Advancing Ripening of Crimson Seedless using potassium metalosate, deficit irrigation, and PGRs

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Abstract: Research in 2011 evaluated foliar K applied early in ripening (14 °brix) along with Ethrel and Protone applied from early- to late-ripening (14 °brix, 16 °brix, and 19°brix). Foliar K applied in combination with Ethrel at 14 °brix resulted in the greatest increase of fruit color (packable fruit). Compared to the untreated control, this combination increased the first pick by 103% and the total harvest (1st + 2nd pick) by 37%. Ethrel was much more effective applied early in ripening.

The best timing for foliar K in combination with Ethrel or Protone applied during early ripening is unknown. The 2012 research investigated applying Ethrel and/ or Protone early in ripening (14 °brix) and then varying the time of foliar K application from early to late (14 °brix, 16 °brix, and 19 °brix).

The research in 2011 was conducted in a vineyard that was deficit irrigated (50% ET) beginning early veraison. Deficit irrigation during ripening advances both color and sugar maturity. An additional objective for the 2012 project was to determine the efficacy of foliar K, Ethrel, and Protone on fruit color when vines are either fully or deficit irrigated.

The results showed that color (packable fruit) was improved most by applying foliar K either at 14 °brix or 18 °brix both in combination with Ethrel. The application of foliar K at 14 °brix or 18 °brix increase in packable fruit (under deficit irrigation) 149% and 95%, respectively. Foliar K applied at 16 °brix was much less effective. Foliar K advanced fruit maturity by about 1 °brix but did not impact berry weight. There is a strong positive interaction that occurs combining foliar K with Ethrel under deficit irrigation.

Deficit irrigation resulted in a six fold increase in total packed fruit. With full irrigation, the late application of foliar K resulted in the greatest increase in fruit color (packable fruit) when foliar K was applied independently. The most effective treatment combination under full irrigation was foliar K applied early in combination with Ethrel and Protone. Deficit irrigation reduced berry weight and advanced sugar maturity by 1 °brix. Berry firmness was reduced.

Materials and Methods: The same Crimson Seedless vineyard was used in 2012 as 2011, near Exeter. The trial was moved slightly south in the block to avoid using the same vines. Vines are uniform and strong and the vineyard is eight years old. The soil type is an Exeter loam and the

The UC SJV Irrigation Scheduler was used for irrigation scheduling and gypsum blocks, tensiometers, and water meters were used to monitor and adjust scheduling. Deficit irrigation was initiated beginning veraison to stop canopy growth and accelerate fruit ripening. The fully irrigated rows were managed by doubling the emitters (flow) to the vine. In-line water meters were installed to monitor water application amounts to both deficit irrigated and full irrigated rows. Both Watermark gypsum resistant blocks and tensiometers were installed at two sites with a 2' and 4' instruments at each site. Deficit irrigation commenced on July 20. The canopy was managed by shoot thinning in the spring and removal of basal lateral shoots (up to last retained cluster) and also the removal of a few basal leaves from the primary shoot. In mid-August, the canopy was mechanically skirted ~ 2-feet below the outer most foliar wire on the gable. No base leaves or other leaf removal occurred.

The experiment was designed as a completely randomized split-split block with 2 main plot treatments; 4 split plot treatments; 4 split-split plot treatments. Two replications (blocks) were used. Individual plots consisted of four vines. Total degree of freedom equal 63. Main, split, and split-split plot treatments are as follows:

Completely Randomized Split Split Plot with two Reps

Main Plot	Split Plot	Split/Split Plot
1. Deficit	1. no K	1. no PGR
2. Full ET	2. K at 14 brix	2. Ethrel
	3. K at 16 brix	3. Protone
	4. K at 18 brix	4. Both

Sprays were applied by dilute application so that fruit and foliage were wetted to run-off (~ 0.5 gallon per vine or 250 gallons per acre). A wetting agent was included with the Protone and Protone + Ethrel sprays.

Harvest: Fruit was harvested on three pick dates, August 27, September 26, and October 15. To be harvested, a cluster had to have ≥ 90% color (essentially full color).

Fruit characteristics: Berry weight, soluble solids (^{o}brix), and tartaric acid (g/100 ml) were measured at each pick. Berries were weighed, macerated, and juice collected after filtering. Sugar, ^{o}brix, was measured using a hand refractometer, acidity was determined by titration with NaOH, and a pH meter used to document hydrogen activity.

Berry firmness was measured by sampling 25 berries, removing styler epidermis with a razor blade, and measuring force with a UC pressure tester and a 4 mm probe. Soft tip was measured by evaluating all clusters on data vines and noting number of berries per cluster with soft tip.

Results and Discussion: Prior to the initiation of deficit irrigation in mid-July, matric potential at the 2' and 4' depth fluctuated between -15 to -20 centibars. Within one week after deficit irrigation commenced, the two and four foot instruments showed a drop in matric potential to -40 to -60 centibars and leaf water potential also dropped, Figure 1. As a result of deficit irrigation, vine growth stopped with only a few actively growing shoots apparent during August and September. The amount of water applied on a daily basis is also shown in Figure 1.

The results showed that color (packable fruit) was most improved by the combination of foliar K applied at 14 °brix or 18 °brix and Ethrel. The increase in packable fruit (under deficit irrigation) was 149% and 95% for the early and late foliar K application combined with Ethrel, Table 1,3.

Ethrel without foliar K and under deficit irrigation increased color (packed fruit) by 64%. But applied together, foliar K and Ethrel increased packable fruit by 150%. Therefore, there is strong positive interaction between foliar K and Ethrel.

Foliar K advanced fruit maturity by about 1 °brix when applied late under deficit irrigation, but it did not impact sugar maturity when applied earlier. In contrast, under full irrigation foliar K under full irrigation advanced sugar maturity applied early, mid-, or late ripening, and the increase was about 1 °brix.

Deficit irrigation increased both color and sugar maturity. But, deficit irrigation reduced berry weight and berry firmness. The most effective treatment combination under full irrigation was foliar K applied early in combination with Ethrel and Protone, Tables 2 and 4.

Foliar K reduced tartaric acid from 3.8 g/L to 3.6 g/L when sampled on October 15th and the pH correspondingly was increased.

Conclusion: Deficit irrigation had the largest impact on fruit color (packable fruit) increasing six fold the amount of boxes packed compared to full irrigation. Potassium metalosate increased the amount of packed fruit under deficit irrigation by about 30% and Ethrel by about 60%, but together packable fruit was increased by 150%. There is a strong positive interaction occurring with the combination of foliar potassium and Ethrel.

Deficit irrigation reduced berry weight by 0.3 g, advanced sugar by about 1.0 °brix, and reduced berry firmness.

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Table 1. The impact of irrigation, foliar K, and PGR treatments on packed yield.

#	Irrigation	Treatments Foliar K	PGR	1st Pick 27-Aug (box/ac.)	2nd Pick 26-Sep (box/ac.)	3rd Pick 15-Oct (box/ac.)	Total Packed (box/ac.)
1	Deficit	No K	No PGR	292	177	191	660
2			Ethrel	613	210	264	1088
3			Protone	191	41	74	305
4			Both	204	74	300	578
		Applied:					
5		14 brix	No PGR	183	123	210	515
6			Ethrel	837	442	368	1647
7			Protone	341	128	177	646
8			Both	224	333	709	1265
		Applied:					
9		16 brix	No PGR	33	123	232	387
10			Ethrel	286	60	82	428
11			Protone	142	115	245	502
12			Both	292	177	169	638
		Applied:					
13		18 brix	No PGR	341	264	232	837
14			Ethrel	701	354	237	1292
15			Protone	455	237	155	848
16			Both	804	191	224	1219
17	Full	No K	No PGR	0	0	0	0
18			Ethrel	33	33	74	139
19			Protone	27	0	0	27
20			Both	19	74	82	174
		Applied:					
21		14 brix	No PGR	0	0	0	0
22			Ethrel	41	33	55	128
23			Protone	49	14	14	76
24			Both	314	68	82	463
		Applied at					
25		16 brix	No PGR	27	0	68	95
26			Ethrel	87	82	128	297
27			Protone	0	0	41	41
28			Both	68	41	0	109
		Applied at					
29		18 brix	No PGR	19	0	14	33
30			Ethrel	60	55	95	210
31			Protone	0	0	33	33
32			Both	0	0	33	33
				***	***	***	***

L.S.D.: 1% = ***; 5%= **;1 0%= * & not significant = ns

Table 2. The impact of deficit irrigation, foliar K, and PGRs on fruit maturity and berry weight.

#	Irrigation	Foliar K	PGR	Sugar 26-Sep (brix)	Sugar 15-Oct (brix)	Berry Weight 26-Sep (g)	Berry Weight 15-Oct (g)
1	Deficit	No K	No PGR	20.0	20.7	4.6	4.9
2			Ethrel	19.7	19.7	4.6	4.5
3			Protone	19.9	20.4	4.7	5.0
4			Both	19.6	20.1	4.3	4.4
		Applied:					
5		14 brix	No PGR	19.7	20.3	4.3	4.3
6			Ethrel	20.4	20.4	4.3	4.3
7			Protone	20.8	21.1	4.6	4.6
8			Both	19.8	19.9	4.3	4.5
		Applied:					
9		16 brix	No PGR	21.4	21.2	4.4	4.8
10			Ethrel	21.0	20.9	4.5	4.6
11			Protone	21.2	21.4	4.0	4.5
12			Both	21.0	20.7	4.3	4.4
		Applied:					
13		18 brix	No PGR	22.3	22.1	4.7	4.6
14			Ethrel	22.0	21.9	4.7	5.0
15			Protone	22.4	22.2	4.5	4.3
16			Both	22.2	22.1	4.4	4.6
17	Full	No K	No PGR	18.9	19.0	4.6	4.7
18			Ethrel	19.4	19.5	5.1	5.3
19			Protone	19.0	19.3	5.0	5.0
20			Both	19.8	19.6	4.9	5.3
		Applied:					
21		14 brix	No PGR	20.0	20.0	4.8	4.7
22			Ethrel	19.8	19.8	4.9	5.1
23			Protone	20.5	20.2	4.6	4.7
24			Both	19.9	19.8	4.8	5.1
		Applied at					
25		16 brix	No PGR	20.8	20.1	4.7	4.8
26			Ethrel	20.8	20.6	4.7	4.9
27			Protone	20.7	20.8	4.7	4.7
28			Both	20.5	19.9	4.4	4.8
		Applied at					
29		18 brix	No PGR	19.3	19.7	4.6	4.9
30			Ethrel	20.3	20.7	4.9	4.9
31			Protone	20.3	20.3	4.6	5.0
32			Both	20.9	20.8	4.4	4.9
				***	***	***	***

L.S.D.: 1% = ***; 5%= **;10%= * & not significant = ns

Table 3. Harvest factorial averages for irrigation, foliar K, and PGRs treatments

Factorial Averages	1st Pick 27-Aug (box/ac.)	2nd Pick 26-Sep (box/ac.)	3rd Pick 15-Oct (box/ac.)	Total (box/ac.)
Deficit Irrigation	371	191	243	804
Full Irrigation	46	25	44	115
	***	***	*	***
No foliar K	172	76	123	371
Applied: 14 brix	248	142	202	592
Applied: 16 brix	117	74	120	311
Applied: 18 brix	297	5	128	430
	**	ns	*	***
No PGR	112	85	117	314
Ethrel	333	158	164	654
Protone	150	65	93	308
Both	240	120	199	559
	**	ns	**	***

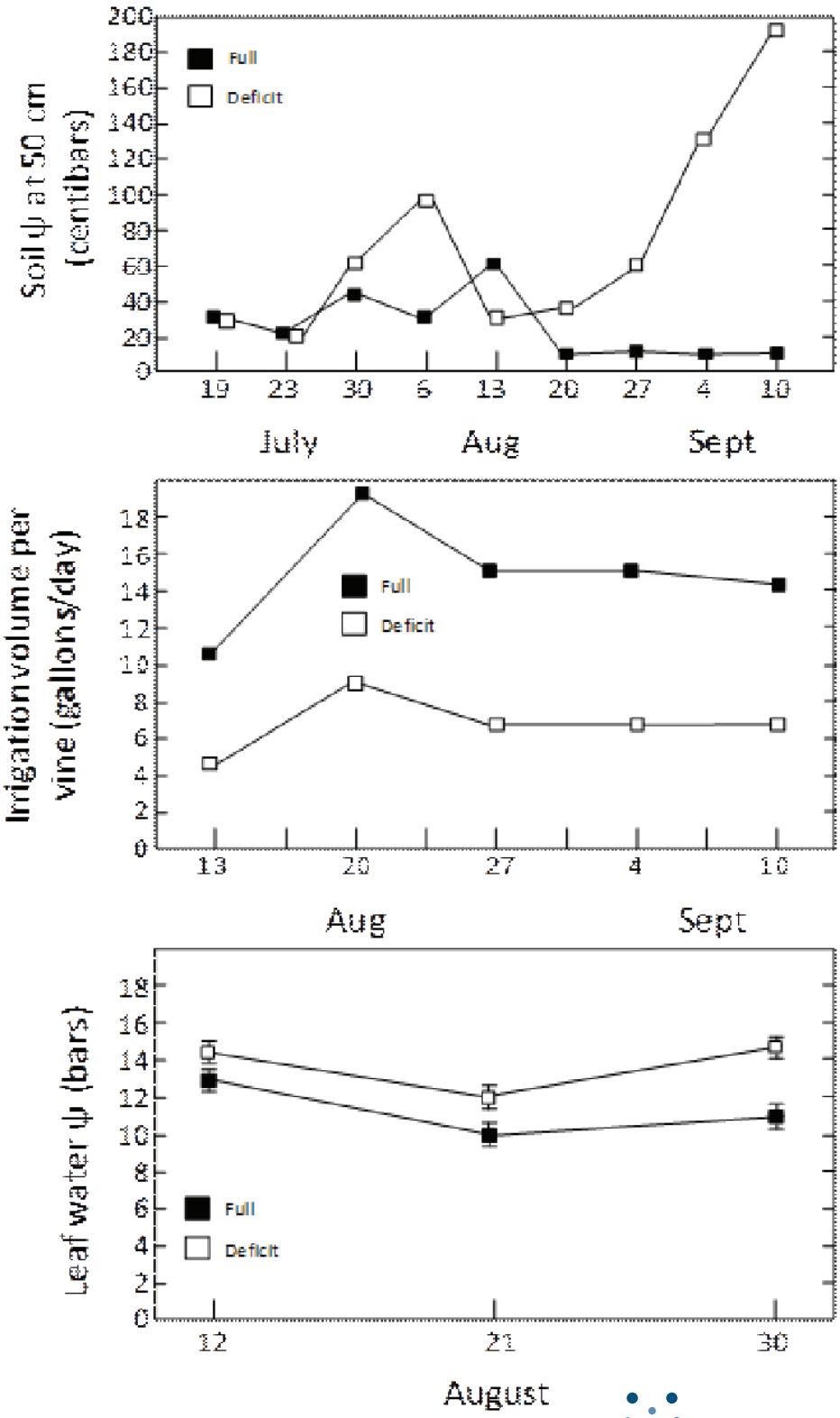
L.S.D.: 1% = ***; 5%= **;1 0%= * & not significant = ns

Table 4. Sugar and berry weight factorial averages for irrigation, foliar K, and PGR treatments

	Sugar		Berry Weight	
Factorial Averages	26-Sep (brix)	15-Oct (brix)	26-Sep (g)	15-Oct (g)
Deficit Irrigation	20.8	20.9	4.4	4.6
Full Irrigation	20.0	20.0	4.7	4.9
	***	***	***	***
No foliar K	19.5	19.7	4.7	4.9
Applied: 14 brix	20.1	20.2	4.6	4.7
Applied: 16 brix	20.1	20.7	4.5	4.7
Applied: 18 brix	21.2	21.2	4.6	4.8
	***	***	ns	ns
No PGR	20.3	20.4	4.6	4.7
Ethrel	20.4	20.4	4.7	4.8
Protone	20.6	20.7	4.6	4.7
Both	20.4	20.3	4.5	4.7
	ns	***	ns	ns

L.S.D.: 1% = ***; 5%= **;1 0%= * & not significant = ns

Figure 1. Leaf and soil water potential and irrigation amount comparing deficit and full irrigation.



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