USE OF RALEX® (GIBBERELLIN) FOR DELAY OF FRUIT MATURITY, IMPROVED DRY RATIO AND LARGER FRUIT SIZE OF 'FRENCH' PRUNE

Stephen Southwick, Renae Moran, James Yeager, Kitren Glozer and Al Bonin

ABSTRACT

Ralex increased firmness of prunes when applied at 24 or 48 g/A in 1996-1999. Best application dates for increasing firmness corresponded with a fruit soluble solids content (SS) of 12-14% in 1996-1998, but with 15% in 1999 when crop load was heavy. With lighter crop load, the delay in harvest may likely be longer. In 1999, compared to untreated fruit, firmness was increased by 0.8 lbs with 48 g/A Ralex at 15% soluble solids. Other treatments tended to increase firmness, but it was not statistically significant. In 1999, harvest was extended three days by four Ralex treatments which were: 24 g/A Ralex at 11% or 13% soluble solids or with 48 g/A Ralex at 13% or 15% soluble solids. The delayed harvest did not result in an increase in fruit drop, nor did it affect fruit size or yield.

PROBLEM AND ITS SIGNIFICANCE:

GA preharvest application to stone fruit tends to delay maturity while increasing firmness, quality, size and yield. The effect of GA differs with species, application timing and rate. In general, it appears that for fruit crops, GA tends to delay fruit maturity, while increasing firmness, quality, size and yield (Southwick and Yeager, 1991 and 1995; Southwick et al., 1995a and 1995b; Southwick and Fritts, 1995). In 'Italian' prunes GA has been shown to increase firmness and delay maturity, resulting in reduced internal browning and watery pit and overall improvement in fruit quality (Proebsting and Mills, 1966). In Australia, Gallop® (GA) is applied at 14% soluble solids (SS) to 'French' prune, grapes and citrus to increase fruit size and delay maturity (Nufarm Limited, 1996). The ability to delay maturity in prunes could be very beneficial in allowing growers and packers to extend the harvest period to more effectively utilize limited dryer space, harvest equipment and work crews. These benefits of GA are already being seen in the cherry industry where growers can selectively delay a portion of their crop to coincide with market demand, packing house schedules and labor availability, while also increasing fruit size and firmness. Similar benefits might also be realized by prune growers if effective guidelines for use of GA on prunes could be established.

Research in previous years has demonstrated that Ralex (GA_3, Abbott Laboratories) consistently increased firmness when applied at 12-14% SS. During 1996 we performed a preliminary study in which we found that application of Ralex at 24 and 48 g/A appeared to increase dry yields, fruit size and average firmness compared to the unsprayed controls. An overall increase in fruit firmness for the 1996 treatments suggested that Ralex may delay maturity. No unusual level of fruit drop or other problems were observed from the time of application to harvest. Applications of Ralex at both 24 and 48 g/A made in 1997 resulted in firmer fruit compared with the

untreated controls. When we applied Ralex in 1998 at 24 and 48 g/A we found that 24 g/A (applied on July 28 at 11.5% SS and 11 lb pressure and applied on August 10 at 14% SS and 9.7 lb pressure) increased firmness in the harvested fruit compared to other Ralex-treated fruit or the untreated control. Soluble solids were unchanged by Ralex, except for some short term fluctuations that were not found at harvest. Fresh and dry yields/tree, fruit size (count/lb), and drying ratio were not changed by treatment. However, in previous trials, fruit from all treatments were harvested at one time, rather than at a consistent fruit firmness maturity index. The consistent increases in fruit firmness found when Ralex was applied between 12% and 14% SS at both 24 and 48 g/A in both 1997 and 1998 strongly suggest that Ralex delays 'French' prune maturity.

A maturity delay may increase fruit size, quality and yield, and may reduce the number of undersized fruit. Although Ralex did not result in an increased fruit size or yield in 1997 or 1998, there is potential to achieve both when fruit are allowed to 'hang' longer, and thereby, achieve greater size and yield. It is not known how a delay in maturity or harvest will affect prune yield or fruit size.

A single 24 g/A treatment (July 28) and five 48 g/A treatments (June 30-28 July) in 1997 delayed bloom in 1998. Effects on bloom date, return bloom and fruit set should be examined in the same trees in the subsequent year to identify potential carry over effects.

OBJECTIVES

1. To investigate the carryover effects of GA_3 (Ralex) on bloom date, return bloom and fruit set.
2. To determine if Ralex can be used to extend prune harvest without excessive fruit drop or negative effects on fruit quality. Prunes will be harvested using flesh firmness as an maturity indicator.
3. To determine the effects of Ralex on firmness, fruit size, SS, yield and fruit drop in 'French' prune.
4. To establish recommendations for effective application rates and dates based on fruit maturity (firmness and soluble solids) for the purpose of spreading out harvest over a longer time period to better utilize limited dryer space.

PLANS AND PROCEDURES

Return Bloom and Fruit Set in 1999 from 1998 treatments. In 1998 Ralex was applied by mistblower at 24 and 48 g a.i./A in a volume of 200 gal/A at a site in Winters, CA (the Garcia Ranch) on seven year-old 'French' prune trees on Marianna 2624 rootstock. The orchard was planted at 21' between rows, 18' between trees (115 trees/acre) and drip-irrigated. Trees had a heavy crop in 1998. Ralex was applied at three treatment timings (Table 1; timed by SS of approximately 11.5, 14, and 16%), based on best firmness results found at harvest in 1997. Soluble solids of 11.5% occurred July 28, 14% on August 10 and 16% on August 18, 1998. Two rates of Ralex were applied on each date in a complete randomized block design. A total of seven treatments, including an untreated control, were applied to single trees with five

replications of each treatment. The trees were harvested September 10. On March 31, 1999, two limbs per tree were tagged, at which time the total number of flower buds along a 100 cm length of shoot were counted. The average number of flowers per cm shoot length (bloom density) was calculated, to determine whether the actual population of flower buds was decreased, increased, or unaffected by treatment. The percentage of open flowers on each tree was estimated among treatments on March 29, March 31 and April 5 to determine whether bloom was advanced or delayed compared to the untreated control. On May 4, fruit set was determined (prior to preharvest fruit drop) by counting number of fruits along the same 100 cm shoot length on each tagged shoot.

Experimental design and treatments, 1999. The same treatments tested in 1998 (see Table 1) were applied in 1999. Trees were 'French Prune' on Mariana 2624 rootstock planted in 1991 at a spacing of 17' X 14'. In 1999, Ralex was applied with an Air-O-Fan speed sprayer at 24 and 48 g a.i./A in a volume of 200 gal/A, at Wolfskill Experimental Orchards in Winters. Both rates were applied on one of three application dates based on fruit soluble solids (Table 2). These dates were July 1 (11% SS), July 22 (13 % SS) and August 5 (15% SS). The use of the UC Davis orchard allowed an extended harvest that has not previously been possible using commercial orchards. A total of seven treatments, including an untreated control, were applied to single-row plots that had 17 trees in each row. Each treatment was replicated four times, with each rate of Ralex applied on each date in a complete randomized block design.

Fruit drop was counted August 27, August 31 and September 3 on three trees of each treatment within each replication. Following each count, fruit under each tree was removed with a rake. Fruit firmness, size and SS were measured August 23, August 30, and September 2. On these dates, a random sample of 20 fruit was collected from all exposures of each tree. Fruit firmness was measured on every fruit and soluble solids and fruit weight on a composite of the 20 fruit sample. Two trees in each replication were sampled for fruit quality. On six trees per replication, fresh yield was taken at harvest and dryer samples collected to estimate dry count/lb, drying ratio and dry yield. Harvest date was determined by fruit firmness. Treatments with mean fruit firmness below 3.3 lbs on Aug. 30 were harvested Aug. 31, and treatments with mean fruit firmness below 3.3 lbs on Sept. 2 were harvested Sept. 3. Fruit firmness was measured on 20 fruit per tree. Control trees, 24 g/A Ralex at 15% SS and 48 g/A Ralex at 11% SS were harvested August 31. The other Ralex treatments were harvested September 3.

Analyses. Analysis of variance and mean comparison tests were used to compare treatments for effects on return bloom, fruit set, fruit yield, maturity (SS and firmness), size and cumulative drop. Fruit set was transformed (standard statistical practice for percentage data) by arcsine square root transformation and then evaluated by Duncan's multiple range test.

RESULTS

Garcia Ranch, Ralex in 1998 on Bloom and Fruit Set in 1999. Bloom delay was based on the number of open flowers at three dates during the bloom period. Bloom was delayed by 24 g /A Ralex at 16% SS on all dates of bloom measurement (Table 1). Bloom was not delayed when 24 g/A Ralex at 11.5% SS was applied. When 24 g/A Ralex at 14% SS was applied, bloom was delayed only on April 5. Bloom was delayed by 48 g/A Ralex (Table 2). All three application

dates resulted in delayed bloom on March 29 and April 5, but only the later application date (16% SS) delayed bloom on March 31. The two treatments that caused the least bloom delay also caused the greatest increase in firmness in the previous season.

None of the treatments reduced return bloom compared to the untreated control (Table 1). 24 g/A Ralex at 11.5 % SS had greater bloom density than 24 g/A Ralex at 14% SS, or 48 g Ralex at 11.5% SS. Fruit density was not affected by any of the treatments. Fruit set was higher in the untreated control compared with 24 g/A Ralex at 11.5% SS, but all other treatments were equal to both the control and 24g/A Ralex at 11.5% SS. We believe conditions at bloom may have affected fruit set.

WEO, Ralex in 1999 on Fruit Maturity. On Aug. 23, there was no difference in fruit firmness between the Ralex treatments and control (Table 3). By Aug. 30, however, 48g/A of Ralex at 15% SS increased firmness. On Aug. 30, other Ralex treatments tended to have greater fruit firmness than untreated fruit, but it was not statistically significant. Harvest date, determined by firmness, was delayed three days by 24 g/A Ralex at 11% or 13% and by 48 g/A Ralex at 13% or 15%. Treatmenst harvested first were the control, 24 g/A Ralex at 15% SS and 48 g/A Ralex at 13% or 15% SS. Soluble solids content on Aug. 23 was reduced by 48g/A Ralex at 13% or 15% SS. This reduction in SS did not persist until Aug 30 or Sept. 2. Ralex did not significantly affect fruit weight at any of the measurement dates.

None of the Ralex treatments resulted in increased fruit drop or loss in fresh yield (Table 4). Although harvest was delayed for some of the treatments, there was no greater fruit drop or yield loss. Both fresh and dry yield were similar for all treatments. Dry away was greater for 24 g/A Ralex at 13% SS than for 48 g/A Ralex at 11% SS. Dry away did not differ between the Ralex treatments and control. Fruit count per pound did not differ between any of the treatments. The use of Ralex allowed the harvest to be delayed without an increase in fruit drop.

CONCLUSIONS

Ralex 24 g/A applied at 11.5% SS in 1998 did not delay bloom in 1999, but at 14% SS, bloom tended to be delayed. Ralex 24 g/A at 16% SS and Ralex 48 g/A at 11.5%, 14% or 16% SS in 1998 delayed bloom in 1999.

Ralex increased firmness and delayed harvest by three days without increasing fruit drop. Ralex did not affect fruit yield or size. Soluble solids appeared to be a better indicator of when to apply Ralex than flesh firmness, which varied from 8 lbs in 1999 to 17 lbs in 1997 at the optimum application date. The higher rate of Ralex, 48g/A, did not significantly increase firmness over the lower rate, 24 g/A when applied at 11-14% soluble solids. With a heavy crop load, fruit maturity is delayed, and this may have influened the effectiveness of Ralex in 1999. When applied at 15% or higher soluble solids, the 48 g/A tended to be more effective for increasing firmness than 24 g/A.

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Table 1. GA (Ralex®) in 1998 on 'French' prune bloom date, return bloom and fruit set in 1999, at the Garcia Ranch in Winters.

Ralex (a.i./A)	Soluble solids (%) at application	% open bloom			Flowers / cm shoot length	Fruit / cm shoot length	Fruit set (%)
		Mar. 29	Mar. 31	Apr. 5			
24 g	11.5	12ab	20ab	91ab	0.92a	0.15	16b
24 g	14	9ab	11ab	88b	0.62b	0.13	22ab
24 g	16	7b	10b	89b	0.72ab	0.20	28ab
48 g	11.5	7b	13ab	87b	0.60b	0.20	28ab
48 g	14	6b	11ab	88b	0.63ab	0.18	30ab
48 g	16	4b	8b	86b	0.74ab	0.24	32ab
Control	—	27a	32a	94a	0.68ab	0.30	43a
						ns	

Application dates in 1998 were July 28 (11.5% soluble solids) August 10 (14% soluble solids) and August 18 (16% soluble solids). Means followed by the same letter are not significantly different. 'Ns' is not significant

Table 2. Application dates in 1999 of GA (Ralex®) on 'French' prune and corresponding fruit soluble solids and firmness (averages), at the Wolfskill Experiment Station.

Ralex (a.i / A)	Date applied in 1999	Soluble solids (%) at treatment	Firmness (lbs) at treatment
24 g	July 1	11	17.2
24 g	July 22	13	12.4
24 g	August 5	15	8.0
48 g	July 1	11	17.2
48 g	July 22	13	12.4
48 g	August 5	15	8.0
Control (untreated)			

Table 3. The effect of GA (Ralex®) rate and application date on 'French' prune fruit fresh weight, soluble solids (SS) and firmness measured at two dates in 1999. The study was conducted at the Wolfskill Experiment Station.

Ralex (a.i. / A)	SS at application*	Firmness (lbs)			Soluble solids (%)			Fruit fresh weight (g)		
		8/23	8/30	9/2	8/23	8/30	9/2	8/23	8/30	9/2
24 g	11	4.5	3.4ab	2.8	18.0ab	21.0	19.9	19.6	19.0	17.6
24 g	13	4.5	3.3ab	2.8	19.0ab	22.0	22.3	21.0	18.5	18.0
24 g	15	4.4	3.1ab		18.7ab	23.0		20.3	19.2	
48 g	11	4.5	3.2ab		18.1ab	21.4		21.3	20.2	
48 g	13	4.3	3.3ab	2.9	17.3b	21.6	21.1	20.2	18.9	18.5
48 g	15	4.4	3.7a	3.1	17.6b	21.0	20.8	20.2	19.3	19.0
Control	---	4.4	2.9b		19.8a	23.5		22.1	20.8	
		ns		ns		ns	ns	ns	ns	ns

Mean separation within columns was by Tukey's Studentized Range Test, 5% level of significance. Means followed by the same letter are not significantly different. 'Ns' is not significant.

*Ralex was applied at 11% (July 1), 13% (July 22) and 15% (August 5) soluble solids.

Table 4. The effect of GA (Ralex®) rate and application date on 'French' prune fruit yield and fruit drop. The study was conducted at the Wolfskill Experiment Station in 1999.

Ralex (a.i. / A)	SS at application*	Fruit drop (no. per tree)	Fresh yield (lbs. per tree)	Dry yield (lbs. per tree)	Dry away	Count per pound
24 g	11	83	266	89	2.98 ab	83
24 g	13	65	263	95	2.78 b	70
24 g	15	57	249	83	2.99 ab	80
48 g	11	65	286	94	3.06 a	79
48 g	13	77	256	92	2.80 ab	78
48 g	15	89	270	96	2.83 ab	76
Control	---	97	252	87	2.87 ab	71
		ns	ns	ns		Ns

Mean separation within columns was by Tukey's Studentized Range Test, 5% level of significance. Means followed by the same letter are not significantly different. 'Ns' is not significant.

Fruit drop was counted on Aug. 27, Aug. 31 and Sept. 3. Fruit drop is the sum of these three dates.

*SS is soluble solids. Ralex was applied at 11% (July 1), 13% (July 22) and 15% SS (August 5).