Evaluating Ethephon
as a tool to manipulate breba crop load (2006-2007)

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INTRODUCTION

Production and harvest costs have been increasing during the last decade to the point that the business of growing fresh fruit is becoming less attractive to farmers. In other commodities, plant growth regulators (PGRs) are being used to maximize fruit yield and quality and minimize harvest cost. These compounds are being used to accelerate or make bloom more uniform; improve fruit set and size; thin fruit or flowers to improve size and quality; and make fruit maturation more uniform. Many of these PGRs have not been tested on fig.

In general, onset of fruit ripening is controlled in part by dormancy (onset of bud break), shoot growth and fruit development. Hormone balance and heat units control bud break and fruit ripening. It is well documented that fruit ripening is triggered and controlled by production of endogenous ethylene, and it can also be triggered by exogenous ethylene application when the tissue is receptive. We have observed that fig ripening is related to training system and light exposure. Understanding and controlling factors that trigger bud break and fig ripening will be the basis to control harvest date.

Ethephon, an ethylene-releasing chemical, was applied at two different moments: fall and spring. In the fall of 2006, applications of Ethephon (Ethrel) were directed toward affecting flower differentiation of the first crop (breba). In the spring of 2007, applications of Ethephon were directed toward dropping the brebas due to the fact that a harvest would not be economical.

FALL ETHEPHON TREATMENTS

A fig cultivar, 'Conadria', cultivated in Madera, was used for researching the effect of Ethephon on fig crop load cultivars. One hundred-twenty trees were selected and were subject to two variables, chemical concentration and time of application. Each combination of treatment, with respect to chemical concentration and time, had 8 replications, each one situated randomly in a different row. Four different concentrations were tested (0, 250, 500 and 1000 ppm Ethephon plus 0.05% surfactant (Triton, Latron B-1956)) and a control (untreated), and three different time applications. The treatments were applied in approximately ten day intervals starting on October 26 until there were no remaining leaves on the trees. Therefore the application dates were October 26, and November 3 and 14. The sprays were applied with a backpack sprayer (STIHL^{R} SR 420) such that each treatment was applied to the entire tree (~0.45 gallon solution/tree).

SPRING ETHEPHON TREATMENTS

A fig cultivar, 'Conadria', cultivated in Madera was used for researching the effect of Ethephon on fig cultivars. Eighty trees were selected and were subject to two variables, chemical concentration and time of application. Each combination of treatment, with respect to chemical concentration and time, had 8 replications, each one situated randomly in a different row. Four different concentrations were tested (0, 250, 500 and 1000 ppm Ethephon plus 0.05% surfactant (Triton, Latron B-1956)) and a control (untreated), and two different time applications. The sprays were applied at two different stages of leaf and breba development. The first stage, which will be referred to as "beginning development", occurred when brebas and leaves started to develop, while the second stage, which will be referred to as "intermediate development", occurred when leaves and brebas were partially developed. The application dates were March 16 ("beginning development") and March 23 ("intermediate development"). The sprays were applied with a backpack sprayer (STIHL^{R} SR 420) such that each treatment was applied to the entire tree (~0.45 gallon solution/tree).

DATA COLLECTION FOR FALL AND SPRING ETHEPHON

The following summer, on June 14, the breba were harvested at commercial maturity. The percentage of shoot bud break was measured after the breba harvest, on July 9.

At breba commercial maturity, the trees were harvested and the breba fruit were counted. The circumference of the trunk of each tree was measured at a distance of about 20cm above the ground. The results were expressed as the number of breba harvested per tree and the number of breba harvested per cross trunk unit area (cm^2). Five random fruit per treatment were used for weight and soluble solids concentration (SSC). The five fruit were weighed together with a digital scale (model PM 4000, Mettler Instrument Corp., Hightstown, NJ) and the weight was expressed as grams per fruit. Then, each fruit was cut in half longitudinally, and one half of each fruit was used for SSC. The half fruits

were wrapped together in two layers of cheesecloth and squeezed with a hand press to obtain a composite juice sample. The juice, with viscous consistency, was filtered through cheesecloth, in order to obtain a liquid sample, which was used for determination of SSC with a temperature compensated handheld refractometer (model ATC-1, Atago Co., Tokyo, Japan).

For the percentage of bud break, 4 branches, one in each quadrant of the tree at the middle height of the canopy, were randomly selected from each tree. The number of total nodes and the number of new shoots on each branch were counted, and the results were expressed as percentage of bud break. The number of figs per branch was also measured.

On July 24, at fig commercial maturity, the fig fruits of the treatments control and Ethephon 500 ppm plus 0.05% surfactant applied on March 16 or "beginning development" stage were harvested. The fig fruit were counted and expressed as the number of breba harvested per tree. Ten random fruit per treatment were used for weight and expressed as grams per fruit.

Commercial mature breba sprayed with Ethephon 1000 ppm and fig sprayed with Ethephon 500 ppm both applied on the second fall application (November 3), and commercial mature fig sprayed with Ethephon 500 ppm on March 16 or "beginning development" stage were analyzed for Ethephon residues by the method GLC of Ethephon and Fenoprop in apples by the company "Anresco laboratories", San Francisco, with a detection limit of 0.10 ppm.

Table 1. Influence of different concentrations of fall Ethephon (0, 250, 500 and 1000 ppm) plus 0.05% surfactant (Triton, Latron B-1956), and a control (untreated) at three different application times (October 26, and November 3 and 14) on 'Conadria' breba harvested on June 14, 2007.

Treatment	Trunk	Fruit per tree	Fruit per area trunk	Fruit weight	Fruit SSC
Control	58.6	23.3 a	0.081 a	38.2	18.9 ab
Surfactant	58.7	23.3 a	0.081 a	34.5	18.3 b
Ethephon 250	58.2	14.4 ab	0.053 ab	32.9	19.2 ab
Ethephon 500	59.5	11.8 b	0.039 b	32.3	20.3 a
Ethephon 1000	60.3	6.3 b	0.019 b	30.9	20.0 a
$LSD_{0.05}$	NS	11.22	0.037	NS	20.1
P-value	0.7871	0.0112	0.0036	0.1379	0.0492
Application					
First	59.2	14.9	0.050	31.8	19.5
Second	58.5	15.6	0.055	34.6	19.0
Third	59.4	17.2	0.059	35.2	19.5
$LSD_{0.05}$	NS	NS	NS	NS	NS
P-value	0.7872	0.8596	0.8058	0.3126	0.6117
Treat x Applic					
$LSD_{0.05}$	NS	NS	NS	NS	NS
P-value	0.7773	0.2262	0.1122	0.9648	0.7877

Table 2. Influence of different concentrations of spring Ethephon (0, 250, 500 and 1000 ppm) plus 0.05% surfactant (Triton, Latron B-1956), and a control (untreated) at two different application times (March 16 or "beginning development" stage and March 23 or "intermediate development" stage) on 'Conadria' breba harvested on June 14, 2007.

Treatment	Trunk	Fruit per tree	Fruit per area trunk	Fruit weight (g)	Fruit SSC (Brix)
Control	62.9	20.2 a	0.068 a	39.2	19.3 b
Surfactant	60.8	15.8 a	0.051 a	36.6	21.6 b
Ethephon 250	60.8	2.6 b	0.010 b	27.4	21.6 b
Ethephon 500	63.4	0.6 b	0.003 b	37.0	21.1 b
Ethephon 1000	61.2	0.2 b	0.0006 b	28.2	28.0 a
$LSD_{0.05}$	NS	6.97	0.02	NS	4.94
P-value	0.4455	<.0001	<.0001	0.1246	0.0439
Application					
First	61.063	6.775	0.024	37.9	20.8
Second	62.563	8.950	0.029	34.4	20.9
$LSD_{0.05}$	NS	NS	NS	NS	NS
P-value	0.2033	0.3284	0.4268	0.2369	0.8744
Treat x Applic					
$LSD_{0.05}$	NS	NS	NS	NS	NS
P-value	0.3177	0.8283	0.7533	0.6488	0.5669

Table 3. Influence of different concentrations of fall Ethephon (0, 250, 500 and 1000 ppm) plus 0.05% surfactant (Triton, Latron B-1956), and a control (untreated) at three different application times (October 26, and November 3 and 14) on 'Conadria' bud break measured on July 9, 2007.

Treatment	Nodes	Shoots	BudBreak	Figs
Control	9.0	1.8	23.9	4.7
Surfactant	8.4	1.8	23.4	4.9
Ethephon 250	9.9	2.0	21.9	4.9
Ethephon 500	10.3	2.1	23.9	5.0
Ethephon 1000	8.3	1.7	22.7	4.5
$LSD_{0.05}$	NS	NS	NS	NS
P-value	0.203	0.2962	0.9394	0.7003
Application				
First	8.8	1.8	23.2	4.6
Second	9.2	1.9	23.4	5.0
Third	9.5	1.9	22.9	4.8
$LSD_{0.05}$	NS	NS	NS	NS
P-value	0.5423	0.9047	0.9394	0.3507
Treat x Applic				
$LSD_{0.05}$	NS	NS	NS	NS
P-value	0.3581	0.8891	0.4325	0.8619

Table 4. Influence of different concentrations of spring Ethephon (0, 250, 500 and 1000 ppm) plus 0.05% surfactant (Triton, Latron B-1956), and a control (untreated) at two different application times (March 16 or "beginning development" stage and March 23 or "intermediate development" stage) on 'Conadria' bud break measured on July 9, 2007.

Treatment	Nodes	Shoots	BudBreak	Figs
Control	9.3	2.0	22.7	5.1
Surfactant	9.3	2.2	26.3	5.2
Ethephon 250	8.9	2.2	26.4	5.2
Ethephon 500	8.6	1.8	23.3	3.9
Ethephon 1000	9.8	2.3	25.4	4.9
$LSD_{0.05}$	NS	NS	NS	NS
P-value	0.7504	0.2552	0.4859	0.1119
Application				
First	9.6	2.0	23.3	5.1
Second	8.8	2.2	26.3	4.6
$LSD_{0.05}$	NS	NS	NS	NS
P-value	0.1701	0.2871	0.0657	0.1469
Treat x Applic				
$LSD_{0.05}$		NS	NS	
P-value	0.0009	0.6223	0.6893	0.0118

Table 5. Influence of spring Ethephon 500 ppm plus 0.05% surfactant (Triton, Latron B-1956) and a control (untreated) applied on March 16 or "beginning development" stage on 'Conadria' fig harvested on July 24, 2007.

Treatment	Fruit per tree	Fruit weight (g)
Control	3213.8	44.2
Ethephon 500	3786.3	41.9
$LSD_{0.05}$	NS	NS
P-value	0.1235	0.2833

Table 6. Residue analysis for commercial mature breba sprayed with Ethephon 1000 ppm and fig sprayed with Ethephon 500 ppm both applied on the second fall application (November 3), and commercial mature fig sprayed with spring Ethephon 500 ppm (March 16 or “beginning development” stage), with a detection limit of 0.10 ppm.

Spray	Ethephon	Harvest	Residus
Fall	1000 ppm	Breba	None detected
Fall	500 ppm	Fig	None detected
Spring	500 ppm	Fig	None detected

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