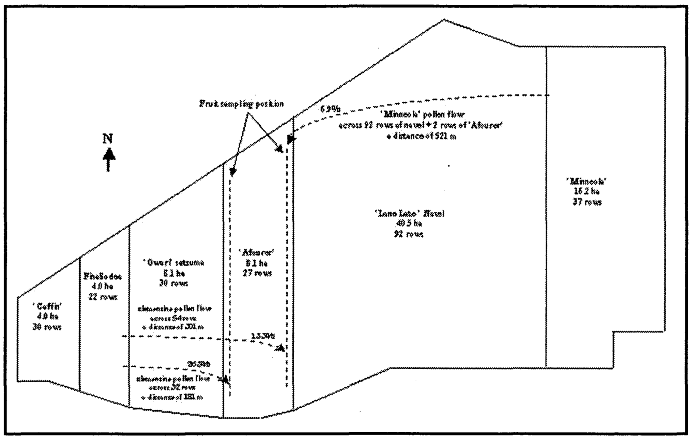

Figure 1: The name, size, and number of row in each cultivar block; fruit sampling position within the Afourer mandarin block (as shown by dash lines and indicated by arrows with solid lines); the pollen dispersal direction (as shown by arrows with dashed lines); percentage of the seedlings from outcrosses (showed on top of the arrows with dashed lines); and the distance of the Minneola tangelo or Clementine mandarin pollen transferred within an orchard near Madera. that was found in the pollen parentage study of Afourer mandarin seedlings.

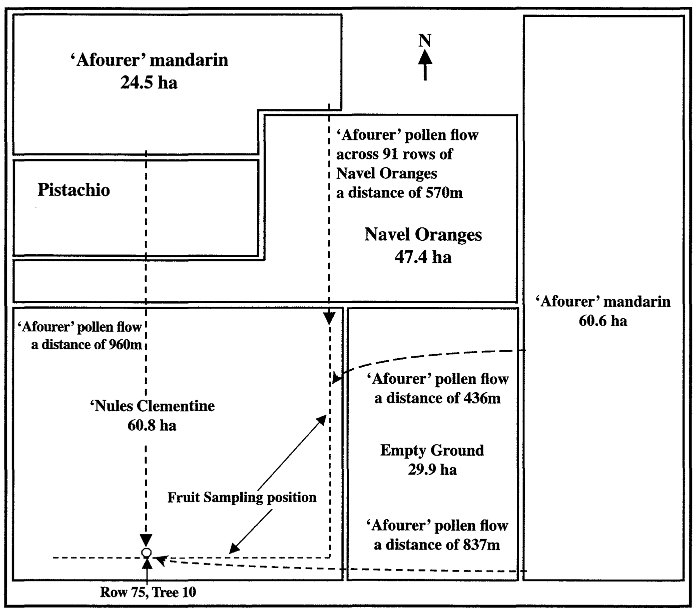

Figure 2: The name, size, and number of rows in each cultivar block; fruit sampling position within the Nules mandarin block (as shown by dash lines and indicated by arrows with solid lines); the Afourer mandarin pollen dispersal direction (as shown by arrows with dashed lines); percentage of the seedlings from outcrosses (showed on top of the arrows with dashed lines); and distance of the Afourer mandarins pollen transferred within an orchard near Bakersfield found in the pollen parentage study of Nules Clementine seedlings.

Metabolomic Analysis of Citrus

Pat Unkefer

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Metabolomics is the study of the entire metabolome within a system, allowing for a more comprehensive look at how that system functions and reacts. The overall objective of this project is to establish metabolomics as a useful tool to analyze the metabolic state of citrus (navel orange). This tool will be applied to characterize the effects of such agriculturally important factors as changes in field management practices such as nutrient regimes, growth regulator use, timing of harvest and postharvest efforts, etc.

The initial efforts are focused on establishing the methodology and defining the metabolic profiles of maturing oranges (harvested over a range of time points and thus degrees of maturation).

Los Alamos has, using its own funds or those from other federal sponsors, assembled a strong program in metabolomics. It has assembled a significant capability in mass spectrometry that will be needed and used. It will apply its expertise in stable isotope technology gained over its 30+-year history as the inventor and leader in this field.

Los Alamos has recently made a large investment for the next three years to advance metabolomics science and technology and will develop the tools necessary to fully utilize metabolomic profiles for application to practical problems such as those faced by citrus growers.

Using Regulated Deficit Irrigation to Optimize Fruit Size in Late Harvest Navels

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Land, Air and Water Resources, UC/Davis and Kearney Ag Center, Parlier

Grower profits with late harvest navels can be significantly reduced due to both excessively large fruit and granulation. We are evaluating regulated deficit irrigation (RDI) as a technique to produce optimal sized, high quality fruit with late harvest (Lane Late) navels.

There are four RDI regimes in addition to a fully irrigated Control (38.9 inches of applied water in 2004) in a commercial orchard in eastern Tulare County. Three of the RDI treatments (T1, T2, and T3) impose stress in the early, middle, and late periods of the season, respectively, and a fourth (T4) imposes stress continuously throughout the season.

Cumulative applied water in 2004 for T1, T2, and T3 ranged from 25 to 30 inches while T4 applied 18.3 inches; less than half of the fully irrigated Control. Severe stress occurred in T2, T3, and T4 late in the summer and early fall as evidenced by midday shaded leaf water potential, a measure of tree water status taken with the pressure chamber, that approached -35 bars.

In 2004, individual fruit fresh weight at harvest was reduced by 4, 13, 26, and 31% for T1-T4, respectively, relative to the Control (Table 1). There were no statistically significant differences in fruit load, although T1 and T3 had values 15 and 24% higher than the Control, respectively. There was little difference in percentages of Fancy, Choice, and Juice fruit between irrigation treatments.

With the exception of T1, fruit size distribution was greatly affected by the RDI, especially for T3 and T4 relative to the Control (Table 1). For example, medium size fruit (56+72 fruit/box) accounted for only 8.8% of the crop in the Control versus 41.6 and 49.5 in T3 and T4, respectively. Conversely, the Control had 50.3% very large size fruit (24+36 fruit/box) compared with 8.3 and 6.8% for T3 and T4. Fruit color in T3, and to a lesser extent T4, was visually better than the Control although not statistically so based on our laboratory analysis. On the other hand, T2 had a detrimental impact on fruit color.

As was the case in 2003 when the crop load was much higher than in 2004, granulation was lower than the Control for many of the RDI regimes across most fruit sizes (Table 1). For example, granulation for medium size fruit (56+72 fruit/box) was 22.4% for the Control compared with 13.9 and 6.0% for T1 and T4, respectively. Open core was dramatically reduced in T3 and T4 relative to the Control

Using market prices, we calculated gross revenue for each treatment including and excluding very large sizes (24+36), which may not be marketable (Table 1). For T3 (late season stress), revenue was higher by $1,300 to $3,000/acre relative to the Control when including and excluding large sizes, respectively.

The important findings of this project to date are: 1) granulation and open core have been significantly reduced using

Table 1. Yield and fruit quality in the 2004 (late April) harvest.

Irrigation Regime	Harvest Wt. (tons/acre)	Individual Fruit Wt. (gms)	Fruit Load (#/tree)	Harvest Fancy (%)	Harvest Choice (%)	Harvest Juice (%)	Small Size 138+163 88+113 (%)	Medium Size 56+72 (%)	Large Size 40+48 (%)	Extra Large Size 24+36 (%)
T1; early summer stress	15.1 c*	411 c	140	68.5	25.9 b	5.6	0.7 a	10.4 a	46.7 b	42.3 bc
T2; mid summer stress	11.4 ab	372 b	117	68.6	24.1 ab	7.4	2.3 a	24.8 b	41.7 b	31.2 b
T3; late summer-fall stress	12.6 abc	316 a	151	74.0	18.4 a	7.6	7.2 b	41.6 c	42.9 b	8.3 a
T4; continuous stress	9.8 a	294 a	127	64.3	28.4 b	7.3	12.7 c	49.5 c	31.1 a	6.8 a
T5; fully irrigation Control	13.8 bc	427 c	122	71.7	23.5 a	4.8	0.8 a	8.8 a	40.2 b	50.3 c
		NSD**	NSD		NSD					

Table 1. continued.

Irrigation Regime	Granulat.*** Average Sizes 56+72 (%)	Granulat.*** Large Sizes 40+48 (%)	Granulat.*** Extra Large 24+36 (%)	Gross Revenue All Fruit Sizes ($/acre)	Gross Revenue Excluding 24+36 ($/acre)
T1; early summer stress	13.9 b	13.8 ab	20.0 ab	5030	3020
T2; mid summer stress	8.0 ab	8.7 a	10.6 a	4260	3030
T3; late summer-fall stress	13.1 ab	16.6 b	24.6 b	5770	5340
T4; continuous stress	6.0 a	9.2 a	11.2 a	4590	4310
T5; fully irrigation Control	22.4 c	19.2 b	29.2 b	4430	2310

* Numbers in each column not followed by the same letter ar statistically different based on Fisher's Least Significant Difference Method at the 5% confidence level.

** NSD: no statistically significant differences.

*** Granulation based on Griffith Farms technique, which produces higher values than the more commonly used industry techniques.

RDI; and, 2) RDI can be used to both positively influence the fruit size distribution and harvest fruit color. To date, none of the RDI regimes have reduced fruit load. With the exception of T2, we have seen no negative impacts of RDI on fruit quality.

Midday stem water potential is measured by Jesus Salinas using a pressure chamber while Mario Salinas prepares to excise the next leaf to be monitored.

Project Concluded: Summary Report

Estimating Crop Coefficients for Mature and Immature Citrus

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Neil V. O'Connell
UC/Cooperative Extension, Tulare County

This project was a follow-up to funded projects by the CRB in 2001, the California Department of Water Resources in 2002, and the UC/Davis Department of Land, Air and Water Resources in 2003.

In 2004, the CRB again supported the project to: (1) Monitor ET_C (crop evapotranspiration) in young citrus orchards to determine K_C (crop coefficient) corrections for immature trees; (2) Relate the percent ground cover, light interception and leaf area index to the K_C corrections; and (3) Investigate instrumentation to measure orchard characteristics related to K_C values.

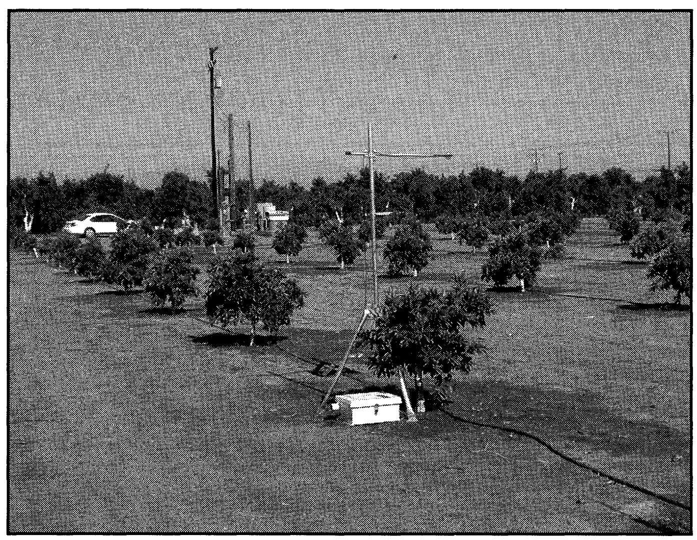
Half-hourly measurements of net radiation, heat flux into and out of the soil and heat flux to and from the air were measured, and ET_C was estimated as the residual of the energy balance equation. The less expensive surface renewal method was used to measure sensible heat flux, which allowed us to replicate measurement of ET_C over four orchards with a range of canopy size. Characteristics of the navel orange canopies used for the immature K_C research including plant spacing, tree age, tree height, ground cover (Cg), leaf area index (LAI), light interception (LI) measured with a PAR light bar and observed K_C values are shown below:

Site	Spacing ft x ft	Age yr	Height ft	Cg %	LAI $ft^2\ ft^{-2}$	LI %	K_c
1	16 x 20	2	3.3	2.4	0.5	10	0.45
2	16 x 20	4	7.5	20	1.4	32	0.57
3	18 x 20	15	14.8	47	2.5	50	0.77
4	19 x 20	37	14.8	70	3.4	85	0.93

Ground cover was estimated as the surface area directly under a representative tree divided by the area per tree represented by the tree spacing. The leaf area index (LAI) of each orchard was determined using a Licor, Inc. LI 2000 leaf area index sensor. Light interception (LI) was determined using a Licor photosynthetically active radiation (PAR) light bar.

Figure 1 shows the relationship between ground cover, PAR light interception and LAI with the crop coefficients observed using midday hourly ET_C and ET_O data. All of the parameters had good linear relationships with observed K_C values. However, ground cover showed the best linear trend, so using percentage ground cover to estimate the K_C for immature orchards is recommended.

Another goal of the project was to determine if the commonly used K_C corrections from the UN FAO 24 paper are still applicable for orchards irrigated with microsprinklers. A comparison with K_C values observed in these trials is shown in Figure 2. While the correction factors were similar, the observed K_C correction values were more linearly related to ground cover, which simplifies the process to correct for immature orchards. It is believed that the difference between the two correction curves is due to the use of higher-frequency irrigation with microsprinklers in these experiments, whereas the FAO 24 correction factors were based on infrequent surface irrigation.



Photograph of the surface renewal station to measure ET_C of the 3.4% ground cover orchard. The upper sensor is a net radiometer, and the lower arm has thermocouples extending out from the end of the arm.