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Irrigation and Canopy Management Strategies for Crimson Seedless

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Deficit irrigation (0.5 ET applied 6 or 10 weeks prior to harvest), shoot positioning (dividing the canopy just prior to bloom), and the application of ethephon were evaluated in a vigorous Crimson Seedless vineyard with an open gable trellis. The effects of these treatments on yield, fruit characteristics, and vine growth were evaluated. The experiment was a factorial and interactions between irrigation treatments, canopy management treatments, and ethephon were analyzed.

Procedure

The experiment was established in a very vigorous Crimson Seedless vineyard planted in 1994. The vineyard is on Exeter loam with a shattered hardpan at approximately three feet. The vines are spaced 7' x 12' (vines x row spacing). The vines are own rooted, head trained, and cane pruned. The trellis is an open gable with 24 inches between cane wires, 48 inches between the first foliage support wires, and 66 inches separating the upper foliage wires on the "Y". Moveable shoot positioning wires are used to divide the canopy. The vineyard is drip irrigated with two one-gallon emitters per vine.

The experiment is a factorial and designed as a split-split plot with five replications. The main plots are irrigation treatments consisting of daily drip irrigations cut back to 0.5 ET either on July 15 or August 15. Cutback treatments were compared to a fully irrigated control (1.0 ET through harvest). Split-plot treatments evaluated the response of dividing the canopy prebloom using positioning wires, and this was compared to a control where the canopy was not divided. The split-split plot treatments evaluated the response of applying ethephon. Ethephon was applied on August 22, 1996 and August 15 1997 using 0.8 pints/acre.

Vines were harvested on October 15, 1996 and October 7, 1997 and weights of packable, cull, and total fruit were obtained. Fruit measurements included color, berry size (weight, length, width), maturity (sugar, acid, pH), and berry firmness (UC pressure tester).

Measurements of soil, water, and plant relationships included using tensiometers to monitor soil matrix potentials at the 18" and 36" depths below the drip line. Leaf water potential was measured using a portable pressure chamber. Vine growth was evaluated by measuring trunk circumference. Light levels were measured in the fruiting zone. Cane fruitfulness was evaluated in the spring by counting shoots and flower clusters per vine.

Results

Seasonal water application was similar for 1996 and 1997. Control vines (1 ET all season) received 28.9 inches and 29.0 inches total for the 1996 and 1997 seasons. Vines cut back to 0.5 ET July 15 received 20.7 and 21.3 inches in 1996 and 1997. Vines cut back to 0.5 ET August 15 received 24.3 inches and 24.0 inches in 1996 and 1997. Monthly irrigation amounts for 1996 and 1997 are shown in Figures 1 and 2.

With full ET irrigation, tensiometer readings in 1996 showed soil matrix potential at 18-inch depth remained constant throughout the season at -15 to -20 kPa indicating that vines were never stressed. However, in 1997 soil matrix potentials were not constant at -15 to -20 kPa, and during the period from mid-August to mid-September soil matrix potential dorpped to -50 to -70 kPa indicating deficit irrigation. This loss of moisture in the soil profile occurred in spite of adequate irrigations and is attributed to poor water infiltration.

In 1996, vines in the fully irrigated control showed no water stress throughout the season, at harvest many shoots were still actively growing, and the deficit irrigated vines appeared severely stressed in comparison. However, in 1997 full ET vines exhibited water stress symptoms by harvest, almost all shoot growth had stopped, and it was difficult to distinguish between fully irrigated and deficit irrigated vines.

Soil moisture was quickly depleted when irrigations were cut to 0.5 ET. Both years, soil matrix potentials quickly became more negative after irrigations were cut back with tensiometer breaking suction after 10 to 14 days (Figs. 3 and 4). In 1996 and 1997, grapevines in the August cutback treatment exhibited moderate water stress symptoms by harvest with the cessation of shot growth and the abscission of a few basal leaves. In 1996 and 1997, vines in the July cutback treatment exhibited the most severe symptoms of water stress by harvest: no shoot growth and abscission of many basal leaves. Grapevines stress symptoms began to appear when leaf water potential was lower than -1.0 MPa (Fig 5).

In 1996, deficit irrigation dramatically improved fruit color and maturity compared to the fully watered control (Tables 1 and 4), and there were no effects on berry weight, berry diameter, berry length, berry firmness, total yield, packable yield, or culls (Tables 3 and 4). In 1997, deficit irrigations did not improve fruit color and maturity which corresponds with the lack of distinct differences in vine stress comparing deficit and fully irrigated vines.

Shoot positioning (dividing the canopy prebloom) in 1996 and 1997 substantially increased yield and fruit quality in 1997. Positioning the shoots resulted in a nicely divided canopy for about three to four weeks. Shoot positioning increased vine fruitfulness 14%, total yield 35%, packable yield 39%, berry weight 7%, and cluster weight 19% (Tables 5 and 6). Shoot positioning increased crop load by 35% and, subsequently, there was less fruit color.

Ethephon increased the number of clusters meeting U.S. #1 Table color standards both years (Table 2). No significant interaction occurred between ethephon, shoot positioning, or irrigation treatments when considering color development, fruit characteristics, or yield.

Conclusion

The positive effects of dividing the canopy (just prior to bloom) on flower cluster differentiation, yield, and fruit quality were profound. Canopy division is a cultural practice Crimson Seedless growers should consider, providing they have a trellis that can accommodate canopy division (gable, open gable, wide T trellis).

Growers with excessively vigorous Crimson Seedless vineyards should consider preharvest deficit irrigation beginning mid-July to mid-August to regulate late season vine growth and advance color and fruit maturity. Benefits can be achieved providing that the deficit irrigation is sufficient to slow or stop growth at least 6 to 8 weeks prior to harvest. In this study, irrigations were cut back to 0.5 ET which resulted in leaf water potentials lowering to less than -1.0 MPa and soil matrix potential, at the 18-inch depth under drip line, lowering to less than -70 kPa.

Severe deficit irrigations did not affect fruit quality (berry firmness and berry size) or vine growth (trunk circumference), which contradicts traditional wisdom. Deficit irrigation is proposed as a cultural practice on excessively vigorous Crimson Seedless vineyards, not weak vineyards. Deficit irrigation is not advisable on weak or moderately vigorous vineyards that quit growing midseason: benefit is questionable

Table 1. Effect of irrigation on development of fruit color.

Treatment	Clusters (%) meeting U.S. #1 Standards Oct. 2, 1996	Oct. 2, 1997
Full E.T.	26.5 a	59.4
July Cut-back[1]	91.0 c	75.4
Aug. Cut-back [1]	49.7 b	64.6
L.S.D.$_{.05}$	11.2	n.s.

[1]Cut-back to 50% of normal vine water use (ET).

Table 2. Effect of ethephon on development of fruit color.

Treatment	Clusters (%) meeting U.S. #1 Standards Oct. 2, 1996	Oct. 2, 1997
Ethephon[1]	63.5	79.6
Control	48.0	53.3
L.S.D.$_{.05}$	12.1	6.4

[1]Ethephon applied on August 23, 1996 and August 15, 1997 using 0.8 pints/acre

Table 3. Irrigation treatments had no significant effect on yield - 1996 and 1997.

Irrigation Treatment	T. Yield (lbs/vine)		Packable (lbs/vine)		Culls (lbs/vine)		T. Clusters (#/vine)		W. Clusters (lbs)	
	96'	97'	96'	97'	96'	97'	96'	97'	96'	97'
Full ET	33	46	32	42	0.5	3.9	33	50	1.0	0.9
July Cutback[1]	30	46	29	43	0.5	3.0	34	53	0.9	0.9
Aug. Cutback[1]	31	49	30	46	0.5	3.2	32	55	0.9	0.9

Table 4. Effect of irrigation treatments on fruit characteristics in 1996 and 1997.

Treatment	Berry Weight		Berry Firmness		Fruit Maturity	
	1996	1997	1996	1997	1996	1997
Full ET	3.9 ns	6.0 ns	426 ns	552 ns	20.2 a	18.4 ns
July Cut-back[1]	3.9	6.0	404	610	21.1 b	18.9
Aug. Cut-back[1]	3.9	6.1	436	603	21.9 b	18.6

[1]Cut-back to 50% of normal vine water use (ET).

Table 5. Effect of shoot positioning (dividing the canopy just prior to bloom) on yield - harvested October 7, 1997.

Treatment	Total Yield (lbs/vine)	Packable (lbs/vine)	Culls (lbs/vine)	Total Clusters (#/vine)	Cluster Weight (lbs)
Shoot Positioned	54.0	50.7	3.3	56.0	0.96
Control	39.8	36.3	3.5	49.0	0.81
L.S.D.$_{.05}$	4.7	4.5	n.s.[1]	4.5	0.06

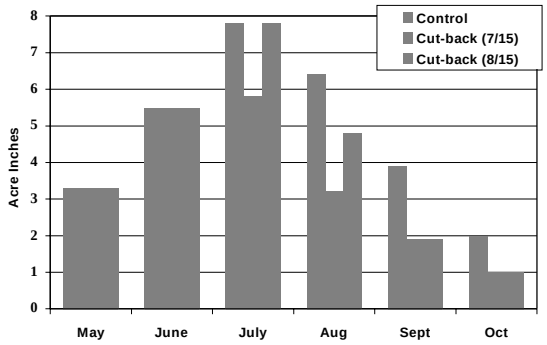
[1]not significant

Table 6. Effect of shoot positioning (dividing the canopy just prior to bloom) on fruit characteristics - harvested October 7, 1997.

Treatment	Berry Weight (g)	Berry Diameter (mm)	Berry Length (mm)	Berry Firmness (g)	Fruit Sugar (^{o}brix)
Shoot Positioned	6.2	19.0	26.7	578	18.6
Control	5.8	18.4	27.2	599	18.7
L.S.D.$_{.05}$	0.09	0.3	n.s[1]	n.s[1]	n.s[1]

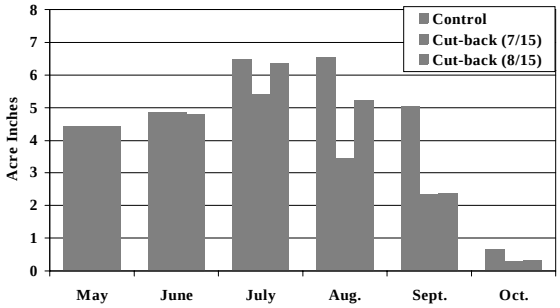
[1]not significant

Fig. 1. 1996 monthly irrigation amounts for: control; cut-back to 0.5 ET July 15; cut-back to 0.5 ET August 15.



Total water applied (ac.in.): Control = 28.9; July cut-back =20.7; August cut-back = 24.3.

Fig. 2. 1997 monthly irrigation amounts for: control; cut-back to 0.5 ET July 15; cut-back to 0.5 ET August 15.



Total water applied for season (ac. in.): Control= 29.0; July cut back= 21.3; August cut back = 24.0.

Fig. 3. 1996 tensiometer readings - soil matrix potential (kPa) at 18 inch soil depth below emitter.

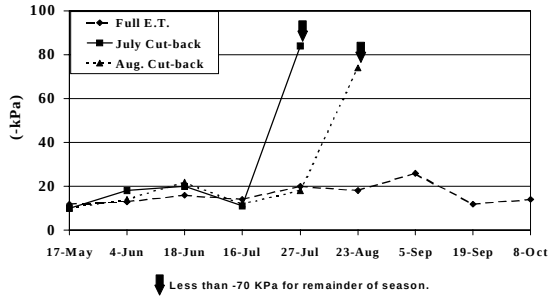


Fig. 4. 1997 tensiometer readings - soil matrix potential (kPa) at 18 inch soil depth below emitter.

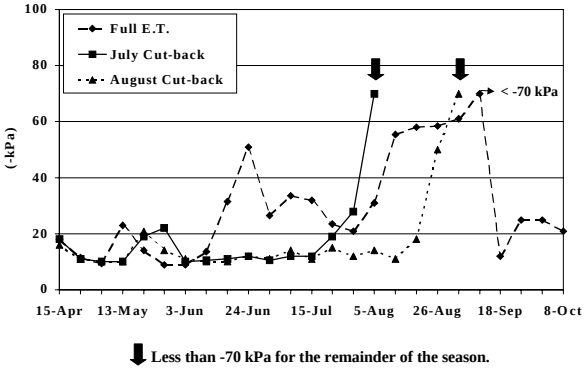


Fig. 5. 1996 seasonal trends of mid-day leaf water potential (-MPa) for irrigation treatments.

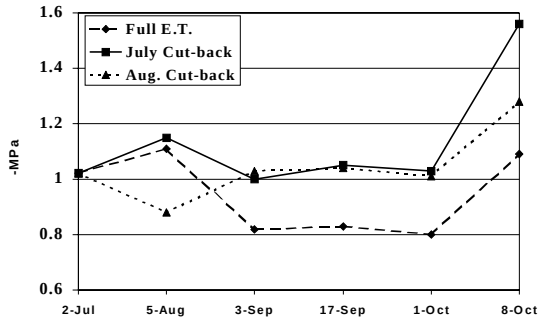


Fig. 6. 1997 seasonal trends of mid-day leaf water potential (-Mpa) for irrigation treatments.