Control of Shoot Growth in 'French' Prune by Apogee in 2002

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Summary:

For our experiments in 2002 we used very vigorous'French' prune trees growing on marianna 2624 rootstock that had been planted in 1991. We applied Apogee as single treatments of 125 and 250 mg·L^{-1} (ppm) on April 8, 11 days after full bloom (average current season shoot length ~4 inches) , and on April 22 at 100 gallons per acre spray volume. We also made a split application of 125 mg·L^{-1} + 125 mg·L^{-1} on April 11 and April 22. Growth was reduced within 7 days after the April 8, 250 mg·L^{-1} Apogee treatment. The April 8 Apogee treatment at the higher concentration (250 ppm), gave the best response with 29% reduction in shoot growth through the season, compared to the control. The 125 + 125 mg·L^{-1} split application was also very effective (23% reduction). All Apogee treatments reduced shoot growth, except the 125 mg·L^{-1} application on April 8, which was statistically equal to the control. Yields were improved by the April 8 treatments of Apogee (125, 250 mg·L^{-1}), and although the other Apogee treatments were statistically equivalent to the control, the untreated trees grew significantly more than did any Apogee-treated tree; 2002 was a fairly vigor-producing year. Count per lb was the highest (smaller prunes, 42-45 prunes per lb) with 250 mg·L^{-1} applied April 22. Fresh weight per fruit was greater in the late Apogee (250) treatment; drying ratios and dry weight per fruit were more or less equivalent among treatments, although the largest dry fruit were found with April 22, 250 ppm Apogee treatment. Results were consistent with very preliminary trials conducted in 2000 and 2001.

Problem and its significance:

Shoot growth of prune trees can be highly variable and sometimes excessive in prune orchards throughout California. To remedy excessive shoot growth, pruning is often necessary, but pruning is one of the highest costs in prune production. Apogee™, a shoot growth inhibitor (prohexadione calcium; BASF Corp., Research Triangle Park, NC), reduces shoot growth of apples, pears, and sweet cherry. Apogee works as a gibberellin biosynthesis inhibitor. Apogee sprays have been reported to reduce secondary growth by as much as 50% in apples (Yoder et al., 1995); shoot growth reduction appears to be concentration- and species-dependent. Apogee may have a relatively short active period in the plant after application (BASF estimates approximately 10 to 14 days with repeat applications at 3 to 5 weekly intervals), therefore timing of application and the possibility that a repeated treatment would be efficacious was investigated. Our preliminary work with back pack mist blower sprayers indicated that Apogee may have promise for shoot growth reduction in 'French' prune. Consequently, our more extensive 2002 orchard sprayer trials were initiated.

Materials and methods

Experimental location and plant material, sample procedures and experimental design:

Experiments were conducted at UC Davis' Wolfskill Experimental Orchard (Masson addition) in Winters, CA. We used a complete randomized design of four replicates with four-tree plots x six treatments and treated trees blocked by treatment along three rows per replicate. Treated trees were fully guarded against spray drift. 'French' prune trees were planted in 1991 on M2624 rootstock. Application of Apogee™ (prohexadione calcium, BASF Corp., Research Triangle Park, North Carolina), was at 100 gallons per acre (936 L·ha$^{-1)}$ using a speed sprayer; 0.1% Regulaid was added as an adjuvant. Ten shoots per tree, from approximately 1 m above ground

level to approximately 2.5 m above ground on all sides of the tree, were tagged on April 8, prior to treatment. On this date shoots averaged ~4 inches (10.2 cm) in length. Apogee was applied at a concentration of 250 $mg \cdot L^{-1}$ (840 $g \cdot ha^{-1}$) + 0.1% Regulaid or 125 $mg \cdot L^{-1}$, either as a single application on April 8 (11 days after full bloom), on April 22, or as a split application of 125 $mg \cdot L^{-1}$ Apogee on April 8 and 22. Fruits on this date measured approximately 1 cm cross-suture diameter and 1.5 cm in length, on average. Shoot growth was measured April 11, 17, and 22, May 6, May 31 and in October. Yield and fruit quality (count per lb, drying ratio, fresh and dry weight per fruit measurements were made at harvest, on August 23. Statistical Analysis Systems software (SAS Institute, Cary, NC) was used to perform the analysis of variance (PROC GLM). Mean separation was by Duncan's Multiple Range Test, 5% level of significance.

Results:

Total shoot growth was found to be reduced approximately 29% by the first treatment with 250 $mg \cdot L^{-1}$ Apogee, applied on April 8, by 23% by the split application of 125 $mg \cdot L^{-1}$ applied April 8 and April 22, and by statistically equivalent amounts in the other Apogee treatments, with the exception of the April 22 application of 250 $mg \cdot L^{-1}$ (Table 1, Figure 3). Unlike our results in 2000 and 2001, we found that at least one later treatment was not equivalent to the first Apogee treatment with respect to reducing shoot growth overall, and, unlike in 2001, we found that a split application did improve growth reduction over the growing season, when compared to a single application. While the first application of 125 $mg \cdot L^{-1}$ Apogee applied on April 8, did not reduce shoot growth, the second or split application of 125 $mg \cdot L^{-1}$ was very successful in growth reduction. It appeared that Apogee, when used on prune, stops shoot growth early in the season. In both 2001 and 2002, a large number of treated shoots set terminal buds within one month of treatment when Apogee was applied shortly after bloom.

Yields were improved by the first two applications of Apogee (125 and 250 $mg \cdot L^{-1}$, April 8); all other Apogee treatments were statistically equivalent to the untreated control and fresh yields were reduced compared to the first Apogee treatments; dry yields were equivalent to the first treatments in the 125 $mg \cdot L^{-1}$, April 22 treatment (Table 2). Dry count per pound was equal among the control, the Apogee treatments of April 8 and the 125 $mg \cdot L^{-1}$, April 22 treatment. Count per lb was reduced (fruit size was increased) in the 250 $mg \cdot L^{-1}$ Apogee application made on April 22. Fresh weight per fruit was somewhat reduced by Apogee applied at 250 $mg \cdot L^{-1}$ on April 8 and by 125 $mg \cdot L^{-1}$ on April 22, equal to that of the control (data not shown). Drying ratios were equal among treatments.

Summary Remarks:

Apogee has a federal registration and is labeled in California for use on apples (it is registered for pears, but not labeled as such). Data is rapidly being developed for pear and cherry. Apogee is normally applied with multiple sprays at either 125 or 250 $mg \cdot L^{-1}$ from 100 to 200 gallons per acre. Preliminary results with 'French' prune suggest Apogee may be an effective plant growth regulator for reducing shoot growth. Effective management of shoot growth may help to reduce costs of pruning, increase light penetration into tree canopies and improve fruit quality and/or yield. We will continue with this work in order to maximize the use of Apogee on 'French' prune trees growing in California.

Pertinent literature:

Costa, G., C. Andreotti, F. Bucchi, E. Sabatini, C. Bazzi, S. Malaguti and W. Rademacher. 2001. Prohexadione-Ca (Apogee®): Growth regulation and reduced fire blight incidence in pear. Hortscience 36:931-933.

Yoder, K.S., S.S. Miller and R.E. Byers. 1995. Suppression of fireblight shoot blight by prohexadione calcium under experimental and natural inoculation conditions. Proprietary publication, BASF.

Table 1. Control of shoot growth in 'French' prune by Apogee™ in 2002. Full bloom was on March 28.

Apogee (mg·L^{-1}; 100 gal/A); date of application; + 0.1% Regulaid	Shoot length (cm)					Incremental growth (cm) from measurement date to measurement date			
	April			May					
	11	17	22	6	31	April 11-17	April 17-22	April 22-May 6	May 6-31
250, April 8	14.8 c[x]	19.4 c	21.1 c	23.2 c	27.1 b	0.77 c	0.27 b	0.14 b	0.16 abc
125, April 8	17.1 ab	23.4 b	26.7 ab	31.6 ab	31.4 ab	1.06 b	0.52 a	0.35 a	0.10 bc
250, April 22	18.4 a	26.3 a	29.0 a	34.2 a	40.0 a	1.31 a	0.46 a	0.35 a	0.23 ab
125, April 22	16.1 a	22.2 b	25.4 b	30.2 ab	33.1 ab	1.01 b	0.52 a	0.32 a	0.11 bc
125 + 125 April 8 + April 22	16.4 bc	22.5 b	25.1 b	27.5 b	29.3 b	1.02 b	0.44 a	0.16 b	0.07 c
Control	15.8 bc	22.9 b	25.9 b	31.7 ab	38.2 a	1.18 ab	0.48 a	0.39 a	0.25 a

[x] Means separation within columns by Duncan's MRT, $P = 0.5\%$.

Table 2. Effect of Apogee™ on yield and fruit quality in 'French' prune Full bloom was on March 28.

Apogee ($mg \cdot L^{-1}$; 100 gal/A); date of application; + 0.1% Regulaid	Fresh yield/tree (lb)	Dry yield/tree (lb)	Count/lb (dry)	Drying ratio
250, April 8	168.4 ab [x]	72.8 a	45.1 a	2.42
125, April 8	184.1 a	73.4 a	42.7 ab	2.50
250, April 22	150.6 bc	57.3 b	39.2 c	2.80
125, April 22	148.4 bc	60.3 ab	43.8 ab	2.48
125 + 125 April 8 + April 22	141.6 bc	55.2 b	40.8 bc	2.53
Control	122.4 c	50.6 b	42.2 ab	2.43 ns

[x] Means separation within columns by Duncan's MRT, $P = 0.5\%$; ns = non-significantly different.