bomb may be an effective means of evaluating the effect of rootstocks on scion leaf water stress. Differences in leaf water stress could be measured by this technique when it could not be detected by visual observations. Additional research is needed to establish the normal range of leaf water stress for different rootstock and scion combinations to aid in interpretation of leaf water stress values. Such information could be helpful in planning the timing of irrigation for citrus trees on certain rootstocks and in evaluating new rootstock selections.

This technique does have limitations because of the time required to execute the measurements. This may limit sample size; but with experience and improved techniques the time required for these measurements can be reduced.

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Rootstocks Affect Postharvest Decay of Grapefruit[1]

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Abstract. **Rootstocks affected decay of grapefruit (*Citrus paradisi* Macf. cv. Redbush) stored for 9 weeks at 10°C plus 1 week at 21°. Fruit from trees on 'Smooth Seville' (Australian sour orange) was least susceptible to decay, 3.3%. Fruit from trees on the hybrid C61-253 ('Shekwasha' × 'Chinotto') was the most susceptible, 27.7%. Postharvest decay was statistically related to rootstocks but not to standard fruit quality characteristics.**

Little research has been reported on the effect of rootstocks on susceptibility to postharvest decay of grapefruit. Rootstock research has been primarily concerned with yield, effects on physical characteristics, chemical composition of the fruit, and tolerance to *Phytophthora,* tristeza and other virus diseases. However, selection of a good rootstock should not only be based on production of large amounts of good quality fruit; but also the shelf-life of the fruit should be taken into account.

Decay of citrus fruit in market channels is extensive. This experiment was designed to determine differences in susceptibility of grapefruit to postharvest decay over a 3-year period among fruit from trees on 21 rootstock cultivars.

Preharvest. Nucellar 'Redblush' grapefruit was harvested in Jan. or Feb. from trees on 21 rootstocks (Table 1) in 4 rootstock trials in 1971, 1972 and 1973. Three replications consisting of 40-fruit samples each were used for postharvest decay studies. Two 80-fruit samples were also collected from trees on each rootstock for fruit quality analyses by standard methods. Each sample was harvested from 2 trees.

Trees were 6 to 10 years old at the beginning of the experiment and received normal grove care, including 4 to 6 flood irrigations and 3 insecticide sprays a year. No fungicides were used. Spring applications of 504 kg of ammonium nitrate (NH_4NO_3) per ha (450 lb./acre) were made. Four trial plantings were located within a 2.4 km (1½ mile) radius on the same farm at Monte Alto, Texas, on bench-levelled Willacy fine sandy loam.

Postharvest. Fruit samples used for the postharvest decay studies were carefully graded for mechanical injury, washed, waxed with a non-fungicidal water-emulsion wax, and dried the day after harvest as in a standard packinghouse operation. The fruit was packed in (4/5 bu) corrugated fiberboard citrus cartons and stored at 10°C for 8 weeks at 95% relative humidity and 1 week at 21°C. Fruit was inspected after 2, 4, 6, 8 and 9 weeks for decay from various pathogens; spoiled fruit was removed as found. Data for fruit quality characteristics, i.e. fruit circumference, rind thickness, soluble solids, total acids and percentage decay were examined for possible simple correlation with susceptibility to decay.

There were large differences in postharvest decay among fruit from trees on 21 rootstock cultivars (Table 1). Approx 80% of the decay was green mold (*Penicillium digitatum* Sacc) and the remainder was diplodia stem-end rot (*Diplodia natalensis* Pole-Evans).

Postharvest decay of fruit from trees on 'Smooth Seville' rootstock was the lowest among the 21 rootstocks in the present experiment. This high resistance to decay combined with tolerance to *Phytophthora* spp. indicate that 'Smooth Seville' should be tested

Table 1. Postharvest decay of nucellar 'Redbush' grapefruit on 21 rootstocks after 9 weeks at 10°C plus 1 week at 21°.

Rootstocks	% decay[z]
Smooth Seville (Australian Sour orange) (*Citrus aurantium* L.?)	3.3 h
Colombian sweet lime (*C. limettoides* Tan.)	4.0 gh
Macrophylla lemon (*C. macrophylla* Wester)	5.5 fgh
Rough lemon (*C. limon* (L.) Burm. f.)	5.7 fgh
Swingle citrumelo (C.P.B. 4475)[y]	8.6 efgh
Texas sour orange (*C. aurantium* L.)	10.5 defgh
Carrizo citrange[y]	11.0 defg
Rich trifoliate orange (*Poncirus trifoliata* Raf.)	11.6 defg
Bittersweet sour orange (*C. aurantium* L.)	12.1 cdefg
Rangpur lime (*C. reticulata* var. *austera* hyb.)	14.1 bcdef
Kunenbo[y]	14.3 bcdef
Sunki mandarin (*C. reticulata* Blanco)	15.2 abcde
Texas sour orange (*C. aurantium* L.)	15.6 abcde
Abers sour orange (*C. aurantium* L.)	16.4 abcde
Taiwanica orange (*C. taiwanica* Tan. & Shim.)	16.9 abcde
Sun Chu Sha Kat mandarin (*C. reticulata* Blanco)	17.9 abcde
Cleopatra mandarin (*C. reticulata* Blanco)	19.9 abcd
C61-241 (Shekwasha × Rough lemon)[y]	21.9 abcd
C61-250 (Shekwasha × Koethen)[y]	24.8 abc
Changsha mandarin (*C. reticulata* Blanco)	25.3 ab
Morton citrange[y]	26.5 ab
C61-253 (Shekwasha × Chinotto)[y]	27.7 a

[z]Avg. of three 40-fruit samples per rootstock at 3 harvests. Means separation between rootstocks by Duncan's multiple range test, 5% level.

[y]Hybrids:

Swingle citrumelo (C.P.B. 4475) (*Poncirus trifoliata* Ref. × *C. paradisi* Macf.)

Carrizo citrange [(*P. trifoliata* × *C. sinensis* (L.) Osbeck)]

Kunenbo (*C. sinensis* × *C. reticulata* Blanco)

C61-241 [Shekwasha *(C. reticulata)* × Rough lemon (*C. limon* L. Burm. f.)]

C61-250 Shekwasha [(*C. reticulata*) × Koethan Sweet orange (*C. sinensis*)]

Morton citrange (*P. trifoliata* × *C. sinensis*)

C61-253 Shekwasha [(*C. reticulata*) × Chinotto (*C. aurantium* (L.) var *myrtifolia* Ker-Gawl.)]

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further.

'Colombian' sweet lime, a rootstock commonly used in Israel (6), also performed very well in this experiment. It exhibited good keeping quality when used as a rootstock for grapefruit, but fruit quality of oranges, tangelos, and mandarins has been poor on this rootstock in Florida (4). Trees on 'Rough Lemon', the major rootstock in Florida (3), also produced fruit which showed little susceptibility to postharvest decay, 5.7%.

Fruit from trees on 'Swingle' citrumelo (C.P.B. 4475), which has been noted as one of the best rootstocks for yield in Texas (1, 5, 8), performed very well in this experiment. Postharvest decay was 8.6%, lower than for the majority of the rootstocks in this study. 'Swingle' citrumelo (C.P.B. 4475), therefore, appears to be one of the most desirable rootstocks for grapefruit in Texas because of high yields, good fruit quality, disease resistance and fruit which is resistant to postharvest decay.

'Texas' sour orange is the most commonly used rootstock in Texas (7); therefore samples were taken from two groups of trees on it. Decay of fruit from trees on this rootstock was relatively low, 15.6 and 10.5%, but differences between this fruit and those showing considerably higher rates of decay were not statistically significant Fruit from trees on trifoliate orange, which is used as a rootstock in many areas, had 11.6% postharvest decay, intermediate between the 2 samples from trees on 'Texas' sour orange.

The four mandarins in this study, 'Changsha', 'Cleopatra', 'Sun Chu Sha Kat' and 'Sunki', also had a high postharvest decay percentage. Decay ranged from a high of 25.3% for fruit from trees on 'Changsha' to 15.2% for those from trees on 'Sunki' but differences were not statistically significant.

Fruit from trees on 'Morton' citrange had over twice as much decay, 26.5%, as 'Carrizo' citrange, 11.0% although the difference was not statistically significant. 'Morton' has been reported to induce better fruit quality than 'Carrizo' (8).

Highest postharvest decay, 27.7%, of 'Redblush' grapefruit was from trees on the hybrid C61-253 ('Shekwasha' × 'Chinotto'). This hybrid, together with the hybrids C61-250 ('Shekwasha' × 'Koethen') and C61-241 ('Shekawasha' × Rough lemon), produced fruit which was very susceptible to postharvest decay as compared to other rootstocks in this study.

No correlation was found among rind thickness, fruit size, total soluble solids, total acids, and susceptibility to decay. All these fruit characteristics are influenced by rootstock, but rootstock effects on decay resistance apparently have other, as yet unknown, bases.

Spoilage of grapefruit in market channels is extensive because of postharvest decay. It was found that fruit from trees on different rootstocks exhibited varying amounts of postharvest decay. Choice of rootstock has typically been based mostly on yield, physical characteristics and chemical composition of fruit. It is clear from these data, however, that differences in susceptibility to decay should also be taken into account.

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Thiabendazole Reduces Chilling Injury (Pitting) of Cyprus-grown Grapefruit[1]

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Abstract. **Thiabendazole (TBZ) incorporated in the wax coating at 2000 ppm, considerably reduced chilling injury of Cyprus-grown grapefruit during storage for 102 days at 8°C plus 34 days at 7°C.**

Chilling injury (CI) is expressed as dark sunken surface lesions on the peel of grapefruit (pitting) stored at low temperatures for prolonged periods. CI has been associated with a breakdown of the ATP/ADP energy transfer system (4, 5) and reduced by high levels (10%) of CO_2 (4). It was prevented when grapefruit were covered with films of polyvinylchloride and cast vinyl for a month at 4.5°C (5). Shiffman-Nadel et al. (3) demonstrated that incorporation of TBZ in a wax coating significantly reduced the amount of low temperature pitting during prolonged storage at 8 and 12°. TBZ has also been found effective against postharvest citrus pathogens. (1, 2).

The purpose of this study was to determine the effect of TBZ on CI of grapefruit grown under Cyprus conditions.

'Marsh Seedless' grapefruit were harvested at the Morphou Experimental Station of the Agricultural Research Institute when the Brix value by refractometer was 11.3° and citric acid 2.3%. The day after harvest, 800 fruit were randomly sorted into 40 telescope cartons. Fruit in 20 cartons were coated with "Sivadar" wax using a hand mist sprayer; those in the remainder were coated with "Sivadar" wax mixed with 2000 ppm TBZ. Cartons were subsequently paired and placed randomly side by side in 4 stacks. Storage temp was 8°C for 102 days followed by 7° for 34 days. Relative humidity of the room was 80 to 85% but in the cartons it was higher. The top 4 pairs of cartons were visually examined once a month for CI. All grapefruit were examined at 116 days and 136 days, then after 3 and 7 days at 27° to 30°C. Fruit was considered

Table 1. Effect of TBZ on the percentage pitting and decay in 'Marsh Seedless' grapefruit.

	102 days at 8°C + 14 days at 7°		102 days at 8° + 34 days 7°		+ 3 days at 27-30°		+ 7 days at 27-30°	
Treatment	Pitting	Decay	Pitting	Decay	Pitting	Decay	Pitting	Decay
	%	%	%	%	%	%	%	%
Wax	7.75	4.25	29.00	7.5	38.75	14.25	43	27.75
TBZ in wax	0.50***	0.75	8.25***	0.75**	20.00***	2.00**	30*	2.75***

*, **, ***Significant at 5% (*); 1% (**); 0.1% (***).

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