reduced the weight of prunings by more than 50 %, BVRC 17 had the heaviest weight of prunings but not significantly more than SA.140 when cane pruned. There was no significant difference between clones in the number of buds retained for either pruning method (Table 6) but minimal pruned vines had nearly 7 times more buds retained.

M a l b e c

Minimal pruning resulted in about a 50 % increase in yield compared with normal cane pruning. There were nearly 3 times more bunches on minimal pruned vines (Table 4) but bunch and berry weight were significantly lower. The large increase in crop resulted in lower °Brix (Table 4) and pH and higher titratable acidity compared with normal pruning. Clone 1056 yielded the heaviest weight of fruit with cane pruning but K.1 had nearly 3 kg more fruit with minimal pruning. Minimal pruning resulted in a significant improvement in yield of clones K.1, 2, 3 and 4 compared with 1056; with cane pruning all were significantly lower in yield than 1056, while when minimally pruned all yielded more fruit than 1056, K.1 significantly more. There was no significant difference in the number of bunches between clones. Clone 1056 had the heaviest bunches but the smallest berries. Clone C6V11 had the heaviest weight of prunings with either method of pruning, minimal pruned vines had about 6 times more buds retained at pruning (Table 6) in 1984.

S e m i l l o n

Minimal pruning resulted in more fruit, lighter but more bunches (Table 5), smaller berries and more berries per bunch compared with normal pruning. The increase in fruit weight with minimal pruning was not as large compared with other varieties and although there was no significant clone × pruning interaction, BVRC 14, the highest yielding cane pruned clone, did not yield any more fruit when minimal pruned. F4V1 yielded significantly less fruit compared with BVRC 14 and SA.143 for the combined analysis of pruning methods. There were only small, often non-significant differences in °Brix (Table 5), acid and pH between pruning treatments and clones, probably as a result of the small yield differences between treatments. As with other varieties minimal pruning resulted in a significant reduction in weight of prunings and a significant increase in the number of buds (Table 6) retained in 1984 but there was no significant difference between clones for either pruning method.

Table 4

Yield and maturity components of 7 Malbec clones

Ertrags- und Qualitätskomponenten bei 7 Malbec-Klonen

	K.1	K.2	K.3	K.4	1056	C6V11	ex.WA	Mean	Least significant differences: Main-plot (pruning)	Sub-plot (clones)	Betw. clones within each pruning trt.	Between pruning trt. for each clone
Number of bunches												
Canes	98	111	107	109	106	99	96	104	23			41
Minimal	321	291	301	328	247	283	249	289			45	
Mean	154	156	155	164	141	145	134					
Bunch weight (g)												
Canes	70.1	65.6	63.1	69.9	82.4	49.9	64.0	66.4	7.5	6.7		
Minimal	41.6	35.9	37.2	33.4	42.3	33.3	33.5	36.8				
Mean	63.0	58.2	56.7	60.8	72.3	45.8	56.4					
Berry weight (g)												
Canes	1.52	1.52	1.45	1.34	1.10	1.41	1.55	1.41	0.09	0.06		
Minimal	1.18	1.19	1.17	1.08	0.85	1.18	1.20	1.12				
Mean	1.43	1.44	1.38	1.28	1.04	1.35	1.46					
Berries per bunch												
Canes	47	43	45	54	77	36	42	49	8	6		
Minimal	36	31	33	32	50	28	28	34				
Mean	44	40	42	48	70	34	38					
Pruning weight (kg/vine)												
Canes	2.8	2.7	2.9	2.5	1.4	3.4	2.6	2.6	0.4	0.3	0.3	0.6
Minimal	0.8	0.9	0.8	0.7	0.2	1.1	0.8	0.7			0.5	
Mean	2.3	2.3	2.4	2.1	1.1	2.8	2.1					
° Brix												
Canes	22.1	24.4	24.5	24.5	22.8	24.5	23.9	24.1	0.3	0.4		
Minimal	22.8	23.1	23.2	23.3	21.9	23.7	23.1	23.0				
Mean	23.8	24.1	24.2	24.2	22.6	24.3	23.7					
Acid (g/l as tartaric)												
Canes	5.6	5.5	5.4	5.5	6.0	5.4	5.3	5.5	0.2	0.2		
Minimal	5.8	5.7	5.6	5.8	6.1	5.7	5.6	5.8				
Mean	5.6	5.5	5.5	5.6	6.0	5.5	5.4					
pH												
Canes	3.52	3.54	3.58	3.54	3.44	3.58	3.58	3.54	0.03	0.03		
Minimal	3.47	3,48	3.51	3.48	3.42	3.53	3.52	3.49				
Mean	3.51	3.57	3.56	3.53	3.43	3.57	3.56					

Table 5

Yield and maturity components of 4 Semillon clones

Ertrags- und Qualitätskomponenten bei 4 Semillon-Klonen

	F4V1	BVRC 14	BVRC 32	SA 143	Mean	Least significant differences			
						Main-plot (pruning)	Sub-plot (clones)	Between clones within each pruning trt.	Between pruning trt. for each clone
Number of bunches									
Canes	51	59	47	47	51	14			
Minimal	142	158	139	154	148				
Mean	96	109	93	101					
Bunch weight (g)									
Canes	124.8	151.8	148.9	163.6	147.3	11.4	9.5	13.4	16.3
Minimal	58.0	73.1	66.4	68.8	66.5			13.4	
Mean	91.4	112.4	107.6	116.2					
Berry weight (g)									
Canes	1.42	1.36	1.35	1.65	1.44	0.07	0.07		
Minimal	1.12	1.10	1.00	1.32	1.14				
Mean	1.27	1.23	1.17	1.48					
Berries per bunch									
Canes	91	114	113	101	105	6	5		
Minimal	53	68	70	54	61				
Mean	72	91	92	77					
Pruning weight (kg/vine)									
Canes	0.8	1.1	0.9	1.5	1.1	0.2	0.2	0.2	0.3
Minimal	0.3	0.4	0.3	0.4	0.3			0.2	
Mean	0.6	0.7	0.6	0.9					
° Brix									
Canes	21.5	21.2	21.1	22.9	21.7		0.5		
Minimal	22.0	21.9	21.9	23.1	22.2				
Mean	21.8	21.5	21.5	23.0					
Acid (g/l as tartaric)									
Canes	5.9	5.9	6.1	5.8	5.9		0.2		
Minimal	5.8	5.9	6.3	5.9	6.0				
Mean	5.8	5.9	6.2	5.8					
pH									
Canes	3.33	3.30	3.29	3.35	3.32	0.02	0.02		
Minimal	3.35	3.32	3.32	3.37	3.34				
Mean	3.34	3.31	3.30	3.36					

Table 6

Main-plot number of buds retained at pruning 1984

Anzahl der in den Schnittvarianten am Rebstock belassenen Knospen beim Rebschnitt 1984

	Shiraz	Riesling	Malbec	Semillon
Canes	70	53	56	26
Minimal	396	358	350	212

Discussion

ANTCLIFF (1973) and CLINGELEFFER (1988) were unable to detect differences in yield between the Riesling clone SA.140 and the German clone GM 110 when respectively cane or spur pruned. Significant yield differences between the clones were apparent (CLINGELEFFER 1988) when the bud number retained was significantly increased from about the 80 buds (CLINGELEFFER, personal communication) on spur pruned vines. CIRAMI *et al.* (1986) reported significant differences in yield between the clones used in this experiment when vines were cane pruned with 50—60 buds retained although, as reported here, there was no significant difference in yield between clones for later harvest years. Minimal pruning however resulted in a greater and statistically significant separation between the highest and lowest yielding Riesling clone (0.9—5.7 kg) due mainly to a large increase in yield for clone GM 198. An increase in separation was apparent with Malbec clones due to a large increase in yield of clone K.1. Malbec clones K.1, 2, 3 and 4 were selections from vineyards that traditionally were pruned to low bud numbers; the large increase in yield with minimal pruning on all 4 K selections demonstrates that the true yield potential of these clones was severely depressed by pruning method. In contrast a 6-fold increase in the number of buds retained on lightly cane pruned Shiraz clones did not result in any significant increase in fruit yield and only a 0.2 kg increase in separation between the highest and lowest yielding clone. The absence of significant yield differences between the 4 Shiraz selections reported here is in agreement with other Shiraz clonal evaluation trials in South Australia (author, unpublished). It is probable that the original Shiraz planting material brought into South Australia was from a limited genetic base, perhaps even from the same source vine and less than 200 years of cultivation in Australia has been insufficient time for any genetic diversity through mutation etc. to arise. Minimal pruning on Semillon resulted in smaller separation between the top and bottom clones due to a non-significant increase in yield of the highest yielding cane pruned clone BVRC 14. As for Shiraz the ranked yield did not change.

Cane pruned Semillon and Riesling clones had yield:pruning weight ratios between 7 and 8 (Semillon clone SA.143 was 5.1); minimal pruning increased this ratio to between 19 and 29. In contrast the 2 red coloured cultivars had yield: pruning weight ratios of less than 5 for most of the clones when cane pruned and except for Malbec clone 1056 were less than 16 when minimal pruned. CLINGELEFFER (1984) suggested an increased total photosynthetic capacity resulting from a larger early season leaf area as a possible explanation for the ability of minimal pruned vines to support larger crops. Data presented here suggest cultivar as well as clonal responses to heavier crops possible with minimal pruning.

Under the conditions of this experiment the yield-limiting factor for cane pruned vines was probably bud number as demonstrated by the significant increase in yield with minimal pruning. However with minimal pruning the yield-limiting factor was most likely to have been water availability. Although irrigated to about 20 % of weekly Class A pan evaporation, additional irrigation on Shiraz resulted in heavier berries and higher yields (McCarthy and Staniford 1983). The large number of small berries on minimal pruned vines offer a large potential yield increase with extra irrigation and possible further separation between clones although maturity may be delayed. Clingeleffer (1988) reported a delay in maturity of 3—4 d with minimal pruning but it is unclear whether this was due to minimal pruning *per se* or the small increase in crop. The data presented here for Shiraz show that at similar cropping levels minimal pruned vines were signficantly lower in °Brix at harvest than cane pruned. This response may be caused by changed fruit to leaf ratios (Clingeleffer 1984) or crop water use.

These results demonstrate that significant clonal differences in yield can be identified in evaluation trials provided sufficient buds are retained by hand pruning. For those grape-growing regions where hand pruning is predominant the results from such evaluation trials are applicable. However the significant interactions with clone and pruning and the improvement in yield of some clones with minimal pruning highlights the need to include this management practice in evaluation trials of clones (provided other factors such as water are not limiting) of all varieties if this method of pruning is to be used in commercial viticulture such as reported by Kidd (1986). The results are thus in agreement with those of Clingeleffer (1988).

Summary

Minimal pruning was imposed on a number of clones of Shiraz, Riesling, Malbec and Semillon to assess if the yield was limited by the pruning method. Minimal pruning resulted in higher yields for Riesling, Malbec and Semillon but not Shiraz. There were significant interactions in yield between some clones of Riesling and Malbec and pruning method.

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M. G. McCARTHY
Nuriootpa Viticultural Centre
South Australia Department of Agriculture
P. O. B. 245
Nuriootpa S.A. 5355
Australia