Project Concluding: Summary Report

New Field Uses for Four Commercial PGRs

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The goal of this research is to determine the commercial value (cost/benefit) of four PGRs – CPPU, AVG, Prohexadione-Ca and 3,5,6TPA – to solve citrus production problems.

The research objectives are to determine the optimal concentration and time of application of: (1) CPPU to increase fruit set, fruit size, stimulate summer vegetative shoot growth during an on-crop year, increase total soluble solids and solids to acid ratio, and reduce peel senescence of the navel orange; (2) AVG to reduce early drop or June drop, increase yield and reduce crease of the navel orange; (3) prohexadione-Ca to reduce growth of vegetative shoots after pruning of the navel orange and especially for lemons; and (4) 3,5,6-TPA to increase fruit size of the navel orange.

Based on the results obtained in year 1, several new treatments were added in year 2 to improve the efficacy of the PGRs tested. These included: 3,5,6-TPA at 15 and 20 ppm applied at 24 mm fruit diameter and 3,5,6-TPA at 15 and 20 ppm applied at maximum peel thickness. This fall we also added AVG (40 and 80 mg/L) treatments designed specifically to prevent preharvest drop to compare with GA_3 (20 g/acre) alone or with 2,4-D (30.3 g/acre).

Our harvests last year for this project were after the lay reports were due so I have included yield data from year 1 and physiological data from both years in this report for comparison. Harvest for year 2 will not occur until January to March 2006 for the various orchards in this experiment.

For the navel orange, foliar application of AVG (20 mg/L) at 10% anthesis plus at maximum peel thickness in July significantly increased the kg and number of fruit per tree of packing carton size > 56 compared to untreated control trees ($P = 0.0625$) (Table 1). This treatment also significantly increased the number of fruit per tree of packing carton size > 56 compared to the untreated control (data not presented). Fruit size peaked on packing carton size 56, thus, it is noteworthy that this treatment could significantly increase the yield of larger fruit without negatively impacting the pack out of fruit in other size categories and total yield. Although not statistically significant, this treatment had the highest total yield (kg per tree).

Use of AVG (20mg/L) at petal fall reduced the kg and number of fruit of packing carton size 72 per tree compared to the untreated control. The reduction was not compensated by an increased number of larger size fruit and was sufficient to result in significantly lower pack out of the combined pool of commercially valuable fruit of packing carton sizes 88+72+56+>56.

We harvested in March in order to be able to evaluate the effect of AVG on crease. However, there was no crease. Surprisingly, despite being applied early in the season, several of the AVG treatments significantly reduced preharvest drop of navel orange fruit (Table 2). Note the smaller number is better. AVG (20 mg/L) applied at petal fall or June drop and AVG (40 mg/L) applied at June drop reduced the total number of fruit that dropped compared to the control. AVG (20 mg/L) applied at petal fall or at June drop significantly reduced the number of fruit of packing carton sizes 88 and 113 that dropped. AVG (40 mg/L) applied at June drop reduced only the drop of 88's (number per tree). It is interesting that AVG (20 mg/L) at 10% petal fall and at maximum peel thickness, which is twice as much material and the latest application time only reduced the drop of 113's (number per tree) and had no effect on reducing total drop.

The net difference between the best AVG treatment and the control with regard to total preharvest fruit drop was 15 fruit per tree. At 100 trees per acre, this would provide a net increase of 1,500 fruit per acre. In Year 2, only early AVG applications (10% anthesis or full bloom) at 80 mg/L reduced preharvest fruit drop.

In year 2, analysis of fruit collected in November provided clear evidence that there were no negative effects on fruit quality due to the foliar application of AVG (20 mg/L) at 10% anthesis plus maximum peel thickness in July (Table 3). Fruit from trees receiving this treatment had transverse diameters, peel thickness, fruit weight, juice weight, juice volume, total soluble solids (brix), percent acidity and brix to acid ratios that were not significantly different from the untreated control. This treatment has potential for increasing fruit size while maintaining yield and without negatively affecting any fruit quality parameter and should, thus, be investigated further. Fruit quality will be analyzed again at harvest in January 2006.

In a new experiment established this fall, AVG (40 or 80 mg/L) was applied just prior to color break (October). The AVG treatments had no negative effect on fruit weight, juice weight, juice volume, percent acid or brix to acid ratio compared to the untreated control (Table 4). Fruit from trees treated with GA_3 + 2,4-D and GA_3 had greater juice weight and juice volume than the untreated control. Fruit from trees treated with 40 mg/L AVG in October had a juice weight and juice volume equal to that of GA_3 + 2,4-D treated fruit and GA_3-treated fruit.

Preharvest fruit drop was excessive this year (year 2) in this orchard with untreated control trees dropped 30 fruit per tree by 16 November and 11 more fruit per tree by 13 December. Trees treated with AVG (40 or 80 mg/L) GA_3 or GA_3 + 2,4-D in October had no fruit drop.

Phytotoxicity in the form of a minor number of yellow spots per leaf on 20% to 30% of the canopy was observed on all trees treated with CPPU. The effect disappeared by early July. All CPPU treatments except CPPU applied at 8 g ai per acre at maximum peel thickness significantly reduced total yield in kg per tree and the yield of fruit of packing carton sizes 56, 72, and 88, but had no effect on the kg of fruit greater than packing carton size 56 (Table 3). Trees receiving CPPU at 8 or 10 g ai per acre at 10% anthesis or at petal fall produced less fruit (kg per tree) of packing carton sizes 113 and <113 (Table 5).

In year 2, the quality of fruit treated with CPPU was evaluated in late November. CPPU had no effect on fruit diameter, peel thickness, fruit weight, juice weight, juice volume, percent acid or brix to acid ratio (Table 6). All CPPU treatments significantly reduced preharvest fruit drop compared to the untreated control, with the exception CPPU at 8 g ai per acre applied at maximum peel thickness (Table 7).

The 3,5,6-TPA treatments had no significant effect on total yield (kg per tree) or the yield of fruit of any size category with the one exception that 3,5,6-TPA (10 ppm) at maximum peel thickness significantly reduced the kg of fruit of packing carton size 113 compared to the control (Table 5). No phytotoxicity was observed with the use of 3,5,6-TPA.

In year 2, the quality of fruit treated with 3,5,6-TPA was evaluated in late November. No treatment affected fruit diameter or peel thickness. Fruit from trees treated with 3,5,6-TPA (20 ppm) when 24 mm in diameter (23 May 2005) were significantly greater in weight ($P = 0.0618$) and had a greater juice weight ($P = 0.0434$) and juice volume ($P = 0.0511$) than the untreated control (Table 6). No 3,5,6-TPA treatment affected total soluble solids (ºbrix), percent acid or brix to acid ratio. Application of 3,5,6-TPA at 10, 15 and 20 ppm when fruit were 24 mm in diameter significantly reduced preharvest fruit drop through 16 November and 3,5,6-TPA at 15 and 20 ppm applied when fruit were 244 mm in diameter continued to significantly reduce preharvest fruit drop through 13 December compared to the untreated control (Table 7).

In year 1, prohexadione-Ca was successful in reducing total shoot growth in response to pruning for both navel and lemon trees. The mechanism by which prohexadione-Ca reduced total shoot growth was different for navel and lemon. Prohexadione-Ca reduced shoot elongation of lemons but did not decrease the number of new shoots that formed on pruned branches, only their growth rate and length. In contrast, for navels, prohexadione-Ca reduced the number of new shoots produced by pruned branches. Thus, the reduction in total shoot growth (average number of new shoots by shoot length at each sampling date) was greater for navel orange trees treated with prohexadione-Ca than lemons.

For both navel and lemon trees, total shoot growth was reduced to a greater degree as the concentration of prohexadione-Ca applied increased. The difference in total shoot production was still significantly different in July, but not thereafter. Prohexadione-Ca had no negative effects on the yield of navel orange or lemon with regard to total yield or fruit size distribution (packout) in kg per tree (Tables 8 and 9, respectively).

In year 2, the navel and lemon trees were pruned in late spring (May) with prohexadione-Ca applied when new growth reached 1.25 to 2.5 cm. In contrast to year 1, prohexadione-Ca had no significant effect on shoot growth of navel orange. From 6 June to 8 November, total shoot growth ranged from 8.5 to 10.5 cm. For lemons, in year 2, prohexadione-Ca (1000 ppm) significantly reduced shoot growth rate for 1 month through 22 June by 40%. As observed last year, the inhibitory effect of prohexadione-Ca on shoot growth increased with increasing concentration. Shoot growth remained slow from 5 July to 8 November with total shoot growth only 5.7 to 6.9 cm after prohexadione-Ca application.

The overall efficacy and potential benefit of the four PGRs to the California citrus industry must await the results of this year's harvests, which will occur between January and March 2006.

Contact Citrus Research Board for tables.