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.

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

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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

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rows were provided at each end of the experimental area, all rows being 1.2 m apart. The treatments were 2 methods of irrigation, trickle (one emitter/plant with a water pressure of 0.07 bars) and flooding in level basins 48 cm wide (main plots); and 3 levels of water achieved by irrigating when the soil-water tension 15 cm from the center of the row at the depth of 15 cm, as measured by tensiometers, reached 0.2, 0.4 and 0.6 bar (subplots). For all treatments 2 liters of water per plant were applied at each irrigation. Following irrigation, tensiometer readings in the trickle 0.2, 0.4 and 0.6 bar plots usually decreased to around 0.1, 0.2 and 0.3 bar, respectively; and in the basin 0.2, 0.4 and 0.6 bar plots to around 0.15, 0.25 and 0.35 bar, respectively. The irrigation water had an electrical conductivity of 0.20 mmho/cm, the salt being mainly NaCl.

Because the soil had previously been limed to pH 5.3 and highly fertilized such that it contained 320 ppm of available P by the method of Nelson et al. (4), 525 ppm of dissolved and exchangeable K and 100 or more ppm of NO_3-N, only 21 kg/ha of N and 23 kg/ha of P were applied when 3-week old seedlings were transplanted. Fruit showing any red color was harvested twice each week, graded and weighed. All plants were topped at 15 weeks of age, and harvesting was completed at 26 weeks of age. After harvest, soil samples for salinity determination were taken from the 0-15 cm layer at distances 8, 16 and 24 cm from the center of the row comprising each subplot. Salinity was measured as electrical conductivity of the saturation extract (EC_e).

Salt tolerance experiments. The salt tolerance of 'Tropic' was measured in randomized complete block pot experiments having 4 replications. Highly acid (pH 4.1) and previously unfertilized soil was used in one experiment and the same soil limed to a pH of 5.7 was used in another. The initial exchangeable H, Al, Ca, Mg and K contents of the unlimed soil in me/100 g were 0.6, 3.0, 1.4, 0.4 and 0.1, respectively, and for the limed soil 0.3, nil, 12.3, 0.8 and 0.1, respectively. Portions of each soil were adjusted approximately to 4 salinity levels (EC_e = 1, 4, 8 and 12 mmho/cm) by the addition of a 1:1 mixture of $CaCl_2$ and NaCl. Fifteen kg weights of each batch of salt-treated soil plus 15 g of treble superphosphate, 15 g of $K_2SO_4 \cdot 2MgSO_4$ and 50 g of 19-6-13 Osmocote slow-release fertilizer were placed in 20-liter pots having a drainage outlet. A single 3-week old seedling was transplanted to each pot. The unlimed soil was irrigated with essentially salt-free rainwater whereas the limed soil was irrigated with water having an electrical conductivity of 0.20 mmho/cm. More or less uniform vertical distribution of salt in the pots was maintained by partially leaching the pots periodically and returning the saline leachate to the top of the pot. The water content of the potted soil when drainage ceased (60.5%) was almost exactly equal to the field capacity content. Harvesting procedure was as described in the previous section. After harvesting at a plant age of 26 weeks the EC_e value of soil from each pot was determined. The average of the initial and final EC_e values were used for relating salinity to yield.

Results and Discussion

Irrigation experiment. At each soil-water tension level there was no significant difference between amounts of water required under trickle and basin irrigation, but for both methods of irrigation about one and one-half and 2 times as much water was required to maintain tension below 0.4 and 0.2 bar, respectively, as to maintain it below 0.6 bar (Table 1). Yield of No. 1 tomato under the 0.2 bar treatment was 20% greater than under the 0.4 and 0.6 bar treatments for both trickle and basin methods. This result is in harmony with that of Cannell and Bingham (2) who for 6 soils at high levels of fertility obtained an average of 34% greater tomato growth when tension ranged from 0.01 to 0.2 bar than when it ranged from 0.01 to 0.7 bar. The result is also consistent with that of Saxena et al. (5) who found a significant inverse relation between tomato yield and mean integrated tension over the range 0.05–0.25 bar. The present result is somewhat at variance with that of Wu et al. (6), however, who report that maximum tomato yields are obtained when the tension is within the range between field capacity and 0.6 bar. There were no significant differences between yields of grades No. 2 and No. 3 (culls) at the various tension levels, nor between methods of irrigation.

Soil salinity at the conclusion of the irrigation experiment tended to increase with decreases in the total amount of water applied and with distance from the center of the row (Fig. 1). These tendencies were slight under basin irrigation, but marked under trickle irrigation. Salt accumulation under trickle irrigation was one and one-half to 2 times as large as under basin irrigation.

Two distinct kinds of weather prevailed during the irrigation experiment. From the time the seedlings were transplanted until the plants were 15 weeks of age most days were sunny with rainfall averaging only 2.4 mm/day whereas during the last 11 weeks of the growth period many days were partly or wholly cloudy with rainfall averaging 7.3 mm/day. Table 1 gives average daily water use for the various irrigation treatments during the period 3–11 weeks when the plants were developing appreciable size, during the period 11–15 weeks when further growth probably had little effect on evapotranspiration, and during the period 15–26 weeks when, as indicated by the much higher rainfall, many days were cloudy and more humid. As would be expected, average daily water use was highest during the 11–15 week period, decreasing markedly during the 15–26 week period.

Salt tolerance experiments. Relative yields of individual pots based on a maximum observed yield of 4.55 kg of marketable tomato per pot are plotted in Fig. 2 against pot EC_e values. The range of EC_e values for the limed soil was greater than for unlimed soil because the water used to irrigate the former was slightly saline. In both cases yield was highly correlated negatively with salinity but, as indicated by the larger negative slope, 'Tropic' was less salt tolerant when grown on unlimed soil. The lower salt tolerance on unlimed soil was probably associated with Al toxicity as the unlimed soil contains appreciable exchangeable Al, and increasing salinity of the soil solution would be expected to bring increasing amounts of Al into solution by cation exchange.

The salt tolerance of plants is often expressed as the EC_e values associated with 10, 25 and 50% decreases in yield. For the limed soil the EC_e values of 3.0, 5.8 and 10.5 associated with yield decreases of 10, 25 and 50%, respectively, compare favorably with the corresponding EC_e values of 4.0, 6.7 and 8.0 reported for tomato by Bernstein (1) and suggest that the salt tolerance of 'Tropic' is similar to that of the

Table 1. Yield of tomato and average daily water use as influenced by irrigation treatment.

Irrigation method	Tension at irrigation	Total irrigation water applied	Yield			Average daily water use		
			No. 1	No. 2	No. 3	3–11 weeks	11–15 weeks	15–26 weeks
	bars	liters/plant		kg/plant			liters/plant/day	
Trickle	0.2	115a[z]	5.06a	0.51a	0.36a	0.71a	0.87ab	0.73a
Trickle	0.4	83b	4.22b	0.47a	0.33a	0.56b	0.79b	0.43b
Trickle	0.6	58c	4.26b	0.56a	0.38a	0.39cd	0.59c	0.29c
Basin	0.2	106a	4.92a	0.53a	0.22a	0.62ab	0.97a	0.64a
Basin	0.4	76b	3.94b	0.74a	0.33a	0.46bc	0.90ab	0.37bc
Basin	0.6	49c	4.06b	0.58a	0.27a	0.27d	0.59c	0.26c

[z] Values followed by the same letter within columns are not significantly different from each other by Duncan's multiple range test at the 5% level.

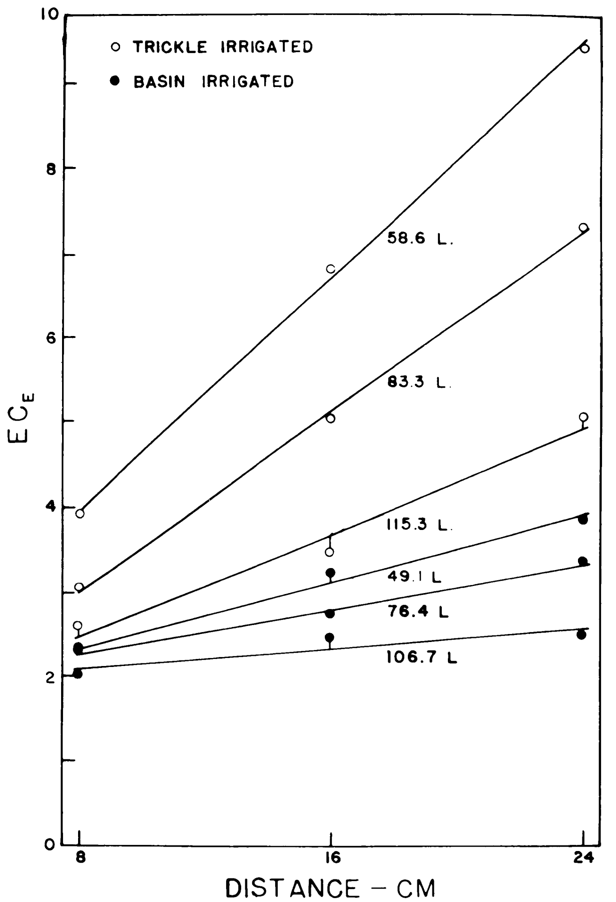

Fig. 1. Salinity of the 0-15 cm layer of soil at various distances from the centers of tomato rows as influenced by irrigation method and total liters of water applied per plant. EC_e = electrical conductivity of saturation extract in mmho/cm.

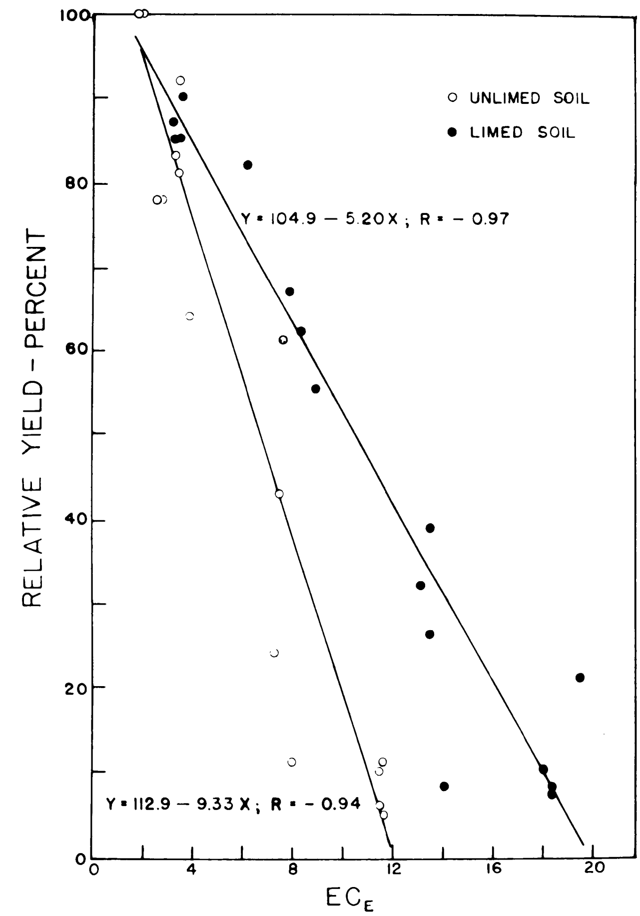

Fig. 2. Relative yield of 'Tropic' tomato on limed and unlimed soil as a function of salinity expressed as electrical conductivity of the saturation extract in mmho/cm (EC_e).

Western U.S. cultivars studied by Bernstein. However, whereas the ratio of saturated paste to field capacity water contents (R) for most soils, including the one used by Bernstein, is about 2 this ratio for the Honuaulu soil is only 1.17. Thus when EC_e values are converted to EC values at field capacity (EC_f) by the equation $EC_f = EC_e \times R$ it is apparent that 'Tropic' is appreciably less salt tolerant than the cultivars studied by Bernstein. For 'Tropic' grown on Honuaulu soil the EC_f values associated with 10, 25 and 50% yield decreases are 3.5, 6.8 and 12.2 mmho/cm, respectively, as compared to corresponding values of 8.0, 13.4 and 16.0 reported by Bernstein.

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