Literature Cited

1. Ballinger, W. E., and D. D. Mason. 1960. Selection of a tissue for use in strawberry nutritional studies. *Proc. Amer. Soc. Hort. Sci.* 76:359–365.
2. Bould, C. 1961. Strawberry nutrition. *Advances in Horticultural Science and Their Application*. Edited by J. C. Garnaud, Pergamon Press, New York, Vol. 1, p. 173–180.
3. ———, and E. Catlow. 1954. Manurial experiments with fruit. I. The effect of long-term manurial treatments on soil fertility and on the growth, yield and leaf nutrient status of strawberry, var. Climax. *J. Hort. Sci.* 29:203–219.
4. Crooke, W. M. and W. E. Simpson. 1971. Determination of ammonium in Kjeldahl digests of crops by an automated procedure. *J. Sci. Fd. Agr.* 22:9–10.
5. Jackson, M. L. 1958. Soil Chemical Analysis. Prentice-Hall Inc., Englewood Cliffs, New Jersey. p. 151–153.
6. John, M. K. 1972. Automated digestion system for the safe use of perchloric acid. *Anal. Chem.* 44:429–430.
7. ———, 1973. A batch-handling technique for hot-water extraction of boron from soils. *Proc. Amer. Soc. Soil Sci.* 37:332–333.
8. ———, and R. Klein. 1972. A semiautomated digestion method for total nitrogen in plant materials. *Can. J. Plant Sci.* 52:123–124.
9. ———, and C. J. Van Laerhoven. 1973. Application of a laboratory analog-digital computer system to data acquisition and reduction for quantitative analyses. *JAOAC* 56:135–139.
10. Kwong, S. S. 1967. Leaf age and leaf fraction influence upon the concentration of micro-elements in strawberry leaves. *Proc. Amer. Soc. Hort. Sci.* 91:257–260.
11. ———, and D. Boynton. 1959. Time of sampling, leaf age and leaf fraction as factors influencing the concentrations of nutrient elements in strawberry leaves. *Proc. Amer. Soc. Hort. Sci.* 73:168–173.
12. Olsen, S. R., and L. A. Dean. 1956. Phosphorus. Methods of Soil Analysis. Agronomy Monograph No. 9. Edited by C. A. Black et al., Amer. Soc. Agron., Madison, WI Part 2. p. 1035–1048.
13. Tabatabai, M. A., and J. M. Bremner. 1970. A simple turbidimetric method of determining total sulfur in plant materials. *Agron J.* 62:805–806.
14. Wilson, A. D., and G. A. Sergeant. 1963. The colorimetric determination of aluminum in minerals by pyrocatechol violet. *Analyst* 88:109–112.
15. Wolf, B. 1971. The determination of boron in soil extracts, plant materials, composts, manures, water and nutrient solutions. *Commun. Soil Sci. Plant Anal.* 2:363–374.
16. Yoshida, Y., and S. Yoshida. 1965. An extraction procedure for rapid determination of boron in plant tissues. *J. Sci. Soil Manure* (Japan) 36:45–48.

Maturation and Ripening of 'Canino' Apricot as Affected by Combined Sprays of Succinic Acid 2,2-Dimethylhydrazide (SADH) and 2,4,5 Tri-chlorophenoxypropionic Acid (2,4,5-TP)[1]

Sylvia Guelfat-Reich and Ruth Ben-Arie

Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel

Abstract. SADH affected color enhancement of 'Canino' apricot (*Prunus armeniaca* L.) thereby increasing the percentage of fruit harvested during the first 2 harvests. The sprays at and after pit hardening had a greater effect on color than "after bloom" spray. Other parameters of ripening, however, were unaffected, or were even retarded, indicating the different effects of SADH on various species of stone fruits.

It is known that 2,4,5-T and 2,4,5-TP both increase the size of apricot fruits and advance their maturation (7, 8, 9). Thus, 2,4,5-TP sprays at pit hardening have become general practice in apricot orchards in Israel. Fruit not treated with 2,4,5-TP is smaller and ripens 2–3 weeks after treated fruit. There are many reports that SADH accelerates ripening of stone fruits (1, 3, 4, 13). These experiments were conducted with peaches and cherries but not with apricots.

We report effects of SADH sprays on maturation and ripening of 'Canino' apricot when applied before, with, or after 2,4,5-TP, with the aim of further advancing the harvest.

Materials and Methods

SADH was applied in different orchards to 'Canino' apricot at concentrations of 2000–4000 ppm 2 weeks after petal fall, at pit hardening, or 2 weeks after pit hardening. Control and SADH-treated trees were sprayed at pit hardening with 20 ppm 2,4,5-TP this is a routine orchard treatment. Trees were sprayed to run-off (*ca.* 7 liters/tree) with a motorized knapsack in the early morning before the dew had evaporated. Each experiment comprised 3 single-tree replicates per treatment, distributed in blocks. The criterion for harvest was that used commercially; the change in color from green to pale yellow. The fruit was weighed at each harvest. Samples of 50 fruits per tree from the first harvest were held in the laboratory for 3–9 days at 20°C. In 1972 and 1973, fruit from the second harvest was also examined in the laboratory.

Ripening parameters evaluated at harvest and during shelf life included fruit color, determined by light reflection with a Bausch and Lomb Spectronic 20 at 670 nm, or with a Gardner color instrument (value a); fruit firmness, measured with a Hunter Penetrometer (1.14-cm tip); tangible softening (hard, slightly soft, or soft) evaluated by hand; total soluble solids (TSS) content measured with a hand refractometer; and acidity measured by titration of the juice with 0.1N NaOH. Carbon dioxide production was measured either by the Claypool and Keefer method (6) or by sampling air from a closed system with a Packard gas chromatograph equipped with a Propack C column and a thermal conductivity detector. A Packard gas chromatograph with an activated alumina column served for measuring ethylene evolution, also sampled from a closed system.

Results

SADH treatment induced an earlier harvest when applied with 2,4,5-TP to 'Canino' apricot at pit hardening or 2 weeks later (Fig. 1a), at a concn of 3000 or 4000 ppm (Fig. 1b), as compared with the 2,4,5-TP spray alone. The post-bloom spray was not always effective and the effect of lower concn of SADH was erratic. Enhancement of harvest time resulted from the accelerating effect of SADH on change in fruit color, which is the principal criterion for the beginning of fruit harvest.

The measurable difference in fruit color at harvest was maintained during shelf-life (Fig. 2). The effects of time of application and of

[1] Received for publication December 19, 1974. Contribution from the Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel; 1974 Series, No. 253-E.

SADH concentration were demonstrated (Fig. 2).

There were no consistent changes in firmness and TSS content of SADH-treated fruit at first harvest compared with the control, either at harvest or during shelf-life. Firmness values were high (above 7.7 kg) and decreased only slightly during shelf-life. However, the acid content showed a trend to higher values in SADH-sprayed fruit (Table 1). At later harvests, there was a tendency to firmer and more acid fruit in SADH treatments compared with controls, but there was no consistent effect related to different concn and time of application (Table 2). Tangible softening of fruit occurred during shelf-life but more hard fruit remained from SADH treatments than from controls (Table 3).

The respiration of SADH-treated fruit after harvest did not differ significantly from that of the control. Ethylene evolution, which is generally low in 'Canino' apricot (*ca.* 0.05 ml/kg/h at harvest), remained low in all treatments without marked differences between treated and control fruit.

Discussion

The expected promotion of ripening by a combined SADH and 2,4,5-TP treatment of 'Canino' apricot was not obtained, although generally more fruit was harvested at the beginning of the season from trees treated with the above combination than from trees treated only with 2,4,5-TP. This was due to the enhancement of fruit color, but not to the acceleration of maturation, as indicated by firmness values at first harvest and by the slow softening rate with no concomitant ripening during shelf-life. Chaplin and Kenworthy (5) reported that SADH enhanced color development and increased sugar content in cherry but had no effect on firmness or respiratory activity. In peach, SADH promotes the development of color and this often precedes the acceleration of other parameters of ripening (1). With 'Canino' apricot, not only was no advancement of ripening observed at first harvest, but an inhibition of the ripening process during shelf-life became apparent in fruit harvested later in the season. SADH-treated fruit was often firmer, with higher acidity and slower softening rate, than control fruit. A similar effect has been shown with apple, in

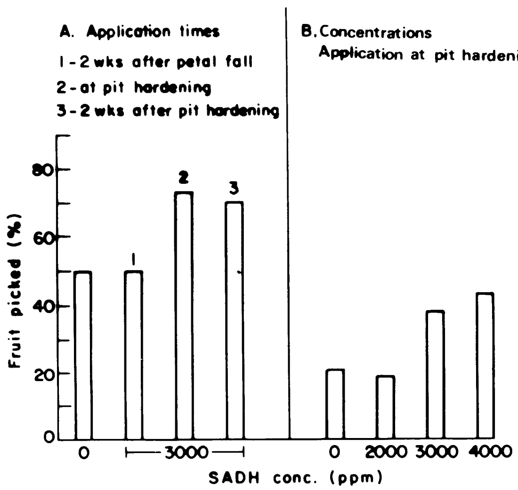

Fig. 1. Effect of SADH orchard spray on percentage of 2,4,5-TP-treated 'Canino' apricot on the first 2 harvests: A. Application times; B. Concentrations at pit hardening.

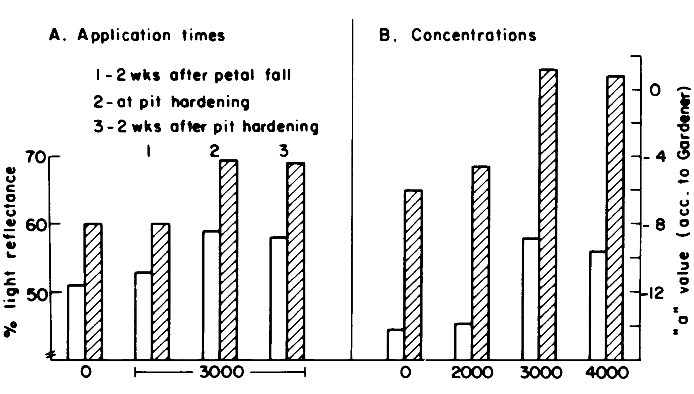

Fig. 2. Effect of SADH orchard spray on enhancement of 'Canino' apricot fruit color at harvest, and after 3 days shelf life at 20°C:
A. Application times.
B. Concentrations at pit hardening: clear at harvest and shaded, after shelf life.

Table 1. Average effect of SADH spray on acidity of 2,4,5-TP treated 'Canino' apricot at first harvest and after shelf life at 20°C.

SADH conc. (ppm)	% Acid	
	At harvest	After 6 days shelf life
0	2.34a[z]	2.26a
2000	2.46a	2.36a
3000	2.46a	2.40a
4000	2.64b	2.57b

[z] Numbers followed by the same letter do not differ significantly at the 5% level, according to Duncan's multiple range test.

Table 2. Effect of SADH spray on firmness and acidity of 2,4,5-TP-treated 'Canino' apricot at mid-season harvest, after 6 days shelf life at 20°C.

SADH concn (ppm)	Application time[z]	Firmness (kg)		Acidity (%)	
		1972	1973	1972	1973
0	—	1.2	3.8a	1.54b	2.18a
2000	1	1.8a	—	1.74c	—
	2	1.4a	5.2b	1.44a	2.24ab
3000	1	1.9a	—	1.75c	—
	2	3.5b	6.0b	1.64bc	2.33b
	3	3.2b	5.0a	1.67bc	2.24ab
4000	1	1.5a	—	1.60bc	—
	2	1.8a	6.9b	1.73bc	2.26ab
	3	1.7a	4.0a	1.54b	2.35b

[z] 1, 2 weeks after petal fall; 2, at pit hardening; 3, 2 weeks after pit hardening. Numbers followed by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

Table 3. Effect of SADH sprays on 2,4,5-TP treated apricots on percent of hard fruit at mid-season harvest, after 6 days shelf life at 20°C.

SADH concn (ppm)	Application time[z]	% hard fruit	
		1972[y]	1973[y]
0	—	13.5a	84.3a
2000	1	17.8ab	—
	2	12.3a	96.1b
	3	26.6b	96.8b
3000	1	20.0ab	—
	2	43.4d	99.0b
	3	37.3c	97.9b
4000	1	20.6ab	—
	2	26.6b	—
	3	22.7b	88.1a

[z] 1, 2 weeks after petal fall; 2, at pit hardening; 3, 2 weeks after pit hardening.
[y] Numbers followed by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

which SADH enhances red color development but prevents the softening effect of 2,4,5-TP when both are used (10, 13). This countereffect in apple is explained as a suppression of ethylene and CO_2 production by SADH (12, 13). Contrary to this effect on pome fruits, ethylene and CO_2 production are increased by SADH treatments on stone fruits such as peach (2, 4). However, in apricot we found no clear effect on the evolution of either CO_2 or ethylene with SADH plus 2,4,5-TP treatments, as compared with auxin treatment alone.

If we consider the apparently conflicting effects of SADH on various ripening parameters such as color development, softening, and ethylene evolution in apple, cherry, peach and apricot, it appears that SADH is probably active soon after application at the hormonal level, and that its effect thereafter is expressed in various ways according to the specific response of each species to the changed hormonal balance.

Literature Cited

1. Baumgardner, R. A., G. E. Steinbridge, L. O. Van Blaricom, and C. E. Gambrell, Jr. 1972. Effect of succinic acid 2,2-dimethylhydrazide on the color, firmness and uniformity of processing peaches. *J. Amer. Soc. Hort. Sci.* 97:485–488.
2. Ben-Arie, Ruth, and Sylvia Guelfat-Reich. 1974. Early ripening of nectarines by succinic acid 2,2-dimethylhydrazide and 2 chloroethylphosphonic acid. Symposium of Fruit Maturation. C.N.R.S., Paris. No. 238: 109–113.
3. Byers, R. E., and F. H. Emerson. 1969. Effects of succinic acid 2,2-dimethylhydrazide (S.A.D.H.) on peach fruit maturation and tree growth. *J. Amer. Soc. Hort. Sci.* 94:641–645.
4. ———, ———, and H. C. Dostal. 1972. The effect of succinic acid 2,2-dimethylhydrazide (S.A.D.H.) and other growth regulating chemicals on peach fruit maturation. *J. Amer. Soc. Hort. Sci.* 97:420–423.
5. Chaplin, M. H., and A. L. Kenworthy. 1970. The influence of succinamic acid 2,2-dimethylhydrazide on fruit ripening of the Windsor sweet cherry. *J. Amer. Soc. Hort. Sci.* 95:532–536.
6. Claypool, L. T., and R. M. Keefer. 1942. Colorimetric method for CO_2 determination in respiration studies. *Proc. Amer. Soc. Hort. Sci.* 40:177–186.
7. Crane, J. C. 1956. The comparative effectiveness of several growth regulators for controlling preharvest drop, increasing size and hastening maturity of Stewart apricots. *Proc. Amer. Soc. Hort. Sci.* 67:153–159.
8. ———, and B. M. Brooks. 1952. Growth of apricot fruits as influenced by 2,4,5 trichlorophenoxyacetic acid application. *Proc. Amer. Soc. Hort. Sci.* 59:218–224.
9. Edgerton, L. J., and G. D. Blanpied. 1970. Interaction of succinic acid 2,2-dimethylhydrazide, 2-chloroethylphosphonic acid and auxins on maturity, quality and abscission of apples. *J. Amer. Soc. Hort. Sci.* 95:664–667.
10. ———, and M. B. Hoffman. 1965. Some physiological responses of apple to N-dimethylamino succinamic acid and other growth regulators. *Proc. Amer. Soc. Hort. Sci.*
11. Gambrell, C. E. Jr., E. T. Sirus, Jr., G. E. Stembridge, Jr., and W. H. Rhodes. 1972. Response of peaches to succinic acid 2,2-dimethylhydrazide as an aid to mechanical harvesting. *J. Amer. Soc. Hort. Sci.* 97:268–272.
12. Looney, N. E. 1971. Interaction of ethylene, auxin and succinic acid 2,2-dimethylhydrazide in apple fruit control. *J. Amer. Soc. Hort. Sci.* 96:350–353.
13. ———, 1972. Effect of succinic acid 2,2-dimethylhydrazide. 2-chlorophosphonic acid and ethylene on respiration, ethylene production and ripening of Redhaven peaches. *Can. J. Pl. Sci.* 52:73–80.

Growth of Tomato on a Tropical Soil under Plastic Cover as Influenced by Irrigation Practice and Soil Salinity[1]

C. A. Bower, B. A. Kratky and N. Ikeda[2]

University of Hawaii, Honolulu

Abstract. When soil-water tension in the rootzone was maintained below 0.2 bar the yield of marketable 'Tropic' tomato was 17% greater than when tension was maintained below 0.4 or 0.6 bar. At all 3 tensions yields and total amounts of irrigation water required under trickle irrigation did not differ significantly from yields and water required under basin irrigation. Soil salinity tended to increase with decreases in the total amount of irrigation water applied and with distance from the center of the row. These tendencies were slight under basin irrigation but marked with trickle irrigation. The salt tolerance of 'Tropic' appears to be lower than that reported for other cultivars; tolerance was considerably lower on highly acid soil (pH 4.1) than on limed soil (pH 5.7). With limed soil the electrical conductivities of the soil water at field capacity associated with yield decreases of 10, 25 and 50% were 3.5, 6.8 and 12.2 mmho/cm, respectively, as compared to corresponding U.S. Salinity Laboratory values of 8.0, 13.4 and 16.0 mmho/cm.

To avoid deleterious effects of acidic rainfall resulting from volcanic air pollution (3), obtain better pest control, and thus achieve consistently higher yields, farmers in Hawaii are increasingly growing tomato under plastic cover rather than in the open. The change in cultural environment has introduced 2 new production factors, irrigation and soil salinity hazard, for which information under tropical conditions is needed. This study determined the effects of several irrigation treatments on tomato yield and soil salinity, and the salt tolerance of 'Tropic', the principal tomato cultivar grown under plastic cover in Hawaii.

Materials and Methods

The experimental work was conducted at the University of Hawaii, Kona Branch Experiment Station, Kainaliu, on Honuaulu clay loam under plastic cover. The soil, a Humic Latosol derived from volcanic ash, was highly permeable and had saturated paste, field capacity and wilting water-contents of 70, 60 and 32%, respectively.

Irrigation experiment. A split-plot, thrice replicated irrigation experiment with 'Tropic' as the cultivar was conducted. Each subplot consisted of a row of 10 plants spaced 30 cm apart in the row. Border

[1] Received for publication December 31, 1974. Journal Series No. 1838 of the Hawaii Agricultural Experiment Station. This research was partially supported by funds provided from a 211(d) Grant AID/csd-2833, "To Strengthen the Capabilities of the University of Hawaii in Special Problems of Tropical Soils."

[2] Department of Agronomy and Soil Science, Department of Horticulture, and Field Technician, respectively.

The statistical work of Dwight Sumida is gratefully acknowledged.