tested had fruit circumferences of less than 22 cm, smaller than the packinghouses were ready to accept. The selections producing the largest fruit, 6-12-26, C52-84-35, and 'Minneola', were all late maturing; growers tend to prefer early maturing cultivars. Only 13 of the 29 selections tested had the deep orange exterior color (J and K in the USDA Color Tables, [3, 4]) expected of commercial mandarin cultivars. All selections except satsumas were seedier than desirable, possibly because of the cross pollination available in our test. Internal quality was generally good although many selections, including 'Nova', 'Robinson', and 'Murcott', which are grown commercially in Florida, had a granulation problem.

Of the cultivars tested, 13 have been released in California and Florida; 'Bower' was released in Texas in 1973 (8). The commercial acceptance of some of these cultivars indicates that they perform better in areas that differ climatically from South Texas. Of the numbered selections, C48-24-45 and C54-4-4 would be promising if they could be made more productive.

The premise that mandarins and mandarin hybrids would be more cold hardy than other citrus in a semitropical area subject to occasional freezes was not borne out in the freeze of Dec. 20-21, 1973. The trees in the test on which this report is based were not damaged because they were located next to a heated grove. In other locations 5 hr of –6°C damaged mandarin trees as severely as grapefruit and orange trees and many had to be removed. The mean maximum temp in the 14 days before the freeze was 23° and the mean minimum temp was 9°. The trees did not harden under those conditions, but some of the selections can be hardy in Jan. (11, 12). The decrease in mandarin and tangelo acreage in South Texas during the 1964-74 period (2) seems to show that planting this type of citrus in semitropical regions is not commercially practical.

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Salt Tolerance of Three Muskmelon Cultivars[1]

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Additional index words. Cucumis melo, cantaloupe

Abstract. **The salt tolerance of 3 muskmelon cultivars (*Cucumis melo* L. cv. Top Mark, PMR 45, and Hale's Best) was determined in plots artificially salinized with NaCl and $CaCl_2$. Marketable yield, total dry weight, vine dry weight, and total fruit weight of all cultivars decreased with increasing salinity. 'Top Mark', the highest yielding cultivar at low salinity, yielded least at high salinity. 'PMR 45' was the least affected with increasing salinity. Na and Cl in the leaves and fruit and % soluble solids in the fruit all increased with increasing salinity levels.**

Muskmelon is one of the major crops of the California and Arizona irrigated deserts. These arid regions have indigenous salinity problems, which are increased as new areas are developed for irrigation. Expansion of agriculture and drought problems reduce water quality as well as quantity, and create a greater need for salt-tolerant crops. Relative to its economic importance, there is only a modicum of information on the salt tolerance of muskmelon; moreover, the effects of salinity on several parameters of growth, other than yield, have not been investigated. Based solely on unpublished reports, muskmelon has been classified as moderately salt tolerant (10).

The purpose of this study was to evaluate the salt tolerance of 3 commercially important muskmelon cultivars, to measure the effect of salinity on several growth parameters in addition to yield, and to determine if cultivar differences exist.

Materials and Methods

Planting. Three muskmelon cultivars ('PMR 45', 'Hale's Best', and 'Top Mark') were planted in 12 field plots on Pachappa fine sandy loam. A uniform application of phosphorus (149 kg P/ha) was tilled into the soil before planting. Drip irrigation lines were installed at spacings of 200 cm between rows and 60 cm between drippers. Each plot contained two 420 cm rows and 14 drippers. On April 20, 1976, 6 seeds of each cultivar were planted on a 15 cm radius around each dripper. The seeds were germinated with water containing 50 mg/liter KNO_3 and 50 mg/liter $Ca(NO_3)_2$ as fertilizer. Plants were thinned to 2 uniform plants per dripper when they had developed 2 or 3 true leaves.

Salinity treatment. Salination was initiated on June 1, 1976. Four levels of soil salinity, replicated 3 times, were established

[1]Received for publication June 21, 1977.

for each cultivar by irrigating with Riverside tap water to which 0, 35, 70, and 105 meq/liter of NaCl and $CaCl_2$ were added in a 1:1 milliequivalent ratio. Salinity levels of the irrigation waters were 0.76, 4.6, 7.8, and 11.0 mmho/cm, respectively. Fertilizer (50 mg/liter KNO_3 and 50 mg/liter $Ca(NO_3)_2$) was added in each irrigation in all treatments. Tensiometers were installed in the row midway between drippers at depths of 15 and 30 cm. All plots were irrigated identically, based on daily tensiometer readings in the control plots (Table 1) and on published recommendations for irrigation of muskmelon (5). Treatment solutions were prepared and thoroughly mixed in 1600-liter tanks and were checked for proper conductivity before application to the plots. A flow rate of about 2.4 liter/hr per dripper was maintained. This did not exceed the infiltration rate of the soil. Throughout the experiment, periodic checks were made to assure uniform flow rates and to clear plugged drippers.

Soil samples were collected in mid-July and after the final harvest to determine the electrical conductivity of the soil saturation extract (EC_e) (10). Three successive 15 cm core samples were taken to a depth of 45 cm in 3 locations, directly below, and 15 cm and 30 cm from the drippers. The mean of the EC_e measurements for each treatment are given in Table 1.

Harvest. Full-slip muskmelons were harvested twice a week over an 8-week period from July 26 to Sept. 17, 1976. The melons were marked, graded, and weighed. During the middle of the harvest period, 3 uniformly mature fruit were selected from each plot. The fruit were peeled, halved, and rinsed free of seeds. Half of each fruit was analyzed for soluble solids by refractometry; the other half, for minerals.

Mineral analysis. Mature nonsenescent leaves were collected midway through the harvest period from the 4th or 5th node basipetal from the apex. Leaves were rinsed, oven-dried, and digested in nitricperchloric acid. Cations were determined by atomic absorption spectrophotometry; chloride, by potentiometric titration (10).

Results

Yield. When pooled across cultivars, 4 yield parameters decreased as salinity increased (Fig. 1). If soil salinity exceeded 1.06 mmho/cm, marketable yield was decreased at a rate of 8.1% per unit increase in EC. Marketable yield was reduced much more than vine dry wt but the latter was highly variable and, consequently, has the lowest confidence level (r = –0.82). Total fruit wt includes both marketable fruit and culls (Table 2). Low and medium salinity treatments increased fruit set but diminished development. Decreases in fruit size and quality resulted in lower marketable yields. High salinity treatments depressed both fruit set and development.

Marketable yield of cultivars differed in sensitivity to salinity

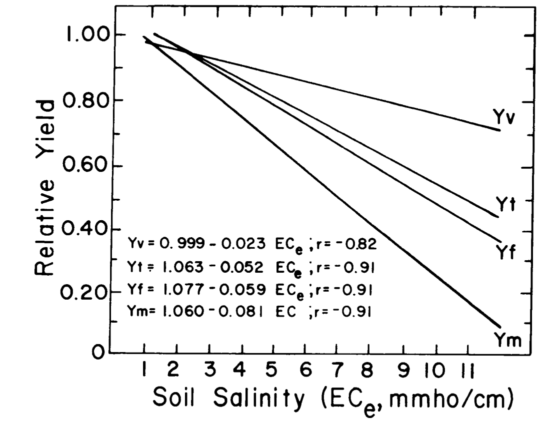

Fig. 1. Marketable yield (Ym), total dry wt (Yt), vine dry wt (Yv), and total fruit wt (Yf) expressed as a function of soil salinity. Each regression represents pooled data from all 3 cultivars relative to their respective controls, with the pooled controls expressed as 1.0.

(Fig. 2). 'Top Mark', the highest yielding cultivar at low salinity levels, was affected most severely by high salinity. 'PMR 45' was the lowest yielding cultivar at low salinity but both it and 'Hale's Best' yielded more marketable fruit than did 'Top Mark' at high salinity (Fig. 2). Using the t-test at the 5% level of significance, the predictions of both slope and intercept of 'Top Mark' differed from those of the other 2 cultivars. Of the 3 cultivars, 'PMR 45' had the lowest reduction of marketable yield and total fruit per unit salinity increase. Its vine dry wt response was intermediate between that of 'Top Mark' and 'Hale's Best'. Significant differences caused by cultivar-salinity interactions were also found for vegetative growth but they differed from yield responses (Table 3). Salinity reduced vine growth the least in 'Top Mark' and the most in 'Hale's Best'.

Net, background color, cracks or spots were not affected by salinity.

Mineral and soluble solids analyses. Tissue analyses revealed that both Na and Cl contents of leaves differed among cultivars and treatments (Table 4); however, in no instance were interactions between cultivar and treatment significant ($F<1$). The high salinity treatments increased leaf Na and Cl contents but had no effect on Ca, K, or Mg content.

Within each treatment level, 'Hale's Best' had higher leaf Cl content than the other cultivars, whereas 'Top Mark' had the highest Na content. Even in control plots, leaf Na content of 'Top Mark' was 2 to 3 times higher than that of either 'PMR 45' or 'Hale's Best'.

Analysis of muskmelon fruit indicated that Cl was the most consistent indicator of treatment salinity. On a dry-wt basis,

Table 1. Mean electrical conductivities (EC) and soil suction measurements at depths of 15 and 30 cm as a result of salinity treatments.

			Electrical conductivity[z] (mmho/cm)			Matric potential[y] (mbar)		
			Replication			Replication		
Treatment	Salinity meq/liter	EC_{iw}[x] mmho/cm	1	2	3	1	2	3
Control	6	0.76	0.81	0.86	1.30	–505	–574	–527
Low salt	35	4.60	3.11	3.28	3.00	–270	–230	–269
Med. salt	70	7.80	4.58	5.00	5.02	–176	–188	–223
High salt	105	11.00	5.73	9.11	11.00	–155	–180	–154

[z]Soil conductivities are means of samples taken midway through the growing season and after final harvest.

[y]Means of daily tensiometer readings taken during the growing period.

[x]Electrical conductivity of the irrigation water.

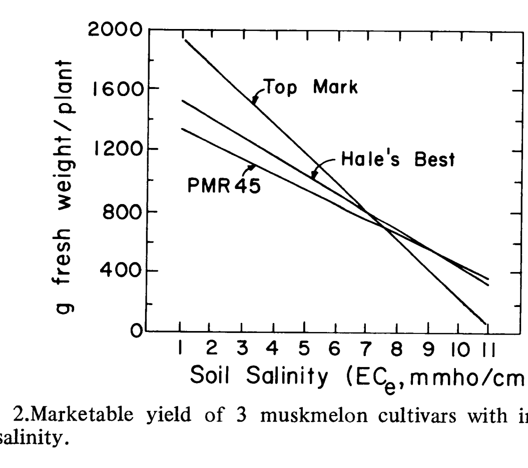

Fig. 2. Marketable yield of 3 muskmelon cultivars with increasing soil salinity.

Table 2. Effect of salinity treatments on fruit quantity and quality.

Treatment	Avg no. of fruit per vine: Total	Culls: Poor quality[z]	Culls: < 650 g	Marketable fruit
Control	3.05	0.31	1.14	1.60
Low salt	3.38	0.56	1.57	1.26
Medium salt	3.29	0.66	1.56	1.07
High salt	2.79	0.55	1.49	0.75
LSD 5%				0.20
LSD 1%				0.26

[z]Fruit of unacceptable market quality due to spots, cracks or blemishes.

Table 3. Effect of salinity on average vine and fruit wt in 3 muskmelon cultivars.

Cultivar	Avg wt (g/plant)	Threshold[z] (mmho/cm)	Slope[y]	r[x]
Vine (dry wt)				
Top Mark	106.4	0.91	−1.0	−0.87
PMR 45	99.4	0.73	−2.2	−0.84
Hale's Best	134.9	0.52	−2.8	−0.80
Melon (fresh wt)				
Top Mark	2696	1.37	−7.4	−0.84
PMR 45	2032	1.27	−3.9	−0.87
Hale's Best	2450	1.29	−5.8	−0.88
Marketable yield				
Top Mark	2178	0.91	−8.8	−0.93
PMR 45	1439	0.73	−6.7	−0.87
Hale's Best	1662	0.52	−7.3	−0.96

[z]Soil salinity at which initial yield decline begins.

[y]Percent yield change per unit salinity increase.

[x]r indicates correlation coefficient.

Table 4. Average mineral content of muskmelon leaves and melons and % soluble solids of melon tissue. Cultivar means pooled over treatments; treatment means pooled over cultivars.

Variable	Na Leaf	Na Melon	Ca Leaf	Ca Melon	K Leaf	K Melon	Mg Leaf	Mg Melon	Cl Leaf	Cl Melon	Soluble solids (% sugar)
	Avg mineral content (meq/100 g dry wt)										
Cultivar											
Top Mark	7.14	16.9	430	25.4	39.8	99.6	85.4	19.9	29.2	29.6	13.0
PMR 45	1.88	11.2	459	24.0	46.9	112.4	78.0	19.9	31.7	36.3	12.4
Hale's Best	2.56	10.6	424	28.6	46.3	116.4	86.2	20.3	45.2	37.7	11.5
LSD 1%	0.68	4.7	94	5.4	8.0	23.0	36.9	1.5	14.8	14.5	0.24
LSD 5%	0.52	3.6	71	4.1	6.1	17.5	28.1	1.1	11.3	11.0	0.18
Treatment											
Control	3.7	6.4	413	25.7	46.4	105	85.8	20.3	22.5	22.0	11.8
35 meq/liter	4.0	11.2	481	29.0	40.4	112	86.3	20.6	38.9	35.3	12.1
70 meq/liter	3.9	16.8	445	25.0	46.3	113	84.6	20.3	34.9	38.4	12.4
105 meq/liter	5.3	17.3	411	24.3	44.3	108	76.0	18.8	45.2	42.6	12.9
LSD 1%	0.91	6.3	125	7.2	10.7	30.7	49.2	2.0	19.8	11.6	0.19
LSD 5%	0.69	4.8	95	5.5	8.1	23.3	37.4	1.5	15.1	8.8	0.15

fruit and leaf Cl contents were similar for each salinity treatment. Cation content of the fruit, on the other hand, varied in several respects from the leaf content (Table 4). Although neither Ca nor Mg content of fruit varied in response to treatment or cultivar, overall values were much lower than those in leaf tissue. Conversely, Na and K were slightly to moderately higher in fruit. As in the leaf, 'Top Mark' had a higher fruit Na content than either 'PMR 45' or 'Hale's Best'.

Soluble solids increased significantly with increased salinity – a desirable effect – and, overall, were higher in 'Top Mark' than in the other 2 cultivars.

There were no significant interactions between treatment and cultivar in any of the melon analysis.

Discussion

Cumulative effects of salinity on vine growth, fruit set, and fruit development resulted in lower marketable yields (Fig. 1). The decrease in marketable fruit cannot be attributed to any single parameter of size, number, or quality (Table 2). The low salt treatment increased fruit set but this was more than offset by large reductions in fruit size and quality. Higher salinity treatments reduced fruit set substantially but had lesser effects on size and quality.

Decline in fruit number and size with increasing salinity differed with cultivar. Under the high-salt treatment, the mean fruit wt component of marketable yield for 'Top Mark', 'PMR 45', and 'Hale's Best' decreased by 59, 44, and 56% of the control values, respectively. The corresponding reductions in mean number of fruit per plant were 16, 10 and 5%. Thus, while mean fruit wt were reduced more in 'Top Mark' and 'Hale's Best' marketable yield of the latter was decreased less because the number of fruit remained higher. A breeding program designed to increase muskmelon salt tolerance could use such differences to advantage.

Although muskmelon cultivars differed in salt tolerance, such differences may vary with environmental and cultural conditions. Under our experimental conditions and with our seed lots, yields from 'Top Mark' were significantly higher than from 'PMR 45' and 'Hale's Best' at soil salinity levels <5 mmho/cm, even though this cultivar was relatively the most sensitive to salinity (Fig. 2). Since absolute yields may vary greatly depending upon the environment, a more reliable estimate of the salt tolerance of a given cultivar may be derived by applying threshold and yield decline (slope) values of Table 3 to the known performance of that cultivar in a particular agricultural area. Mean salt tolerance of the cultivars tested is shown in Fig. 1 in a format most useful for comparison with other crops (8). The data are generally consistent with previous studies at this Laboratory (Bernstein and Ehlig, unpublished data). Our results confirm that muskmelon has medium salt tolerance as previously reported (10). The 50% yield decline is associated with a soil conductivity value of about 7 to 8 mmho/cm overall, and 6 to 7 mmho/cm for 'Top Mark'.

Accumulation of minerals in leaf and melon tissue may indicate how well the plant adapts to salinity stress. Plants growing under saline conditions must adjust to the osmotic potential of the soil water (1, 2, 3). Osmotic adjustment is more rapid in species that accumulate salt than in those that exclude salt (4), but accumulation, if excessive, may cause specific ion toxicities and imbalances unless prevented by discrimination mechanisms within the plant. For example, in some glycophytes, salt tolerance has been associated with low absorption of toxic Na and Cl ions (6).

Capacities for differential uptake or translocation of Na, Ca, K, and Cl are evident in muskmelon (Table 4) and differ with cultivar. All cultivars selectively inhibit Na transport to the leaves and upper plant parts and prevent high concentrations of Ca from reaching the melon flesh. 'Top Mark' differs from the other 2 cultivars by having significantly higher leaf and melon Na contents at all treatment levels – including the control. However, it is doubtful that this factor is responsible for 'Top Mark's' sensitivity to salinity. Under high-salt treatment, Na levels in 'Top Mark' did not exceed 14.8 (leaf) or 30 (melon) meq/100 g dry wt.

Cultivar differences in K concn are also important, in that ample K availability may reduce Na uptake. Furthermore, NaCl tolerance in some halophytes has been attributed to unhampered K metabolism and availability (7, 9). 'Top Mark' had slightly lower K levels in conjunction with its high Na concn and, while absolute K concn were not exceptionally low, these trends support previous findings (6, 7, 9).

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J. Amer. Soc. Hort. Sci. 103(1):130–134. 1978.

Relationship of Stage of Ripeness and Holding Temperature to Decay Development of Blueberries[1]

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Additional index words. marketing *Vaccinium corymbosum*

Abstract. **The relationship of holding temperature and stage of ripeness to decay development of blueberries (*Vaccinium corymbosum* L) was determined comparing 6 sets of 5 ripeness classes (light-sorted; 740-800 nm) stored at 1.1°, 10.0°, and 22.2°C. On each of 6 dates, 1 set (3 temperatures × 5 ripenesses × 4 replications) was removed from storage and sorted for decay. Regardless of cultivar or stage of ripeness, all blueberries stored at 22.2° decayed rapidly (within 5 days). Only when the blueberries were held at 1.1° did the time and expense of light-sorting appear economically justifiable; i.e., overripe berries (% soluble solids (SS)/% acid (Ac) ratio = 30) required about 12 days while just-ripe blue fruits (SS/Ac = 10) required about 32 days to develop 20% decay. Estimates of maximum degree of ripeness (SS/Ac) for fresh marketing (< 20% decay at retail) were made: Trans-Atlantic (up to 20,) transcontinental (up to 27), and local ($\lesssim$ 1200 km) (up to 30). Fruit riper than SS/Ac = 30 should be processed within 24 hours.**

Shipment to fresh market of uncooled, overripe blueberries which tend to decay quickly costs consumers and producers millions of dollars each year. Only a small percent of the blueberries are pre-cooled quickly before they are loaded into refrigerated trucks for shipment to fresh market. Perhaps growers and packers think that refrigerated trucks cool the blueberries by the time they arrive at market. However, the mechanical refrigeration systems of most trucks are not capable of reducing the temperature of blueberries quickly (1). Rapid cooling aboard trucks is also almost impossible because of the insulative characteristics of and restriction of air movement about the berries by the packages.

[1]Received for publication June 22, 1977. Paper No. 5239 of the Journal Series of the North Carolina Agricultural Experiment Station, Raleigh, N.C.

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