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of pruning mechanization (3, 7), which requires cordon trained vines, there is a need to shift to cordon training systems. GDC training will increase vine productivity and aid in maintaining acceptable fruit quality compared to SC training in Arkansas (1). However, the comparison of 'Concord' trained to GDC, SC, and UK under Arkansas conditions has not been made.

Preliminary studies in Arkansas indicated that the conventional pruning schedule of 30+10 (30 nodes retained for the first 454 g (1 lb.) of 1 year old prunings and 10 additional nodes retained for each additional 454 g of prunings removed) may be too severe to obtain maximum fruit yields with acceptable juice quality from GDC trained vines (1). The objective of this study was to evaluate the response of 'Concord' yield and juice quality to GDC, SC, and UK training systems under 2 pruning severities.

Materials and Methods

This study was conducted for 5 years (1974-1978) in an own-rooted 'Concord' vineyard established in 1957 at the Arkansas Agricultural Experiment Station, Fayetteville, on a Lintonia silt loam. The GDC trellis was converted from a SC trellis by installing 2 horizontal wires with a 1.2 m spread as described by Shaulis et al. (9) and extending each cordon to 2.4 m in length during the fall of 1973. The SC trellis had two 1.2 m cordons. UK was established as described by Shaulis et al. (5). The trellis height of each system was 1.8 m. Vine size in 1973 averaged 1.3 kg/vine.

All vines were balanced pruned to either a 30+10 or 70+10 schedule (30 or 70 nodes retained for the first 454 g of 1 year old dormant prunings and 10 additional nodes retained for each additional 454 g of prunings removed). Fruiting nodes on GDC and SC trained vines were retained on 6-node canes and canes on UK trained vines were 12-15 nodes long. All vines on GDC and SC systems were shoot positioned (current season's growth positioned vertically toward the vineyard floor) and shoots on UK trained vines were allowed to grow at random.

Records were kept for individual vine yields and pruning weight. Each treatment was imposed on the same vines each year. The experimental design was a 2 × 3 factorial with 7 replications of 4-vine plots.

Samples consisting of 3 whole basal clusters were collected at harvest from each plot and immediately frozen in polyethylene bags for later analysis. All treatments were harvested in 1974 and 1975 when a composite sample of 100 randomly sampled berries on vines trained to the UK system pruned to the 30+10 severity tested 15% soluble solids and in 1976-1978 when this treatment tested 16%. Harvesting was on Aug. 22, Aug. 21, Sept. 3, Sept. 7, and Sept. 12, for 1974-1978, respectively.

For quality analysis, berries were separated from stems, counted, and weighed to determine individual berry weight and number of berries/cluster. The number of completely green berries in each cluster were determined. The samples (green and colored fruit recombined) were then blended for 15 sec in a laboratory blender, placed in 250 ml beakers, warmed to 20°C, and % soluble solids were determined using a Bausch and Lomb Abbe refractometer.

For color and acid determinations, beakers containing the blended samples were covered with watch glasses and placed in a water bath at 85°C for 1 hr, removed and cooled to about 40°. Pulp was removed by straining samples through 2 layers of coarse cheesecloth. A 5 ml aliquot of juice was diluted to 100 ml using distilled water, centrifuged, and optical density was read on the centrifuged samples using a Bausch and Lomb spectrophotometer (model 340) at 520 nm. Another 5 ml aliquot of juice was diluted to 125 ml using distilled water, and titrated to pH 8.4 with 0.1 N NaOH. Acidity is reported as % tartaric acid.

Results and Discussion

When yields were averaged across the 5 years of the study, GDC was the most productive training system tested and the SC and UK systems were not significantly different (Table 1). During the initial year, 1974, GDC did not out-yield the UK training system, possibly because the GDC vines were still becoming established to the trellis. GDC trained vines were more consistently high yielding than the SC or UK trained vines during the remaining 4 years of the study.

Weather conditions during bloom were poor for fruit set in 1976 and this was the lowest yielding year of the 5 year period. Low yields in 1976 could have partially contributed to the exceptionally high yields produced on all treatments the following year. Berries/cluster in 1977 averaged 48.7 (data not shown in tables) over all treatments compared to the 5 year average of 36.4 (Table 2).

Light pruning (70+10) produced higher yields than the 30+10 pruning schedule for the 1st 4 years (Table 1). Following the high yielding year, 1977, vines pruned to the 70+10 schedule showed definite overcropping stress, resulting in reduced yields in 1978.

UK trained vines maintained a large vine size throughout the study (Table 1). Lower pruning weights on GDC and SC are indicative of the effects of shoot positioning as previously reported (1, 4), and are not directly related to yield. When means are pooled across training systems, effects of pruning severity on vine size is yield and stress related. The low vine growth for 1978 can be partially attributed to heavy cropload and the fact that only 12.4 cm of rainfall fell in the last 85 days prior to harvest. These conditions resulted in poor maturity of canes that were produced and vine size is determined by weighing only the mature canes.

GDC trained vines produced the most fruitful nodes for the 5 year average (Table 2). However, in 1978, the 5th and final year of the study, nodes on GDC trained vines were not significantly more fruitful than those on SC trained vines. Node fruitfulness for both the 5 year average and for 1978 was directly related to yield. Since berry weight and number of berries/cluster were unaffected by training systems for the 5 year average, or for 1978, clusters/vine (not determined) may have accounted for the differences in yield and node fruitfulness. With higher yields on GDC trained vines, no sacrifice of % soluble solids occurred for the 5 year average or for 1978 (Table 2). Since % soluble solids of fruit produced on the 3 training systems was similar, higher yields on GDC trained vines resulted in high yields of soluble solids/ha for the 5 year average and for 1978. The effect of training systems on acidity, though significant, was not large enough to be of commercial importance. The overriding factor which ultimately controls juice acidity in southern production areas is the day and night temperatures during fruit maturation (1).

Color of fruit from GDC and SC trained vines was superior to fruit from UK trained vines for the 5 year average and for 1978 (Table 2). This is probably due to the effects of shoot positioning the GDC and SC trained vines which reduces interior canopy fruit and foliage shading (4). The extent of uneven ripening was not affected by training systems for the 5 year average or for 1978, as indicated by % green fruit (Table 2). In 1977, the highest yielding year, vines trained to the GDC system did not have the uneven-ripening problem present on the other training systems (data not shown). This is in agreement with Couvillon and Nakayama (2) who reported more uniform 'Concord' ripening in Georgia when vines were trained to a Modified Munson system which is similar to GDC.

With the high average yields on lightly pruned (70+10) vines (Table 1), node fruitfulness was reduced for the 5 year average (Table 2). Node fruitfulness remained low on lightly pruned vines in 1978, even though these vines yielded less than 30+10

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Table 1. Main effects of training system and pruning severity on 'Concord' yield and pruning weight.

Main effect[z]	1974	1975	1976	1977	1978	Mean
			Yield (MT/ha)			
Training system						
GDC	12.6a[y]	14.1a	10.9a	22.3a	17.1a	15.4a
SC	10.1b	8.9b	6.9b	18.5b	14.9ab	11.9b
UK	12.7a	8.8b	8.1b	20.6ab	13.5b	12.7b
Pruning severity						
30+10	9.5b	9.9b	6.7b	18.6b	16.1a	12.2b
70+10	14.1a	11.4a	10.5a	22.3a	14.2b	14.5a
			Pruning wt (kg/vine)			
Training system						
GDC	1.00b	1.01b	1.02ab	1.07b	0.65b	0.95b
SC	0.99b	0.89b	0.79b	1.20b	0.63b	0.89b
UK	1.38a	1.54a	1.27a	1.70a	0.85a	1.35a
Pruning severity						
30+10	1.19a	1.20a	1.07a	1.41a	0.79a	1.13a
70+10	1.06b	1.09b	0.99a	1.23b	0.63b	1.00b

[z]Means within main effect blocks pooled over the over variables.

[y]Means separation within columns and main effects by Duncan's multiple range test (5%).

Table 2. Effects of training system and pruning severity on fruiting characteristics and juice quality of 'Concord' grapes.

Main effect[z]	Node fruitfulness (g/node)	Berry wt (g)	Berries/ cluster (no.)	Soluble solids (%)	Soluble solids (MT/ha)	Tartaric acid (%)	Color (O.D.)	Green fruit (%)
				5 year mean				
Training system								
GDC	191a[y]	3.08a	35.9a	15.4a	2.35a	0.87b	0.228a	3.4a
SC	150b	3.11a	36.4a	15.6a	1.84b	0.89a	0.238a	4.7a
UK	139b	3.05a	36.9a	15.2a	1.93b	0.86b	0.197b	5.6a
Pruning severity								
30+10	189a	3.23a	36.9a	15.7a	1.92b	0.87a	0.242a	1.8a
70+10	131b	2.93b	35.9a	15.0b	2.16a	0.88a	0.200b	7.3b
				1978				
Training system								
GDC	206a	2.89a	26.6a	15.5a	2.61a	0.84a	0.213a	3.5a
SC	185ab	3.01a	29.8a	16.0a	2.39ab	0.85a	0.208a	3.1a
UK	160b	2.97a	32.3a	15.7a	2.12b	0.80b	0.171b	3.3a
Pruning severity								
30+10	234a	3.14a	32.5a	16.1a	2.58a	0.82a	0.213a	1.7a
70+10	134b	2.78b	26.5b	15.4b	2.17b	0.84a	0.182a	4.9b

[z]Means within main effect blocks are pooled over the other variables.

[y]Means separation within columns and main effects for 5 year mean and 1978 by Duncan's multiple range test, 5%.

pruned vines during the last year of the study. Light pruning reduced berry size for the 5 year average and in 1978 (Table 2), but not until 1977 (data not shown) and 1978 (Table 2) were the no. of berries/cluster reduced.

For the 5 year average, fruit quality was poor on lightly pruned (70+10) vines as indicated by lower soluble solids, poorer color and a higher percentage of green fruit (Table 2). With comparative low yields on 70+10 vines in 1978, soluble solids remained lower and % green fruit was higher, indicating a stress condition after 5 years of light pruning. The uneven ripening problem on the lightly pruned (70+10) vines could be critical since green fruit is considered a serious damage defect by USDA Grades and Standards and only 6% by wt. of seriously damaged berries are allowed in the U.S. No. 1 grade (10).

No significant interactions occurred during any year between the training systems and pruning severities, indicating that vines on the 3 training systems responded similarly to the 2 pruning schedules.

Conclusions

Training grapevines to the shoot positioned GDC system resulted in consistently larger yields than SC or UK training. Vines of the size used in this study will benefit from GDC training under Arkansas conditions. Even though yields were higher on GDC, no sacrifice of fruit quality occurred. The 70+10 pruning schedule showed definite trends of overcropping stress, resulting in continued quality reduction and eventually yield loss.

Changing vineyard training from the conventional UK system to a shoot positioned SC training system can be accomplished with minimal effort without a reduction in productivity

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