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Some growth regulator and cluster thinning effects on berry set and size, berry quality, and annual productivity of de Chaunac grapes[1])

by

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L'effet de phytorégulateurs et l'éclaircissement des grappes sur la nouaison, la grosseur et qualité des baies, et le rendement du cépage de Chaunac

Résumé. — L'éclaircissement pré-floral du cépage de Chaunac (hybride français) à une ou deux grappes par rameau fructifère a généralement augmenté la qualité des fruits l'année du traitement et les rendements l'année suivante. Les réductions de rendement l'année de l'éclaircissement étaient minimisées par une légère augmentation de la nouaison et de la grosseur des baies. Les vignes soumises à l'éclaircissement durant trois années consécutives ont produit environ 18 % plus de sucre que les vignes témoins. Cependant dans la deuxième saison les rameaux éclaircies à une seule grappe proximale avaient une moins bonne nouaison que les rameaux ou deux grappes avaient été laissées. Cette observation ainsi que d'autres amènent à conclure que la compétition sur le même rameau est moins importante qu'on ne le croyait et qu'une réduction générale de la récolte pourrait être aussi efficace qu'un éclaircissement en détail.

Le chlorméquat (CCC) a augmenté la nouaison des vignes éclaircies et non-éclaircies mais il a réduit la grosseur (poids) et la qualité des baies. Contrairement, l'acide gibbérellique (GA_3) a réduit la nouaison, augmenté le poids des baies et amélioré la qualité du jus. Appliqués sur les mêmes plants, les effets du CCC et du GA_3 se sont annulés. Les traitements au GA_3 en 1977 et 1978 ont eu des effets moins prononcés. Le GA_3 a réduit l'acidité du jus en 1977 et augmenté la teneur en solides solubles en 1978. La benzyladénine, appliquée avec ou sans GA_3, a été sans effet.

Introduction

Development of the French hybrid wine grape, de Chaunac (= Seibel 9549), involved interspecific crosses among *Vitis lincecumii*, *V. rupestris*, and *V. vinifera* parents. It is productive, reasonably winter hardy, and can be used to produce a satisfactory dry red dinner wine when grown in the interior valleys of southern British Columbia. However, de Chaunac is prone to overcropping which is attended by lowered juice quality, greater vulnerability to cold injury, and reduced flowering and vine yields the following year (Fisher *et al.* 1977).

Earlier experiments showed that cluster thinning before bloom improved berry quality and because both set and size of berries on the remaining clusters were increased, vine yields were not reduced in the year of treatment (Wood and Looney 1977, Looney and Wood 1977). However, additional experiments were needed to determine optimal thinning rate and to determine if this practice helps to stabilize annual production.

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Several growth regulator techniques have also been examined with the aim of improving juice quality and/or vine productivity of de Chaunac grapes. Daminozide (succinic acid-2,2-dimethylhydrazide), which is reported to increase berry set on *V. labrusca* cultivars (TUKEY and FLEMMING 1968), was ineffective on de Chaunac (LOONEY 1975). Chlormequat, (2-chloroethyl)trimethylammonium chloride, applied as a vine spray 7 to 10 d before full bloom did increase berry set (LOONEY 1975), but this benefit was offset by reduced berry size and reduced juice soluble solids. This result was predicted by earlier work with *V. vinifera* (COOMBE 1967) and French hybrid cultivars (BARRITT 1970).

The most promising growth regulator technique examined to date has been gibberellic acid (GA_3) applied as a vine spray about 10 d after full bloom. In tests in 1974 and 1975 GA_3 treatment increased the weight of individual de Chaunac berries without reducing berry set (LOONEY and WOOD 1977).

The experiments reported herein examined the GA_3 treatment applied in three consecutive years to the same cluster-thinned and unthinned vines and investigated the possibility that chlormequat (CCC) and GA_3, benzyladenine and GA_3, and cluster thinning treatments might be beneficially combined.

First (most proximal) clusters from one-cluster shoots and the two proximal clusters on two-cluster shoots on thinned vines were analyzed separately and compared with first, second and third clusters from unthinned vines. This procedure, coupled with the use of growth regulators to generally increase or decrease berry set permitted speculation about the relative importance of within-shoot and within-vine competition with regard to set, size and quality of de Chaunac grapes.

Materials and methods

The commercial de Chaunac planting used for these experiments was planted in early 1973. Vine spacing is 1.8 m in rows spaced 2.7 m. The site is considered excellent for the region with a southwest exposure and a loamy sand soil. The vines are trained to a bilateral cordon and were spur-pruned each year.

The experiment was carried out over three years (1976, '77, '78) with minor modifications each year. Three factors were studied each year in a 2 × 2 × 2 factorial experiment. The first factor was 0 or 50 ppm GA_3 applied each year. The second was CCC (0 or 500 ppm) in 1976, no treatment (CCC residual effect) in 1977, and benzyladenine (0 or 50 ppm) in 1978. The third factor was cluster thinning (with or without) each year. The experimental unit for this experiment was four adjacent vines and each treatment was replicated eight times. The cluster thinning operation in 1976 and 1977 resulted in an average of 1.5 clusters per fruitful shoot (alternate shoots retained one or two proximal clusters). Grape clusters from various positions were analyzed (six clusters per position per replicate) and this factor (cluster position) was nested within the thinning factor as follows:

Unthinned vines. — a) proximal cluster analyzed; b) second cluster analyzed; and c) third cluster analyzed;

Thinned vines. — a) the single cluster on one-cluster shoots analyzed; b) the proximal cluster on two-cluster shoots analyzed; and c) the second cluster on two-cluster shoots analyzed. Only two cluster positions were sampled in 1978 on the thinned vines since two clusters were retained on all shoots.

The data of each year were studied separately by analysis of variance. Duncan's multiple range test was applied when statistical significance was detected and when the use of this test was appropriate.

1976. — The cluster thinning treatment was completed on June 8, about 18 d before full bloom. CCC (500 ppm) was applied to drip with a gun sprayer on June 18 and GA_3 (50 ppm) was similarly applied on July 5. On October 11 six clusters per replicate were randomly sampled from each cluster position described above. Each cluster was examined for berry number and berry weight. Berries from all six clusters were then pooled and a subsample of berries was frozen, thawed and then juiced prior to analysis of juice soluble solids (by refractive index), juice acidity (by titration to pH 8.1 and calculation as percent tartaric acid) and tannins (mg tannic acid/100 ml of juice) using the Folin-Ciocalteu reagent as described by SINGLETON and ROSSI (1965). The general harvest of the experimental vines occured on October 18—20. Total yield of each four-vine replicate was recorded. Treatment effects on vine growth were estimated by collecting and weighing the wood removed by dormant pruning in early March of 1977.

1977. — All vines cluster-thinned in 1976 were thinned by the same procedure in 1977. Thinning was done on June 15, 1977, about 10 d before full bloom and all vines treated with 50 ppm GA_3 in 1976 were again sprayed on July 2, 1977. CCC was not applied in 1977. Thus, thinned and unthinned vines treated with CCC in 1976 received no growth regulator spray in 1977, those treated with CCC and GA_3 in 1976 were treated only with GA_3 in 1977. Sampling at harvest was done as in 1976 and the same data were collected. Commercial harvest was completed on October 14, 1977, and dormant pruning weights were obtained in late February, 1978.

1978. — The number of clusters removed was reduced in 1978. The two most proximal clusters were left on each fruitful shoot on vines cluster-thinned in 1976 and 1977. This operation was performed on June 15, 1978. Full bloom occurred on approximately June 22. GA_3 (50 ppm) and/or benzyladenine (50 ppm) were applied July 2. The same range of measurements was taken at and following harvest on October 18, 1978.

Results

Cluster thinning to one or two clusters per fruitful shoot greatly increased berry set, weight of individual berries, and average weight of the retained clusters in 1976 (Table 1). Total vine yields were reduced somewhat by cluster thinning, but berry quality for wine production was improved as indicated by substantial increases in soluble solids and tannin levels and a modest decrease in juice acidity (Table 1).

Cluster thinning resulted in a tendency for the vines to grow more vigorously, as indicated by the weight of wood removed during dormant pruning (Table 1). Vine growth was also affected by CCC and GA_3. CCC tended to reduce growth, especially of unthinned vines, and GA_3 increased growth of thinned vines (Table 1).

The growth regulator treatments also influenced berry set, size and quality. CCC tended to increase berry set with resulting smaller berry size and relatively poor juice quality (Table 1). Conversely, GA_3 treatment substantially reduced berry set, increased berry weight and improved juice quality. The combination of CCC followed by GA_3 led to berry set and juice quality values not different from unsprayed vines. However, this combination did result in somewhat heavier berries.

Thinning to a single proximal cluster in 1976 did not generally result in fruit set, berry size or juice quality values different from those recorded for each cluster

Table 1

Cluster thinning and chlormequat (CCC) and GA_3 spray treatment effects on berry set, weight and quality; cluster weight; vine yield; and vine growth of de Chaunac grapes in 1976

L'effet de l'éclaircissement des grappes et des traitements au chlorméquat (CCC) et au GA_3 sur la nouaison, le poids et la qualité des baies, le poids des grappes, le rendement des vignes et la croissance des sarments du cépage de Chaunac en 1976

Treatment	Berry set no./cluster[1])	Mean berry wt g[1])	Mean cluster wt g[1])	Total yield kg/vine	Juice soluble solids %[1])	Juice acidity % as tartaric[1])	Tannins mg/100 ml[1])	Wt of dormant prunings kg/vine
1. CK — unthinned[2])	125.8	1.50	196.5	16.9	13.3	0.95	88.1	0.71
2. CK — thinned	171.1	1.61	268.2	15.2	15.9	0.90	107.0	0.76
3. CCC — unthinned	143.1	1.33	189.6	16.1	12.7	0.98	92.2	0.56
4. CCC — thinned	194.4	1.54	298.9	16.9	15.5	0.93	103.0	0.72
5. GA_3 — unthinned	92.9	1.80	166.9	13.8	15.4	0.92	109.5	0.73
6. GA_3 — thinned	132.8	1.87	247.3	13.6	17.9	0.88	134.1	1.14
7. CCC+GA_3 — unthinned	127.8	1.63	208.6	15.7	14.0	0.95	95.8	0.54
8. CCC+GA_3 — thinned	154.4	1.75	269.4	14.0	15.9	0.87	118.4	0.72
S.E.	8.459	0.033	13.79	0.820	0.389	0.021	3.911	0.243
			Significance of main factors and interactions					
GA_3 (G)	**	**	n.s.	**	**	*	**	*
CCC (C)	**	**	*	n.s.	**	n.s.	*	**
Thinning (T)	**	**	**	*	**	**	**	**
Interactions	n.s.	n.s.	n.s.	GCT*	GC*	n.s.	GC*	GC* GT*

[1]) Data derived from the average of the 1st and 2nd clusters (on the same shoot) on thinned vines and from the 1st and 2nd clusters on unthinned vines.

[2]) CK = Check.

** * n.s. = Main factor or interaction significant at $P = 0.01$, $P = 0.05$ or not significant, respectively.

Table 2

Number of berries per cluster, average weight per berry and juice quality of de Chaunac grapes from various cluster positions as influenced by thinning and selected growth regulator treatments in 1976[1])

Le nombre de baies par grappe, le poids moyen des baies et la qualité du jus des grappes de différentes positions sur le rameau du cépage de Chaunac et l'influence de l'éclaircissement et de quelques phytorégulateurs en 1976

Treatment	Cluster position on thinned vines			Cluster position on unthinned vines		
	1 of 1	1 of 2	2 of 2	1 of 3	2 of 3	3 of 3
			Berry set/cluster			
GA_3	135.4 aB[2])	144.9 aB	142.3 aB	108.3 bA	112.4 bA	64.2 aA
No GA_3	189.2 bC	189.2 bC	176.3 bC	136.5 cB	132.4 cB	85.6 aA
CCC	178.3 bcC[2])	182.5 cC	166.2 bC	139.5 cB	131.3 cB	79.7 aA
No CCC	146.3 aB	151.5 aB	152.3 aB	105.2 bA	113.5 bA	70.1 aA
Overall means	162.3	167.0	159.3	122.4	122.5	74.9
			Mean berry weight (g)			
CCC	1.62 aB[3])	1.64 aB	1.64 aB	1.50 aA	1.46 aA	1.44 aA
No CCC	1.72 bB	1.73 bB	1.74 bB	1.66 bB	1.64 bB	1.64 bB
Overall means	1.67	1.685	1.69	1.58	1.55	1.54
			Juice soluble solids (%)			
GA_3	17.2 dE[4])	17.1 cdE	16.7 cE	14.9 cD	14.5 bcC	15.0 cD
No GA_3	15.9 bCD	16.0 bD	15.4 aBCD	13.1 aA	12.9 aA	14.3 bB
Overall means	16.55	16.55	16.05	14.0	13.7	14.65
			Juice acidity (% as tartaric)			
No spray	0.91 abcAB[5])	0.89 abcAB	0.90 abcAB	0.96 abcdAB	0.95 abcdAB	0.95 abcdAB
GA_3	0.90 abcAB	0.87 abA	0.89 abcAB	0.92 aAB	0.93 aAB	0.95 abcdAB
CCC	0.96 dAB	0.92 bcdAB	0.93 cdAB	0.97 abcdAB	0.99 cdB	1.00 dB
GA_3 and CCC	0.89 abcAB	0.89 abcAB	0.86 aA	0.94 abAB	0.95 abcdAB	0.98 bcdAB
Overall means	0.915	0.892	0.896	0.945	0.956	0.971
			Juice tannins (mg/100 ml)			
Overall means	112.5 B[6])	116.5 B	115.3 B	97.1 A	95.7 A	102.4 A

from two-cluster shoots (Table 2). The exception was that the single cluster on GA_3-treated vines had higher juice soluble solids than the second cluster on two-cluster shoots. Third clusters on unthinned vines set substantially fewer berries, but the weight of individual berries and juice quality values were not poorer and in some cases (i. e. juice soluble solids and tannins) slightly better than for the more proximal clusters (Table 2).

Cluster thinning in 1976 led to significant improvements in vine yields in 1977 (Table 3). However, because the thinned vines cropped more heavily in 1977 and thinning again improved berry set somewhat, juice quality (soluble solids and tannins) was lower on the thinned vines (Table 3).

GA_3 treatment did not reduce berry set in 1977 and did not significantly increase individual berry or cluster weights (Table 3). Juice acidity and soluble solids were reduced significantly by the GA_3 treatment.

CCC applied in 1976 resulted in increased berry set and cluster weights in 1977 (Table 3). Conversely, vine growth and juice tannin levels in 1977 were suppressed by the 1976 CCC treatment.

An examination of berry set on clusters of thinned and unthinned vines revealed that the most proximal cluster on shoots of thinned vines set fewer berries if all more distal clusters were removed; the second cluster on two-cluster shoots set fewer berries than the first cluster; and on unthinned vines, berry set was progressively lower with more distal clusters (Table 4). These effects were independent of 1976 or 1977 growth regulator treatment.

Cluster position on thinned and unthinned vines did not affect mean berry weight (Table 4). The second cluster on thinned vines displayed lower juice soluble solids and tannin values whereas the third cluster on unthinned vines was lower in acidity (Table 4).

Vine yields were uniformly high in 1978 (Table 5). Cluster thinning did not result in reduced yields even though the thinned vines bore more heavily the previous year, individual clusters on thinned vines set fewer berries, and mean cluster weights of comparable clusters were somewhat lower on the thinned vines. Apparently the thinning treatment led to a greater number of fruitful shoots per vine.

Thinning improved juice soluble solids levels in 1978, tannin levels were unaltered, and acidity tended to be higher although this latter effect was complicated by the growth regulator treatments (Table 5). GA_3 treatment also resulted in increased juice soluble solids in 1978 and benzyladenine increased tannin levels on thinned vines (Table 5).

The second cluster on unthinned vines set more berries than the first cluster on unthinned vines and either the first or second cluster on thinned vines (Table 6).

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[1]) The selection of treatment means for presentation was based upon whether the differences between thinning treatments or among cluster positions related to the growth regulator being present or absent as determined by the analysis of variance.

[2]) Use lower case letters to separate the 6 means within one thinning treatment and growth regulator category (S.E. = 6.63) and capital letters to compare means across thinning treatments (S.E. = 11.68).

[3]) Lower case letters separate means within one thinning treatment (S.E. = 0.029); capital letters separate means across thinning treatments (S.E. = 0.050).

[4]) Lower case letters separate means within one thinning treatment (S.E. = 0.229); capital letters separate means across thinning treatments (S.E. = 0.629).

[5]) Lower case letters separate means within one thinning treatment (S.E. = 0.021); capital letters separate means across thinning treatments (S.E. = 0.050).

[6]) Capital letters separate means across thinning treatments (S.E. = 4.03).

Table 3

Cluster thinning and GA_3 spray treatment effects on berry set, weight and quality; cluster weight; vine yield; and vine growth of de Chaunac grapes in 1977 · Treatments 3, 4, 7 and 8 received a postbloom CCC spray in 1976 (see Table 1)

L'effet de l'éclaircissement et du traitement au GA_3 sur la nouaison, le poids et la qualité des baies, le poids des grappes, le rendement des vignes et la croissance des sarments du cépage de Chaunac en 1977 · Les traitements 3, 4, 7 et 8 ont reçu une application post-floraison de CCC en 1976 (voir Tableau 1)

Treatment	Berry set no./cluster[1]	Mean berry wt g[1]	Mean cluster wt g[1]	Total yield kg/vine	Juice soluble solids %[1]	Juice acidity % as tartaric[1]	Tannins mg/100 ml[1]	Wt of dormant prunings kg/vine
1. CK — unthinned[2]	85.8	1.63	139.6	7.2	20.4	0.91	98.0	1.10
2. CK — thinned	98.7	1.72	170.2	10.0	19.6	0.89	89.7	1.25
3. CK — unthinned	100.6	1.66	165.2	6.7	20.8	0.92	90.8	1.12
4. CK — thinned	112.9	1.67	188.2	10.6	19.0	0.91	78.8	1.13
5. GA_3 — unthinned	96.8	1.70	164.0	10.5	19.5	0.83	93.3	1.10
6. GA_3 — thinned	106.2	1.72	182.1	12.2	19.2	0.84	82.4	1.36
7. GA_3 — unthinned	94.5	1.74	162.9	8.7	19.4	0.85	89.7	0.99
8. GA_3 — thinned	113.3	1.65	185.8	10.0	18.9	0.83	81.4	0.98
S.E.	2.46	0.017	3.76	0.37	0.18	0.009	1.99	0.16
	Significance of main factors and interactions							
GA_3 (G)	n.s.	n.s.	n.s.	**	*	**	n.s.	n.s.
CCC in 1976 (C)	*	n.s.	*	n.s.	n.s.	n.s.	*	**
Thinning (T)	**	n.s.	**	**	**	n.s.	**	n.s.
Interactions	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

[1]) Data for 1st and 2nd clusters on 2-cluster shoots of thinned vines and 1st and 2nd clusters on unthinned vines were pooled.
[2]) CK = Check.
** * n.s. = Means differ significantly at P = 0.01, P = 0.05 or not significant, respectively.

Table 4

Influence of cluster position and thinning on berry set, average berry weight and juice quality parameters of de Chaunac grapes in 1977

Influence de la position des grappes sur le rameau et de l'éclaircissement sur la nouaison, le poids moyen des baies et la qualité du jus du cépage de Chaunac en 1977

	Cluster position on thinned vines			Cluster position on unthinned vines		
	1 of 1	1 of 2	2 of 2	1 of 3	2 of 3	3 of 3
Berry number/cluster	93.3 aB[1])	113.7 cC	101.9 bB	98.8 cB	90.1 bB	71.8 aA
Average berry weight (g)	1.70	1.69	1.68	1.69	1.67	1.65
Juice soluble solids (%)	19.6 B[2])	19.4 B	19.0 A	20.1 B	19.9 B	20.0 B
Juice acidity (% as tartaric)	0.85	0.87	0.87	0.87 b[3])	0.88 b	0.84 a
Juice tannins (mg/100 ml)	87.2 B[4])	85.4 B	80.8 A	91.8 B	94.0 B	93.8 B

[1]) Use lower case letters to separate ($P = 0.05$) the 3 means within one thinning treatment (S.E. = 3.26) and capital letters to separate means across thinning treatments (S.E. = 5.67).

[2]) As above (S.E. = 0.450).

[3]) As above (S.E. = 0.0114).

[4]) As above (S.E. = 3.96).

The third cluster again set fewer berries than the more proximal clusters but it was larger than in either of the two previous years. However, average berry weight on this cluster was lower than for more proximal clusters, a result not observed in previous years.

Likewise, the second cluster on unthinned vines not treated with GA_3 developed higher juice soluble solids than the first cluster (Table 6). Otherwise, the above mentioned GA_3 effect of increasing juice soluble solids was uniformly displayed across all cluster positions on thinned and unthinned vines.

Finally, juice acidity tended to be lower in grapes from the third cluster on unthinned vines (Table 6). It also varied among growth regulator treatments and due to thinning but these differences are probably not of practical significance.

Discussion

Previous experiments (Coombe 1967, Looney 1975) have demonstrated that CCC improved berry set of seeded grapes and of the de Chaunac cultivar specifically. Furthermore, a postbloom GA_3 spray resulted in larger berries without influencing berry set of de Chaunac grapes in 1974 (Looney and Wood 1977). Therefore, one aim of the present study was to learn if GA_3 could be used to enhance cluster weights (and thus vine yields) on vines also treated with CCC to improve berry set. It was reasoned that cluster thinning could be used to prevent over-cropping and hence maintain berry quality and annual yields.

However, results of the CCC treatments applied in 1976 discouraged further testing. Increased berry set was accompanied by smaller berries, lower juice soluble solids and tannins, and higher acidity. In that season the GA_3 treatment did partially counteract these adverse effects on berry size and quality but it appeared to do so by reducing berry set.

CCC applied in 1976 also resulted in reduced vine growth in that season and increased fruit set in 1977. This residual effect of increasing fruit set one year after treatment has also been reported for pear trees (Stahly and Williams 1976).

The GA_3 treatment applied about 10 d after full bloom to thinned and unthinned vines produced different results each year. The main effect in 1976 was a sharp reduction in berry set and a resulting improvement in the weight of individual berries and increased juice soluble solids and tannins. GA_3 treatment plus cluster thinning also led to a significant increase in vine growth in 1976. In 1977 GA_3 reduced juice acidity but was otherwise largely ineffective. Unthinned vines treated with GA_3 yielded more heavily in 1977 but this was largely a reflection of the reduced crop in 1976. GA_3 improved juice soluble solids in 1978 without reducing berry set or improving mean berry weight.

These variable effects of GA_3 treatment may relate to critical differences in timing of the spray application in relation to berry developmental stage. Previous work with seeded cultivars indicates that sprays applied 10 to 20 d before full bloom result in more seedless berries (Motomura and Ito 1972), but since cluster weights were drastically reduced, either berry weights or berry numbers, or both, were drastically reduced; sprays applied during anthesis can reduce berry set (Weaver and Pool 1971, Hopping 1976); and sprays applied after anthesis may enhance set of seeded berries (Bukovak *et al.* 1960) or enhance berry growth without thinning (Looney and Wood 1977). Clearly, timing is important and cultivars respond dif-

Table 5

Cluster thinning and GA_3 and benzyladenine (BA) spray treatment effects on berry set, weight and quality; cluster weight; and vine yield of de Chaunac grapes in 1978 · See Tables 1 and 3 for treatments applied to these vines in 1976 and 1977

L'effet de l'éclaircissement des grappes et du traitement au GA_3 et à la benzyladénine (BA) sur la nouaison, le poids et la qualité des baies, le poids des grappes et le rendement des vignes du cépage de Chaunac en 1978 · Voir Tableaux 1 et 3 pour les traitements faits sur ces vignes en 1976 en 1977

Treatment	Berry set no./cluster[1]	Mean berry wt g[1]	Mean cluster wt g[1]	Total yield kg/vine	Juice soluble solids %[1]	Juice acidity % as tartaric[1]	Tannins mg/100 ml[1]
1. CK — unthinned[2]	134.6	1.73	231.7	17.8	14.3	0.97	62.5
2. CK — thinned	127.9	1.75	223.2	17.6	15.4	0.97	65.4
3. BA — unthinned	134.4	1.70	227.3	17.7	14.4	0.89	63.3
4. BA — thinned	121.9	1.75	211.8	16.8	16.5	1.00	79.6
5. GA_3 — unthinned	130.6	1.71	223.4	18.5	15.2	0.94	66.9
6. GA_3 — thinned	122.1	1.79	218.6	16.3	17.2	0.98	63.5
7. GA_3 + BA — unthinned	139.8	1.71	240.8	15.4	16.2	0.95	69.9
8. GA_3 + BA — thinned	121.3	1.74	209.7	15.7	15.9	0.92	71.8
S. E.	3.07	0.019	5.11	0.54	0.143	0.010	1.87
	Significance of main factors and interactions						
GA_3 (G)	n.s.	n.s.	n.s.	n.s.	**	n.s.	n.s.
BA (B)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Thinning (T)	*	n.s.	*	n.s.	**	*	n.s.
Interactions	n.s.	n.s.	n.s.	n.s.	GBT**	GBT**	n.s.

[1]) Average values for 1st and 2nd clusters for thinned and unthinned vines.
[2]) CK = Check.
** * n.s. = Main factors or interactions significant at P = 0.01, P = 0.05 or not significant, respectively.

Table 6

Influence of cluster position, thinning and selected growth regulator treatments on berry set, average berry weight and juice quality parameters of de Chaunac grapes in 1978

Influence de la position des grappes sur le rameau, de l'éclaircissement et de quelques phytorégulateurs sur la nouaison, le poids moyen des baies et la qualité du jus du cépage de Chaunac en 1978

	Cluster position on thinned vines		Cluster position on unthinned vines		
	1 of 2	2 of 2	1 of 3	2 of 3	3 of 3
Berry number/cluster	123.1 aB[1])	123.5 aB	129.7 bB	140.0 cC	101.0 aA
Average berry weight (g)	1.77 aB[2])	1.75 aB	1.72 bB	1.71 bB	1.61 aA
Juice soluble solids (%)					
GA_3	16.6 bB[3])	16.5 bB	15.8 cB	15.6 cB	16.1 cB
No GA_3	15.8 aB	16.1 abB	13.9 aA	14.7 bA	14.4 abA
Juice acidity (% as tartaric)					
No spray	0.97 abA[4])	0.98 abA	0.94 abcdABC	1.00 dABC	0.88 abAB
GA_3	0.99 abB	0.96 abA	0.98 cdABC	0.91 abcABC	0.89 abAB
BA	1.02 bC	0.97 abA	0.89 abAB	0.89 abAB	0.87 aA
GA_3 + BA	0.92 aA	0.92 aA	0.94 aABC	0.95 bcdABC	0.93 abcABC
Juice tannins (mg/100 ml)	69.8	70.3	65.2	66.2	68.1

[1]) Use lower case letters to separate means (P = 0.05) within one thinning treatment (S.E. = 3.69) and capital letters to separate means across thinning treatments (S.E. = 6.65).

[2]) As above (S. E. = 0.030 and 0.041).

[3]) As above (S. E. = 0.272 and 0.459).

[4]) As above (S. E. = 0.031 and 0.048).

ferently. If a commercial GA_3 treatment is to be developed for de Chaunac grapes, a careful study of spray timing must be conducted.

Likewise, the ineffectiveness of the benzyladenine treatment may relate to improper timing. BANGERTH and GÖTZ (1975) report reduced acidity in *Vitis vinifera* cultivars following benzyladenine treatment.

Cluster thinning before flower opening improved berry quality each year of this experiment and also stabilized vine yields. From a juice quality standpoint the best result was obtained when an average of 1.5 clusters was left on each fruitful shoot. However, the 1977 result suggested that berry set on clusters of single cluster shoots was reduced relative to two-cluster shoots. This led to the uniform two-cluster thinning treatment applied in 1978. Since the berry quality improvement benefit was small in 1978 we suggest that the optimal rate of thinning is somewhere between the two rates tested. Nonetheless, the total yield of sugar over three years for vines thinned in 1976, 1977 and 1978 was approximately 18 % higher than for unthinned vines. The benefits of cluster thinning reported herein were greater than those reported by FISHER *et al.* (1977) for the same cultivar but generally confirm the results of this earlier study.

The procedure of thinning alternate shoots to one or two clusters permitted some insight into the effects of within-shoot competition on berry set, berry growth and quality. Earlier experiments (LOONEY and WOOD 1977) showed that thinning entire de Chaunac vines to one cluster per shoot enhanced berry set on that cluster in one experiment but not in another. Removing a portion of two flower clusters per shoot by pruning led to a substantial increase in the set of the remaining flowers on each cluster in all experiments. This appeared to indicate that for the process of berry set, within-cluster competition was more likely to be critical than competition between clusters on a single shoot. The present experiment provided more evidence to support that suggestion. Clusters on shoots thinned to a single cluster in 1977 actually set fewer berries than the comporable cluster on two-cluster shoots. In 1976 the single clusters set about the same number of berries as the comparable cluster on two-cluster shoots. Apparently, removing clusters cannot be relied upon to improve berry set on the remaining clusters on a shoot. Likewise, the growth and sugar content of individual berries in a cluster were not influenced by within-shoot competition (one versus two clusters per shoot), but thinning did generally improve mean berry weight. Therefore, a general reduction in crop load may be as effective as the detailed thinning practiced in the present study although accomplishing this by vine pruning is not satisfactory (FISHER *et al.* 1977).

Conversely, berry thinning within clusters, as was accomplished by GA_3 treatment in 1976, dramatically improved berry weight and sugar content in the year of treatment and resulted in improved vine yields the following year. When combined with cluster thinning these effects were more dramatic still and were in contrast to the results of the CCC treatment which promoted berry set. Thus, chemical thinning of berries may be a very practical approach to improving berry quality and stabilizing yields of de Chaunac grapes. Cluster thinning is clearly beneficial but is labor intensive.

Summary

Prebloom thinning of de Chaunac grapes (a French hybrid cultivar) to one or two proximal flower clusters per fruitful shoot generally improved berry quality in

the year of treatment and increased vine yields in the subsequent year. Yield reduction in the year of thinning was minimized by small increases in berry set and berry size. Overall, vines thinned for three consecutive years yielded about 18 % more sugar than comparable unthinned vines. However, in the second of the three seasons, shoots thinned to a single proximal cluster exhibited poorer set on that cluster than when two clusters remained. This and other observations led to the conclusion that within-shoot competition is less critical than expected and that a general reduction in crop load may be as effective as detailed thinning.

Chlormequat (CCC) treatment increased berry set on thinned and unthinned vines but reduced berry size (weight) and juice quality. Conversely, gibberellic acid (GA_3) reduced berry set, increased berry weight, and improved juice quality. CCC and GA_3 were counteractive when applied to the same vines. In subsequent seasons the GA_3 treatment effects were less dramatic. GA_3 reduced juice acidity in one season and increased juice soluble solids in another. Benzyladenine applied with or without GA_3 proved to be without effect.

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Literature cited

Bangerth, F. und Götz, G., 1975: Zur Wirkung von Gibberellinsäure- und Kinetinapplikationen auf Qualität und Ertrag verschiedener Sorten von *Vitis vinifera* L. Wein-Wiss. 30, 121—128.

Barritt, B. H., 1970: Fruit set in seedless grapes treated with growth regulators Alar, CCC and gibberellin. J. Amer. Soc. Hort. Sci. 95, 58—61.

Bukovac, M. J., Larsen, R. P. and Bell, H. K., 1960: Effect of gibberellin on berry set and development of Concord grapes. Mich. Quart. Bull. 42, 503—510.

Coombe, B. G., 1967: Effects of growth retardants on *Vitis vinifera* L. Vitis 6, 278—287.

Fisher, K. H., Bradt, O. A., Wiebe, J. and Dirks, V. A., 1977: Cluster thinning de Chaunac French hybrid grapes improves vine vigor and fruit quality in Ontario. J. Amer. Soc. Hort. Sci. 102, 162—165.

Hopping, M. E., 1976: Effect of bloom applications of gibberellic acid on yield and bunch rot of the wine grape "Seibel 5455". N. Z. J. Exp. Agricult. 4, 103—107.

Looney, N. E., 1975: Some growth regulator effects on berry set, yield and quality of Himrod and de Chaunac grapes. Canad. J. Plant Sci. 55, 117—120.

— — and Wood, D. F., 1977: Some cluster thinning and gibberellic acid effects on fruit set, berry size, vine growth and yield of de Chaunac grapes. Canad. J. Plant Sci. 57, 653—659.

Motomura, Y. and Ito, H., 1972: Exogenous gibberellin as responsible for seedless berry development in grapes. II. Role and effects of the prebloom gibberellin application as concerned with flowering, seedlessness and seedless berry development of Delaware and Campbell Early grapes. Tohoku J. Agricult. Res. 23, 15—32.

Singleton, V. L. and Rossi, J. A., Jr., 1965: Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Amer. J. Enol. Viticult. 16, 144—158.

Stahly, E. A. and Williams, M. W., 1976: Induction of earlier fruiting of "Anjou" pear trees with growth regulators. HortScience 11, 502—504.

Tukey, L. D. and Flemming, H. K., 1968: Fruiting and vegetative effects of N-dimethylaminosuccinamic acid on "Concord" grapes, *Vitis labrusca* L. Proc. Amer. Soc. Hort. Sci. 93, 300—310.

Weaver, R. J. and Pool, R. M., 1971: Thinning "Tokay" and "Zinfandel" grapes by bloom sprays of gibberellin. J. Amer. Soc. Hort. Sci. 96, 820—822.

Wood, D. F. and Looney, N. E., 1977: Some cluster thinning and gibberellic acid effects on juice and wine quality of de Chaunac grapes. Canad. J. Plant Sci. 57, 643—646.

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