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Evaluation of (2-Chloroethyl)methylbis (phenylmethoxy)silane (CGA-15281) as a Chemical Fruit Abscising Agent for Olive Using Detached Shoots[1]

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Abstract. **CGA-15281 was tested using an *in vitro* laboratory system with fruit-bearing shoots of 'Manzanillo' olive (*Olea europeae* L.). Foliar sprays produced greater fruit abscission and lower leaf abscission than stem feeding. Maximal fruit abscission with the least leaf abscission occurred at a concentration of 600 ppm, 23 to 25°C, and pH 7.**

Hand-harvest accounts for up to 50% of the annual cost of California olive production. There is a consequent incentive to harvest mechanically to reduce costs, to increase harvest rate, and to avoid the unreliability of hand-harvest. Presently, 50–70% of the olive fruit can be removed by mechanical shaking, but 90% must be removed to make the practice economically sound and to insure return cropping the next year.

Olives are harvested for the California black ripe or Spanish style processes about 4 months before they are physiologically mature, and strong attachment forces must be overcome to separate the fruit from the tree. Removal of immature fruit is made easier with chemical fruit abscising agents (3, 6). Several fruit abscising chemicals have been tested (2, 3, 6). Cycloheximide has been used in the orange industry (1) but not in the olive industry (2) because of excessive leaf abscission. The successful use of a chemical fruit abscission agent in olives is restricted by the tendency to cause excessive leaf abscission. If olive leaf abscission exceeds 25%, flower bud formation does not occur for next year's crop (2). The search continues for an abscission agent which can facilitate fruit removal without excessive leaf abscission.

Evaluation of chemical abscising agents is slow and difficult because field testing can be conducted only once per year. To expedite the evaluation process under controlled and less expensive conditions, a system using detached shoots was developed for olive (5) which allows testing from July until February. Two chemicals, CGA-15281 and (2-chloroethyl)phosphonic acid (ethephon) were tested, and the effects of timing, concentration, application method, chemical additive, pH, and temperature on fruit and leaf abscission were compared.

Uniform 'Manzanillo' olive shoots with fruit were collected in the morning and carried to the laboratory where the stems were re-cut under water to prevent air blockage in the conducting system. Shoots were randomized among treatments and placed in 150-ml glass jars. Ethephon (Union Carbide) or CGA-15281 (Woolfolk Chemical Co.) were added to the container for stem uptake. The solution pH of CGA-15281 ranged from 4.82 at 100 ppm to 4.25 at 600 ppm, and ethephon pH ranged from 3.26 at 100 ppm to 2.61 at 600 ppm. Both CGA-15281 and ethephon decompose, releasing ethylene within hours of dilution with water; in all treatments these compounds were freshly prepared prior to treatment. The containers contained tap water when CGA-15281 and ethylene were sprayed on the leaves. Tap water was used for controls in most of the experiments. Buffer (citric acid—dibasic sodium phosphate) was used as control in the experiment on pH adjustment. Samples were transferred into tap water after a designated treatment period, usually 4 hr. Fruit and leaf abscission were determined every 24 hr after samples were transferred into tap water. Leaf and fruit removal were assisted by slight pressure from a single finger. Each experiment lasted 4–5 days and was repeated 3–4 times. Experiments were conducted from September through January, thus shoot systems with fruit were at various stages of maturity.

Table 1. Fruit and leaf abscission as affected by stem feeding of ethephon and CGA-15281[z].

Growth regulator (ppm)	Abscission (%)					
	Fruit			Leaf		
	Hours after trt			Hours after trt		
	24	72	144	24	72	144
CGA-15281						
200	0	0	29	0	0	11
400	0	14	44	0	0	16
600	10	17	84	0	0	29
Ethephon						
0	0	0	0	0	0	0
250	0	99	---	0	50	100
500	5	100	---	0	100	---

[z]Treatment time: 4 hr.

Table 2. Fruit and leaf abscission as affected by stem feeding and foliar sprays of CGA-15281.

CGA-15281 concn (ppm)	Abscission (%)[z]					
	Fruit			Leaf		
	Hours after trt			Hours after trt		
	24	72	120	24	72	120
Spray						
600	75	100	---	0	0	7
800	100	---	---	8	14	29
1200	100	---	---	3	10	32
2400	100	---	---	17	50	91
Stem feeding						
0	0	0	0	0	0	0
600	0	0	38	7	24	26
800	30	50	70	3	3	27
1200	71	85	100	0	4	33
2400	100	---	---	0	19	34

[z]Determined after indicated hours following treatment.

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Table 3. Fruit and leaf abscission as affected by 10% methanol in water-CGA-15281 stem-feeding solution.

CGA-15281 concn (ppm)	Abscission (%)[z] Fruit Hours after trt 34	72	120	Leaf Hours after trt 34	72	120
0[y]	0	0	0	0	0	0
100	32	44	60	0	0	15
200	44	68	92	0	0	25
400	57	87	100	0	3	14
600	60	88	100	0	0	39

[z]Determined after indicated hours following treatment.
[y]10% methanol in H_2O

Table 4. Fruit and leaf abscission as affected by CGA-15281, ethephon stem feeding, and temperature.

Temp. (°C)	Growth regulator (ppm)	Abscission (%)[z] Fruit Hours after trt 24	48	72	Leaf Hours after trt 24	48	72
35	*CGA-15281*						
	250	0	19	57	0	59	61
	500	0	40	70	0	64	72
	Ethephon						
	0	0	0	0	0	0	0
	250	27	100	---	0	81	91
	500	57	100	---	13	100	---
25	*CGA-15281*						
	250	0	9	73	0	1	37
	500	9	36	81	10	13	52
	Ethephon						
	0	0	0	0	0	0	0
	250	19	88	100	12	100	---
	500	62	100	--	32	100	---

[z]Determined after indicated hours following treatment.

Table 5. Fruit and leaf abscission as affected by CGA-15281 and ethephon stem feeding at pH 7.

Growth regulator (ppm)	Abscission (%)[z] Fruit Hours after trt 24	48	72	96	Leaf Hours after trt 24	48	72	96
CGA-15281								
250	0	36	70	100	0	5	14	23
500	7	40	70	100	0	6	12	21
Ethephon								
Buffer[y]	0	5	10	16	0	0	1	14
250	0	61	88	99	5	33	78	99
500	24	69	100	---	23	60	89	100

[z]Determined after indicated hours following treatment.
[y]Citric acid-dibasic sodium phosphate.

Except for the temperature experiment, all tests were conducted in the laboratory, where temperatures ranged from 23 to 25°C. The light was Cool White fluorescent. The experiment for testing higher temperature effects on the 2 abscission chemicals was conducted in a growth chamber containing Cool White fluorescent light.

CGA-15281 at 600 ppm resulted in 85% fruit abscission with 29% leaf abscission (Table 1). In these experiments there was an ethephon-treated and a nontreated control. Ethephon induced excessive leaf abscission whenever fruit abscission was rated satisfactory as in previous experiments.

CGA-15281 applied as a foliar spray induced fruit abscission sooner and more efficiently than by stem feeding (Table 2). In contrast, leaf abscission was similar by either application technique up to 1200 ppm. Complete fruit removal induced by CGA-15281 was possible without excessive leaf loss (Table 2).

The use of detached olive shoots with stem feeding has been particularly useful in evaluating olive fruit-loosening chemicals. Thus, it was important to know why greater fruit removal occurred when CGA-15281 was applied by spray than when stem fed. Aqueous CGA-15281 forms a suspension; addition of 10% methanol increased solubility resulting in greater uptake of CGA-15281 and effective loosening at lower concentrations (Table 3). Even at 200 ppm, CGA-15281 induced 92% fruit removal 120 hr after treatment. Equally important was that tripling the effective concentration of CGA-15281 led to only 39% leaf abscission (Table 3).

Ambient air temperature at treatment time can alter results with growth regulators such as ethephon (4, 7). Chemical action can be increased or decreased as temperature exceeds 30°C. At 35°, CGA-15281 was less effective for fruit removal and induced greater leaf abscission than treatments at 25° (Table 4). No discernible differences were apparent for ethephon at either temperature, apparently because the concentration was already inducing maximum abscission.

Field trials with ethephon at pH 7 have resulted in greater fruit removal with less defoliation (6). CGA-15281 and ethephon were compared at pH 7 via the stem-feeding system. Citric acid—dibasic sodium phosphate buffer was used to get pH 7. Fruit removal action of CGA-15281 was improved, but pH 7 did not alter the effectiveness of ethephon (Table 5). All olives were removed with 250 ppm CGA-15281, while leaf loss was held to 23% (Table 5).

Based on the detached shoot system, CGA-15281 appears to be superior to and safer than ethephon at high concentrations. These data agree with field comparisons where CGA-15281 treatment has led to fruit abscission with less leaf abscission than ethephon (6). In all of our detached shoot tests, CGA-15281 treatment resulted in less leaf abscission than ethephon. The safety margin provided by application of CGA-15281 at pH 7 to moderate ambient temperature may allow field application to olives with leaf abscission less than 25%.

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