Petroleum Oils as Navel Orange and Tangelo Fruit Thinning Agents

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The major objective of this research was to evaluate the potential of petroleum spray oils to increase fruit size of navel orange. Past research (1996-98) with concentrated petroleum oils in Kern County (see the April-June 2001 issue of HortTechnology) showed that 15-20 gallons per acre (GPA) of heavy narrow-range or supreme-type horticultural petroleum oil in a spray volume of 200 GPA sprayed in June could be used to increase average fruit size of early navels, with some decrease in yield. Subsequent research from 1999-2003 has focused on determining if lower volumes of concentrated oil (5 or 10 GPA of oil in 200 gallons of water) can produce similar results to higher-volume applications when applied to navels and tangelos.

After four years (1999-2002) of research in a block of Tule Gold navels in Kern County near Edison, and two years (2001 and 2002) of research in a block of Washington navels located on the U.C. Research and Extension Center at Lindcove in Tulare County, the answer appears to be that oil applied at the rate of 10 gallons per acre of a 440-weight narrow-range oil per year in June or July cannot dependably increase fruit size of navel oranges.

The experimentation has provided a large set of data relating fruit size distribution to fruit numbers per tree in relation to various thinning treatments including napthaleneacetic acid (NAA), NAA plus oil, and hand thinning. These data suggests that the response obtained in the earliest work in 1996-98 with the high volumes of oil may have been due, at least partly, to the unusually heavy fruit set in that particular orchard during the years this experiment was conducted.

The experimentation on Minneola tangelo continues. The objectives of this experiment are to determine how an application of 440-weight narrow-range petroleum oil would affect the alternate bearing characteristics, fruit size and yield of Minneola tangelo. The first oil application was made to tangelo in August 2001 and the fruit harvested March 2002. The second oil application was made in August 2002 and harvested March 2003.

Results in 2001-2002 showed the oil-treated trees significantly outyielded the non-treated trees, while in 2002-2003 the oil-treated trees had significantly more fruit in the larger size categories. No difference in alternate bearing was noted between treated and untreated trees. Although the treatments were replicated six times, a response of this magnitude, especially in the first year and in a light fruit-bearing year, suggested a statistical anomaly and that the experiment should repeated on a different set of trees.

In September 2003 oil was applied to a new area of the orchard and the number of replications increased to eight. The harvest is planned for early March 2004.

Application of Plant Growth Regulators and/or Fertilizers to Increase Fruit Size and Yield of Clementine Mandarin

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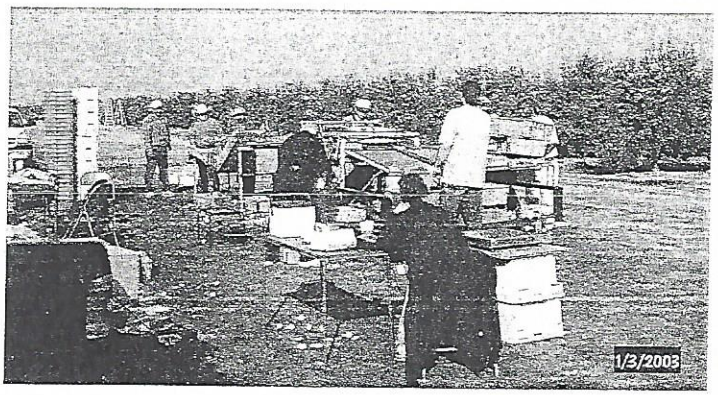
Excessive fruit drop during fruit set and June drop contributes to low yield of the Clementine mandarin. Pre-harvest drop also reduces yield. Despite the loss in fruit during these periods, fruit size remains small. Management strategies to increase fruit set and size are needed.

In three separate experiments we tested the efficacy of plant growth regulators (PGRs), both synthetic and natural, and fertilizer treatments to increase fruit retention, fruit size, yield, and grower returns. Fruit quality was also evaluated. The overall objective of this research is to develop production management strategies to increase grower income for Clementine mandarins in California.

OBJECTIVE 1:
To test the efficacy of fertilizers and/or PGRs to increase fruit set, fruit size, fruit quality, and yield.

We provide a summary of the effect of the treatments in this experiment on fruit set and fruit size and quality for three years of the study. This report includes data for the crop harvested from the spring bloom 2003 (technically part of the 2003-04 funding period).

Averaged across the three years of the experiment, 3,5,6-TPA significantly increased yield compared to the control and all other treatments except 2,4-D. Trees treated with 3,5,6-TPA had a net increase in yield of 40.6 lbs. fruit per tree over the control (3-year average). The 2,4-D treatment did not significantly increase yield over any treatments except CPPU and the control. Trees treated



Harvest of Fina Sodea Clementine mandarin trees near Grapevine, January 2003.

with 2,4-D had 27.4 lbs. more fruit per tree than control trees averaged over three years. At 200 trees per acre, the yield increase is substantial: 4.1 and 2.7 tons more fruit per acre for trees treated with 3,5,6-TPA and 2,4-D, respectively.

It is important to note that for trees treated with 3,5,6-TPA, the increase in yield was in large size fruit. The net increase in yield of large size fruit per acre averaged over the three years of the experiment for the 3,5,6-TPA treated trees compared to the control trees was: 1,336 lbs. of jumbo (fruit 63.51-69.85 mm in diameter), 2,843 lbs. of large (57.16-63.50 mm), and 2,570 lbs. of medium (50.81-57.15 mm) size fruit. No other treatment increased the yield of large size fruit compared to the control.

Both 3,5,6-TPA and 2,4-D significantly increased the three-year cumulative yield compared to the control. The net increase in yield over the control was 122 and 82 lbs. per tree per three years for the two treatments, respectively. Only 3,5,6-TPA increased the three-year cumulative yield of large size fruit compared to the control; i.e., fruit in size classes jumbo, large and medium. The net increase in three-year cumulative yield in each size class per acre was: 4,009 lbs. more jumbo fruit, 9,288 lbs. more large fruit, and 7,726 lbs. more medium fruit for 3,5,6-TPA treated trees than the control. In year 1 of the experiment, fruit from 3,5,6-TPA treated trees suffered from low juice content compared to the control. This was not the case in subsequent years.

OBJECTIVE 2:
To test the efficacy of PGRs and other compounds to delay senescence and increase fruit quality of late-harvested fruit.

The two GA_3 treatments and the 2,4-D plus GA_3 treatment could delay the color break, but the results are not statistically significantly.

OBJECTIVE 3:
To test the efficacy of PGRs and/or fertilizers to increase fruit set and yield.

The results of the 2002-2003 crop year are shown in Table 1. Overall, the major discovery of the 2002-2003 experiment was that the early 24 ppm 2,4-D treatment at 30 days after petal fall

Table 1. Harvest data (lb/tree) for Fina Sodea Clementine mandarin trees in the experiment for Objective 3 for 2002-2003. Means separation was by Duncan's multiple range test. Means in a vertical column followed by different letters are significantly different at $P \leq 0.05$.

TREAT/SIZE CLASSES	TINY	SMALL	MEDIUM	LARGE	JUMBO	MAMMOTH	COLOSL	JUMBO-COLOSL	LG-MAMMOTH	TOTAL
24D-12ppm@30dapf	1.96 abc	3.98 def	11.75 cd	71.50 bc	26.82 b	17.47 b	2.60 bc	46.88 b	115.81 bc	136.09 bcd
24D-24ppm@30dapf	1.98 abc	4.69 bcdef	11.33 cd	68.75 bc	36.34 a	37.95 a	7.22 a	84.50 a	146.06 a	171.25 a
24DP-10ppm@mxpl	2.27 abc	5.90 abcdef	15.73 abcd	75.48 abc	18.19 def	9.22 cd	2.00 bc	29.41 de	102.89 cde	128.79 bcde
24DP-25ppm@mxpl	2.11 abd	5.63 abcdef	16.06 abcd	88.31 A	22.42 bcd	13.24 bcd	3.34 bc	39.01 bcd	123.97 b	151.10 ab
Accel@fb+30dapf	1.67 bc	5.21 abcdef	15.66 abcd	70.99 bc	17.38 def	9.33 cd	2.24 bc	28.97 de	97.70 cde	122.52 cde
Acell@full blm	2.66 ab	6.58 abcd	16.72 abc	72.58 bc	16.76 def	9.00 cd	2.79 bc	28.56 de	98.34 cde	127.09 bcde
Acl+Ur@fb+30dapf	1.25 c	3.32 f	10.38 d	69.87 bc	24.24 bc	14.48 bc	3.56 bc	42.31 bc	108.61 bcd	127.12 bcde
CompX@fb+30dapf	2.46 abc	5.54 abcdef	15.09 abcd	80.10 ab	19.51 cde	9.68 cd	2.64 bc	31.83 cde	109.30 bcd	135.04 bcd
CompX@full_blm	2.68 ab	7.35 ab	18.61 ab	82.10 ab	20.46 cde	10.52 cd	2.35 bc	33.33 cde	113.08 bcd	144.06 bc
Control	3.12 a	7.33 ab	19.73 a	80.10 ab	14.67 ef	8.73 cd	1.80 c	25.21 e	103.51 cde	135.48 bcd
CPPU@30dapf	2.77 ab	7.59 a	18.39 ab	67.01 bc	12.87 f	8.03 d	1.63 c	22.53 e	87.89 e	118.27 de
GA3@30dapf	2.20 abc	5.24 abcdef	14.87 abcd	67.41 bc	16.57 def	9.35 cd	1.47 c	27.39 de	93.35 de	117.11 de
GA3@blm+30dapf	1.58 bc	3.70 ef	11.40 cd	60.52 c	15.66 ef	10.65 cd	5.50 ab	31.81 cde	86.83 e	109.01 e
GA3+Urea@30dapf	1.72 bc	4.51 cdef	12.65 bcd	68.88 bc	17.91 def	10.16 cd	2.00 bc	30.07 de	96.95 cde	117.83 de
@fb+30dapf	2.62 ab	6.40 abcde	18.22 ab	76.45 ab	17.49 def	9.37 cd	1.72 c	28.56 de	103.29 cde	132.26 bcde
Tryptophan@fb	2.60 ab	7.04 abc	17.91 ab	73.92 abc	15.97 ef	10.30 cd	2.82 bc	29.06 de	100.19 cde	130.55 bcde
P-value	0.0339	0.0013	0.0012	0.0042	<.0001	<.0001	0.0137	<.0001	<.0001	<.0001

significantly increased the weight of fruit in the size classes mammoth (fruit 69.86-76.20 mm in diameter) and jumbo (fruit 63.51-69.85 mm in diameter) compared to all other treatments and the control. This was a net increase of 24.7 and 29.3 lbs. of jumbo and mammoth fruit per tree, respectively, over the control. The 24-ppm 2,4-D treatment increased total yield in lbs. per tree by 26.40% over the control and increased the lbs. of large sized fruit (large, jumbo and mammoth) by 41.11% more than the control. Trees receiving this treatment also produced more fruit in the combined pool of jumbo plus colossal size fruit (fruit with transverse diameters 63.51-82.55) than all other treatments, three-fold more than the control.

The 2,4-D treatment at 12 ppm 30 days after petal fall increased the lbs. of jumbo and mammoth fruit per tree over the control but not all other treatments. Trees treated with 2,4-D at 12 ppm 30 days after full bloom produced approx. 22 lbs. more fruit in the combined pool of jumbo plus colossal size fruit than the control but not all other treatments. The PGR 2,4-D has been registered for increasing fruit size of navel and Valencia oranges and grapefruit in California.

Production and Management Strategies for New Mandarins in California

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The overall goal of this research is to develop proper management strategies for all new mandarin production in California. There are three objectives for this research: (1) Study the phenology of new mandarins in California; (2) Study the pollination, fertilization and seediness of new mandarins; and (3) Develop postharvest treatments and storage condition for new mandarins.

OBJECTIVE 1: Study the phenology of new mandarins in California.

The winter of 2002-2003 was a very mild winter and we had low level of chilling accumulation in the San Joaquin Valley. This low level of chilling accumulation and expected low crop of an "off" year had a significant impact on the flowering and fruit set of Clementine mandarins in 2003. In general, the flowering of all Clementine mandarins was delayed and there was prolonged blooming for Clementine mandarins. There were also large numbers of trees with high proportion of leafy inflorescence, a single terminal flower with multiple leaves. The overall numbers of flower/fruit set of all Clementine mandarins were lower this year. The prolonged blooming resulted in uneven fruit size in the Clementine orchard. This created an issue for GA_3 application to enhance fruit set of Clementine mandarin. Larger numbers of GA_3 application were used in 2003.

Based on the observation of Clementine mandarin cultivars at the University of California Lindcove Research and Extension Center (LREC), the 16 Clementine mandarin cultivars could probably be divided into two groups for their responses to low winter chilling. Cultivars Nules, Arrufatina, and Corsica #1 were sensitive to low chilling accumulation and did not have normal flowering in the spring of 2003. Cultivars Algerian, Caffin, Carte Noir, Corsica #2, Fina, Fina Sodea, Herrandian, Marisol, Nour, Oroval, Sidi Aissa, SRA63, and SRA92 had more normal flowering patterns in spring 2003.

Afourer mandarin (W. Murcott) at Southern Kern County,

Table 1. Results of hand pollination study of mandarins in 2002-2003.

FEMALE PARENT	TYPE OF CROSS OR MALE PARENT	#CROSS MADE	TOTAL FRUIT #	% FRUIT SET	AVERAGE SEED #	SEED # RANGE
Fina	Open pollinated	100	3	3.00%	5.00	4-11
	Parthenocarpy	100	2	2.00%	0.00	-
Marisol	Open pollinated	100	9	9.00%	3.44	1-7
	Parthenocarpy	100	1	1.00%	0.00	-
	Selfing	100	2	2.00%	0.00	-
Fina Sodea	Open pollinated	100	3	3.00%	2.33	2-5
	Parthenocarpy	100	0	0.00%	0.00	-
	Selfing	100	1	1.00%	0.00	-
	Afourer	107	33	30.84%	23.42	3-35
	Tahoe Gold	116	1	0.86%	4.00	-
	Gold Nugget	117	0	0.00%	0.00	-
Nules	Afourer	106	42	39.62%	25.36	1-41
	Tahoe Gold	103	14	13.59%	1.50	1-4
Afourer	Nules	107	30	28.04%	9.47	1-24
	Fina Sodea	113	32	28.32%	12.00	5-17