

EFFECTS OF ADDITIVES
 IN PREHARVEST ETHEPHON
 APPLICATIONS ON THE
 DEGREENING AND
 LOOSENING
 RESPONSE
 OF
 CITRUS FRUIT

By
 OTTO L. JAHN
 Agricultural Research
 Science and Education Administration
 U. S. Dept. of Agriculture
 2120 Camden Road
 Orlando, FL 32803

Additional index words. surfactants,
 buffers, pH, urea, phosphates

Abstract. The addition of several phosphate buffers or urea tended to increase the effectiveness of ethephon in coloring and loosening citrus. Increased responses were equivalent to those caused by about 50 ppm higher ethephon rates. Buffers caused some increases in leaf losses. The addition of surfactants to ethephon increased fruit color and loosening in some tests. Responses varied among cultivars, with differences among surfactants.

Preharvest applications of ethephon (2 chloroethyl) phosphonic acid, cause degreening and loosening of tangerines and tangerine hybrids (4, 5). The addition of surfactants is not recommended, although studies on effectiveness are lacking. Triton X100 was used as a surfactant in earlier studies (4) without causing excessive defoliation. Recently, low ethephon concentrations were found effective

This paper reports the results of research only. Mention of a pesticide or proprietary product does not constitute a guarantee or warranty of the product by the U. S. Dept. of Agriculture, nor does it imply registration under FIFRA as amended.

WE LOVE A Challenge

At Aquaman, we don't shy away from difficult irrigation problems ... we love a challenge!

In fact, we can handle most any irrigation job in Florida; no matter what the size or terrain. We have an extensive topographical map and aerial photo library to assist our in-house irrigation design specialists. Plus we have the old-fashioned field experience it takes to tackle the toughest irrigation assignment you can dish out.

Whether your irrigation problems are large or small — Challenge us. Call for a free, no-obligation consultation.

aquaman, inc
 The irrigation specialists

P.O. Box 386 Waverly, Florida 33877
 Phone 813/439-2600



After hedging and topping this year, pulverize prunings with the Marwald KV-220 Flail Chopper. The heavy-duty 220 will easily shred all average size branches and with its offset capabilities, there is no need for windrowing.

The Marwald Flail Chopper is designed for quick, efficient pulverizing ... it will get you in and out of the grove fast

saving you time and money!

Call today for a free demo. See the KV220 in action. We have 220's ready for immediate delivery anywhere in Florida!

MW Marwald of Florida, Inc.

Specialized Agricultural Equipment
 Phone (813) 665-2309
 1716 S. Combee Rd., Lakeland, FL
 P.O. Box 1330, Eaton Park, FL 33840

46 YEARS
EXPERIENCE
& TECHNICAL TRAINING
... including laboratory ...

IDEAL FERTILIZER FOR CITRUS

Want to Deter YTD and
Sandhill Decline in
Your Groves?

Improve Grove Vigor
and Increase Pounds
Solids Per Box?

FERTILIZE ONCE
(OR TWICE) PER YEAR

FOR PASTURE

Want to Carry up to
Two Adult Cattle Per Acre on
Bahia Pastures even in Winter?

FOR TRUCK CROPS

Want to Produce 40,000-60,000
Pounds of Melons or
Tomatoes per acre?

CHECK WITH US!

*SPECIALIZING in Better
NUTRITION! We PRESCRIBE
SPECIAL*

*FORMULA Fertilizers for
Groves, Pastures & Truck Crops*

Whether it's citrus, cattle or truck
—watermelons, canteloupes, toma-
toes, or cucumbers—check with us
... More than 45 years of technical
training and experience including
laboratory supervision with 40 years
of formulation and manufacture of
fertilizers, and also 30 years of
independent research in plant
nutrition.

*Call Us for Better Crops with
Better Nutrition from Better
Balanced Fertilizers*

IDEAL FERTILIZER COMPANY

TELEPHONES

Day Only—813/533-5151
Night or Day—813/533-5428
2270 North Park Avenue
P. O. Box 113
BARTOW, FLORIDA 33830

on pineapple when sprays were ad-
justed to pH 9 with CaCO_3 (2). On
olives, adjusting ethephon to pH 7
with potassium phosphate increased
the fruit loosening response (1).

The present study was undertaken
to determine the effectiveness of
several additives for improving the
activity of preharvest ethephon appli-
cations on citrus fruit.

Materials and Methods

Trees of 'Hamlin' orange (*Citrus
sinensis* [L.] Osb.), 'Robinson' (*C.
reticulata* Blanco X [*C. paradisi* X
C. reticulata]) and 'Dancy' (*C. reticu-
lata* Blanco) tangerines, and 'Orlando'
tangelo (*C. paradisi* X *C. reticulata*)
were used in these studies. Surfactants
studied in four tests included Triton
X100 and Regulaid at 0.1%, Ag-chem
Activator at 0.125%, and γ -butyrolac-
tone at 800 ppm. In six tests, K_2HPO_4 ,
 $(\text{NH}_4)_2\text{HPO}_4$, urea, Ca acetate,
 Na_2HPO_4 were used as additives in
ethephon sprays. Rates for phosphate
buffers were between .003 and .008 M
concentration and urea was used at
rates as high as 3%. Ethephon rates
ranged from 150 to 200 ppm on
'Orlando' to as high as 500 ppm on
'Hamlin'.

Fruit samples were taken one and
two weeks after treatment. Fruit
removal force was measured on 10
randomly selected fruit per plot with a
Chatillon tester. An additional 10 fruit
were hand pulled so that 20 fruit were
available for color measurements. Rind
carotenoid levels in fruit were mea-

sured with a difference meter and
expressed as $\Delta R_{540-650 \text{ nm}}$ (3, 4).
All fruit were checked for the degree
of separation and plugging (tearing of
rind). Leaf losses were determined
from leaf counts made on four to six
twigs per plot before spraying and
after one and two weeks.

Leaf diffusive resistance measure-
ments showed no water stress in
test trees at the time the tests were
initiated. Treatments were applied to
1/2- or one-tree plots with two to four
replicates. All data were analyzed
statistically.

Results and Discussion

Preliminary tests of surfactants
with ethephon on 'Robinson' tan-
gerines and 'Hamlin' oranges in 1976
showed no effect on color, fruit
removal force, or defoliation. In 1977,
the fruit removal force of 'Robinson'
tangerine treated with 250 ppm
ethephon and Triton X100 or
 γ -butyrolactone was lower than with
ethephon alone (Table 1). Defoliation
and the frequency of clean abscission
(smooth separation at the abscission
zone) of fruit tended to be greater
with Triton X100.

'Orlando' tangelo color and fruit
removal force were improved with the
addition of surfactants (Table 1).
However, the ΔR of .55 for 200 ppm
ethephon is out of line compared to
.61 ΔR obtained with 150 ppm
ethephon. Although not significant,
fruit abscission tended to be greater
with surfactants added to ethephon.
As with 'Robinson', defoliation of
'Orlando' tended to be greater with
Triton X100 than the other sur-
factants but none of these leaf losses
are considered serious.

Buffers applied alone had no effect
on fruit or leaf responses. The addi-
tion of buffers to 250 or 350 ppm
ethephon did not improve carotenoid
development in 'Robinson' tangerines
in 1977, but did significantly increase
leaf and fruit abscission and reduce
fruit removal force. On 'Robinson'
fruit, combinations of buffers with
250 ppm ethephon gave results similar

See Our New Facilities

ON U.S. 17 HALFWAY
BETWEEN WAUCHULA & ZOLFO
Complete Sales & Service



COME SEE OUR NEW FACILITIES TO
IMPROVE SERVICE
LET US QUOTE ON TRACTORS OR IMPLEMENTS

AMERICAN TRACTOR
& Equipment Corp.

Shug Shackelford, Mgr.—Lawrence Shackelford, Pres.
P. O. Box 251, ZOLFO SPRINGS, FL 33890—813/735-5801

LOOSENING

Continued from Page 26

to those from 350 ppm ethephon alone (data not shown). On 'Orlando' tangelo, the addition of buffers increased color development and tended to increase fruit and leaf abscission (Table 2). Higher levels of buffers tended to increase leaf losses.

In 1978, calcium acetate was not effective on 'Robinson' or 'Orlando' (Table 3, 4). Potassium and ammonium phosphate and urea generally increased both fruit and leaf abscission. On 'Robinson', the effects of buffers plus 200 ppm ethephon were similar to those due to 250 ppm ethephon alone. Fruit ringing was increased by buffers with 200 ppm ethephon but not with 250 ppm. (Ringing is a zone where color de-

velopment is delayed by high levels of ethephon residue [3].) On 'Orlando', defoliation was increased by the buffers, but losses were less than on 'Robinson'. On 'Orlando' additional plots were treated using buffers at .005 M (Ca acetate at .003 M) with results similar to those shown.

'Dancy' tangerines treated on

Continued on Page 33

Table 1. Response of 'Robinson' tangerines and 'Orlando' tangelos to preharvest applications of combinations of ethephon and surfactants.

Treatment	Ethephon	Surfactant	Robinson			Orlando				
			Color AR	Fruit removal force kg	Leaf losses %	Clean abscission %	Color AR	Fruit removal force kg	Leaf losses %	Clean abscission %
0	0		.56	6.8	2	0	.56	11.0	0.3	13
low ²	0		.58	6.4	5	17	.61	9.5	1.0	73
		Triton X100	.58	5.4	12	35	.64	6.9	13.0	93
		Regulaid	.60	5.9	4	18	.63	7.8	10.0	97
		A. Activator	.60	6.4	3	25	.59	9.1	2.0	60
		R. Lactone	.59	5.0	2	18	.61	8.2	6.0	80
high	0		.63	5.0	9	60	.55	10.4	5.0	67
		Triton X100	.60	4.5	16	57	.62	7.3	9.0	83
		Regulaid	.63	5.4	9	50	.63	7.4	7.0	80
		A. Activator	.61	5.9	6	32	.61	7.7	3.0	80
		R. Lactone	.61	4.5	3	43	.63	7.3	8.0	90
LSD		A ³	ns	0.8**	8*	35*	.03**	1.6**	8.0*	25**
		B	ns	0.8**	8*	ns	.02**	1.7*	ns	ns

²'Robinson' tangerines treated on Oct. 20, 1977, with ethephon at 250 and 350 ppm and 2 replications. 'Orlando' tangelo treated on Nov. 28, 1977, with ethephon at 150 and 200 ppm and 3 replications. All observations at 1 wk, except 'Orlando' leaf losses are for 2 wk from treatment.

³Statistical analyses of all treatments (A) or with untreated check omitted (B). Differences significant at levels shown, 1% (**), 5% (*), 10% (+), or not significant (ns).

Table 2. Response of 'Orlando' tangelo to preharvest applications of combinations of ethephon with buffers. Treated November 28, 1977².

Ethephon	Additive	Rate	Fruit			
			Color AR	removal force kg	Leaf losses %	Clean abscission %
0	0		.56	11.0	0.3	13
200 ³	0		.55	10.4	5.0	67
200 K ₂ HPO ₄	L ^x		.61	10.3	8.0	65
	M		.63	7.5	5.0	87
200 (NH ₄) ₂ HPO ₄	H		.63	8.0	11.0	90
	L		.64	7.0	10.0	90
200 Urea	M		.61	7.4	14.0	93
	H		.62	7.7	15.0	93
LSD	L		.61	6.5	7.0	90
	M		.63	6.6	7.0	83
	H		.63	7.6	17.0	87
	A ⁴		.04**	3.0**	9.4+	22**
	B		.03**	3.1**	ns	ns

²Measurements obtained 1 wk after treatment, except leaf losses were obtained after 2 wk.

³This test also included ethephon at 150 ppm with medium buffer rate for a total of 15 treatments with 3 replications.

^xAdditive rates of phosphates were selected to raise the spray to pH 6.5, 7.0 and 7.5. (for 200 ppm ethephon rates were between .003 and .007 M) rates for urea were 1, 2 and 3%.

⁴Statistical analyses of all treatments (A) or with untreated check omitted (B). Differences significant at levels shown, 1% (**), 10% (+), or not significant (ns).

Table 3. Response of 'Robinson' tangerine to preharvest applications of ethephon and buffer combinations.²

Ethephon	Buffer	Fruit					
		Color AR	removal force kg	Leaf losses %	Clean abscission %	Plugged fruit %	Ringed fruit %
0	0	.53	7.3	9	1	19	0
200	0	.58	6.9	13	11	15	24
200 K ₂ HPO ₄		.61	6.3	14	17	12	34
200 (NH ₄) ₂ HPO ₄		.61	6.2	15	26	11	61
200 Urea		.60	6.3	12	29	10	50
200 Ca acetate		.57	6.9	7	0	15	0
250	0	.61	6.2	9	24	15	60
250 K ₂ HPO ₄		.62	6.1	26	41	4	64
250 (NH ₄) ₂ HPO ₄		.62	5.8	16	41	7	75
250 Urea		.60	5.8	17	22	6	57
250 Ca acetate		.58	6.8	9	8	16	0
LSD	A ³	.03**	ns	8.4**	20**	ns	19**
	B	.03*	ns	8.1**	17**	ns	19**

²Measurements obtained 1 wk after treatment.

³Treated on Oct. 26, 1978, with additives at .005 M concentration and with 4 half tree replicates.

⁴Statistical analysis of all treatments (A) or with untreated check omitted (B). Differences significant at levels shown, 1% (**), 5% (*), 10% (+), or not significant (ns).

Table 4. Response of 'Orlando' tangelo to preharvest applications of ethephon and buffer combinations.²

Ethephon	Buffer	Fruit				
		Color AR	removal force kg	Leaf losses %	Clean abscission %	Plugged fruit %
0	0	.51	5.1	0.3	5	66
200	0	.53	4.8	1.0	22	50
200 K ₂ HPO ₄		.54	3.7	5.0	50	34
200 (NH ₄) ₂ HPO ₄		.55	3.7	3.0	71	32
200 Urea		.56	3.8	4.0	61	28
200 Ca acetate		.53	4.8	2.0	24	47
250 Na ₂ HPO ₄		.55	4.2	3.0	50	31
LSD	A ³	.02**	.77**	3.2*	20**	21**
	B	.02*	.79*	3.3*	21**	ns

²Measurements obtained 1 wk after treatment.

³Treated on Nov. 30, 1978, with additives at .008 M except Ca acetate at .005 M concentration, and with 4 half tree replicates.

⁴Statistical analysis of all treatments (A) or with untreated check omitted (B). Differences significant at levels shown, 1% (**), 5% (*), 10% (+), or not significant (ns).

LOOSENING

Continued from Page 28
Dec. 14, 1978, showed no response to ethephon alone at 250 ppm (data not shown). Buffers, including commercial sodium phosphate, significantly improved carotenoid development and fruit loosening. However, fruit which were past optimum maturity still had 30-40 per cent plugging, indicating inadequate separation. 'Hamlin' oranges sprayed on Jan. 24, 1979, with ethephon at 350 ppm and buffers at .005 or .008 M showed less color and fruit loosening responses (data not shown) than were obtained from ethephon in previous studies (4). Temperatures were low (5-20°C) and this probably reduced the response.

Of the two types of additives tested the surfactants tended to be less effective than the buffers. Differences among the surfactants suggest that other surfactants or different rates may have greater effects. Several phosphate buffers or urea increased the responses to ethephon, frequently at levels comparable to those caused by an increase of 50 ppm ethephon. However, responses to combinations of ethephon and additives varied between cultivars and were reduced by cool weather, patterns which have been noted with ethephon above (4, 5).

To the extent tested all of the buffers appeared to give similar responses, except calcium acetate. The failure of this chemical suggests that

tion to pH change. Observations suggest that buffers are effective surfactants on citrus. Attempts to compare several rates indicated that the concentration is not critical. Most of the buffers used in these studies were reagent-grade chemicals. Preliminary work indicates that reagent and commercial grades of sodium phosphate induce similar responses. Commercial grades of ammonium phosphate and urea also should be tested for grove use.

CITRUS SEED

Wide Range of
Varieties
Price List Available

WILLITS & NEWCOMB, INC.
P. O. BOX 428
ARVIN, CALIFORNIA 93203

PH: (805) 366-7269

SWANSON The Quality Sprayer Gives Total Coverage

- * Superior Spray Pattern
- * Penetrating Coverage
- * Uniform Spray Droplet Size
- * Stainless Steel Construction



Model DA500 PTO Machine Shown

Economical To:

- * Purchase
- * Operate
- * Maintain

Before You Purchase, Give Us A Call Today (Toll Free) For A Free Demonstration And Location Of Dealer Nearest You.

Phone Toll Free.....800-241-2308

Durand-Wayland, Inc.

P. O. Box 1404
LaGrange, Georgia 30241

*B. C. Cook & Sons
Enterprises, Inc.*



Bulk Sales Processing
Participation Plans Cash Buyers

Grove Service

OVER 40 YEARS SERVICE
TO THE CITRUS INDUSTRY

Phone: 813/422-1121

Haines City, Florida 33844