

EVALUATION OF COLD-HARDY AVOCADOS IN FLORIDA

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INTRODUCTION

The avocado (*Persea americana*) has been divided into 3 races, West Indian, Guatemalan and Mexican, which have been well described (11). The Mexican race, which is native to cool, mountainous regions, is of particular interest from the standpoint of cold hardiness. Webber (10) reported some varieties of the Mexican type had only young leaves damaged at 21°F after the 1917 freeze in California, while all Guatemalan varieties were killed to the bud. West Indian varieties were even more tender than the Guatemalan, being severely damaged at 27°F. In Texas, Cooper and his associates (4) reported that pure Mexican cultivars were hardier to cold but less tolerant to salt than other races or hybrids of other races with Mexican. Maxwell (6, 7) reported a wide range of tolerance both to cold and to anthracnose (*Coletotrichum gloesporioides*). Anthracnose is the most serious fruit disease of the avocado. In Florida, a series of researchers, including Mowry, Camp, Wolfe, Blackman and Dickey (1, 2, 3, 8, 10), have described the performance of Mexican types at Gainesville. Camp (2) reported that some Mexican types withstood 15°F without serious damage in 1928. Reports of this work ceased about 1935 but some of the trees still exist.

Nurserymen and hobbyists have also played important roles. For example, Mr. W. F. Ward of Avon Park has maintained a variety collection of avocados for many years and Mr. T. J. Anderson of Mulberry has been very active in the past decade in propagating cold tolerant avocados for dooryard use. Mr. J. P. Young of Jacksonville has grown avocados for over 30 years, bringing graftwood and seed directly from Mexico.

The primary demand for avocados north of the commercial avocado region is not for commercial use; however, the avocado would offer

diversification in the citrus area. The tree is much in demand for dooryard culture because it is a handsome, evergreen ornamental as well as a producer of desirable fruit.

The purpose of this paper is to report on the present status of cold-hardy avocados for Florida and their potential for dooryard and limited commercial use.

MATERIALS AND METHODS

Plant material.—Trees of several varieties that were residues of previous research were located in 1961 on the University of Florida campus. These included 2 large, mature trees of 'Mexicola', 'Topa Topa' and 'Brogdon'. There was also one very large, old Mexican type tree of unknown origin. Efforts to root cuttings of this unnamed selection, which as best as can be determined is nearly 40 years old, were successful (5). Some of the cuttings were given to nurserymen who have distributed them under the name of 'Gainesville'. Observations of these varieties have been made annually since 1961.

In the winter of 1962-1963, the temperature reached a low of 12°F and severe subfreezing temperatures were encountered for many hours. The cold-hardiness of some of the Mexican trees was so pronounced it was decided to propagate them and to search for other varieties and selections that might be useful. In 1965, 10 trees each of 'Mexicola' and 'Gainesville' were planted. Graftwood of 'Duke' was obtained from California and 2 trees planted in 1965. In 1966, Mr. T. J. Anderson furnished trees propagated from an old Mexican seedling growing in Summerfield and Mr. J. P. Young donated 2 trees from selections made in Jacksonville. These were placed in a new planting along with trees propagated from the other cold-hardy varieties growing at Gainesville.

In 1968, 'Winter Mexican', 'Zutano', 'Yama', and a number of selections produced in the breeding program of the University of California at Riverside, were obtained through Mr. Lawrence Zill of Delray Beach and added to the collection.

Varietal characteristics.—Observations as to the cold-hardiness of the large, old Mexican types growing on the Gainesville campus have been made since 1961, along with their flowering

and fruiting characteristics. More limited observation and information has been obtained from trees growing at Avon Park, Mulberry and Jacksonville.

Handling cold-damaged trees.—In 1965, 10 'Gainesville' and 10 'Mexicola' trees (about 8 feet tall) suffered cold damage both to major scaffold branches and trunks. These young trees were damaged in several freezes even though mature trees of the same varieties were not. Damaged limbs of each variety were handled in 3 different ways. First, the damaged portions were pruned out as soon as new growth occurred and damage could be ascertained, about April 15. Second, similar pruning was done following the maturation of new growth, about May 15. Third, limbs were pruned following the development of several additional flushes of growth in late summer, about August 15. Observations as to the recovery of these limbs were made periodically.

RESULTS AND DISCUSSION

Tolerance to cold.—Temperature records in Table 1 indicate that a minimum of 25°F or lower was reached every year from 1961 to 1970. A minimum temperature of 20 or below was reached in 6 of the 9 years and in 5 years the temperature dropped below 20. Only 2 of the varieties tested, 'Gainesville' and 'Mexicola', appear well adapted. These 2 varieties have fruited reasonably well in 7 of the 9 test years, failing to fruit only in the 2-year period from 1962 to 1964. The historic freeze of December 1962 killed the 'Gainesville' and 'Mexicola' back to major framework branches and eliminated fruiting for that year and the following year. The 'Topa Topa' and 'Brogdon' were killed back to

a foot or 2 above the bud union but they recovered rapidly. 'Topa Topa' fruited only 4 of 9 years and 'Brogdon', only 2. Less information is available for the 'Duke' but it did fruit in 2 years and appeared hardier than 'Brogdon', ranking about equal with 'Topa Topa'.

On the other hand, a large 'Brogdon' tree growing in the courtyard of McCarty Hall has fruited nearly every year. This tree gets only a few degrees more protection from cold than the others. It is possible that homeowners could grow varieties such as 'Brogdon' in protected places in the Gainesville area. Of course, tree damage is inevitable when historic freezes such as 1962 occur.

In addition, observations in 1965 and 1969 of 'Brogdon' and 'Winter Mexican' trees growing in the citrus area (Highlands, Polk and Hillsborough Counties) indicated that these 2 varieties will fruit in those areas in all but the severest winters.

It is noteworthy that bloom on all of these avocados starts in late December or early January and continues through February in a prolonged bloom. Often bloom is initiated and then cool weather prevents its development for several weeks. In every season except 1967-68, appreciable bloom was damaged on all trees that flowered. Even so, 'Gainesville' and 'Mexicola' fruited from a "second bloom" that developed from lateral buds in back of the frozen blooms. This is an important characteristic because temperatures which will damage flowers in January are almost inevitable throughout the northern half of peninsular Florida. The reduction of flowers is advantageous in the case of 'Mexicola'

Table 2.--Years during which several avocado varieties fruited at Gainesville.¹

Year	Variety				
	Gainesville	Mexicola	Topa Topa	Brogdon	Duke
1961-62	Yes	Yes	Yes	No	--
1962-63	No	No	No	No	--
1963-64	No	No	No	No	--
1964-65	Yes	Yes	Yes	No	Planted
1965-66	Yes	Yes	No	No	No
1966-67	Yes	Yes	Yes	No	No
1967-68	Yes	Yes	Yes	Yes	Yes
1968-69	Yes	Yes	No	Yes	Yes
1969-70	Yes	Yes	No	No	No

¹Yes indicates a fair crop of fruit; even in some years labeled No there might have been a few fruit from blooms within the tree canopy.

Table 1.--Minimum temperatures for December, January and February respectively on the Gainesville campus (Agronomy Farm).

Month	Temp	Month	Temp	Month	Temp	Month	Temp	Month	Temp
1961-62		1963-64		1965-66		1967-68		1969-70	
Dec	18 F	Dec	25 F	Dec	28 F	Dec	30 F	Dec	30 F
Jan	21	Jan	20	Jan	17	Jan	25	Jan	19
Feb	31	Feb	29	Feb	23	Feb	29	Feb	23
1962-63		1964-65		1966-67		1968-69			
Dec	12	Dec	30	Dec	26	Dec	20		
Jan	24	Jan	22	Jan	29	Jan	31		
Feb	27	Feb	29	Feb	18	Feb	39		

Table 3.--Wood and shoot damage¹ to several varieties of avocados at Gainesville.

Year	Variety				
	Gainesville	Mexicola	Topa Topa	Brogdon	Duke
1961-62	None	None	None	Shoots	--
1962-63	Large limbs	Large limbs	Trunk base	Trunk base	--
1963-64	None	None	None	Shoots	--
1964-65	None	None	None	None	Planted
1965-66	None	None	Shoots	Shoots	Shoots
1966-67	None	None	Shoots	Small limbs	Shoots
1967-68	None	None	None	None	None
1968-69	None	None	None	None	None
1969-70	Shoots	Shoots	Shoots	Large limbs	Large limbs

¹None indicates inconsequential damage and not its complete absence. Blooms were damaged to some extent every year they occurred. Shoots indicates very appreciable shoot damage. Large limbs means killed to 2 to 4 inch wood. Trunk base means killing to 1 to 2 feet above the bud union.

and 'Gainesville' because the remaining crop is generally adequate and the fruit much larger. The one year that flowers were not frozen these varieties set excessively heavy crops of very small fruit and some dieback of limbs was experienced. Limited observation of the 'Young', which is almost identical to 'Mexicola', indicates it too will produce secondary blooms. 'Topa Topa' does not produce a second bloom. 'Winter Mexican' and 'Brogdon' have produced a limited second bloom but observations on these 2 varieties are inadequate for a firm conclusion.

A minimum lethal air temperature for these varieties has not been established because the duration of cold and other factors influence the tree response. Plant dormancy does not appear to be as influential as in citrus and other subtropical crops. Damage to vegetative portions has not been more severe when the tree was producing new shoots and bloom than when it is not. This has been previously noted (6). It is reasonably accurate to state that 'Gainesville' and 'Mexicola' will sustain minimum temperatures from 15 to 20°F in northern Florida for several hours without damage to vegetative portions. 'Topa Topa' and 'Duke' are 2 to 3° less cold-hardy, while 'Brogdon' and 'Winter Mexican' are 2 to 3° less cold-hardy than 'Topa Topa'.

The search for cold-hard varieties is by no means exhausted. The 'Yama' and several hybrid selections from California show promise of being as hardy or possibly harder than 'Mexi-

cola'. Several years of additional testing will be needed, however, before firm conclusions can be drawn.

Handling cold-damaged trees.—Ten trees each of 'Gainesville' and 'Mexicola' were planted in the experimental block in 1965. They have not been banked or protected in any way. Some of the limbs and trunks have been damaged at temperatures that did not harm older trees of these varieties. The damage was too sporadic for the development of a systematic experiment; however, as the opportunity arose, comparable limbs were treated in 3 different fashions as the opportunity arose. First, apparently damaged wood was cut out as soon as the damaged area could be delineated, about April 15. Second, the dead wood was cut out after an appreciable number of new shoots had developed and the leaves matured, about May 30. Third, damaged wood was removed in late summer, about August 15.

Regeneration of tissue below the damaged areas occurred quite commonly and the limbs survived. Removing the obviously damaged portion in mid-April resulted in an unnecessary loss of wood. Moreover, early pruning of the avocado commonly resulted in a further dieback of several inches. Frequently, the freeze damage could not be accurately delineated as late as the end of May. Pruning at this time was much superior to that in April. The best results were obtained by pruning in late summer, at which time the freeze damage and subsequent recovery could be well delineated. Little dieback resulted from pruning at that time. On the other hand, there were times when it became obvious within a month or 2 that very extensive damage had been done to the bark of large limbs. In such cases, it was better to completely remove the limb than to try and save it because new limbs grow very vigorously and the replacement of a major part of a tree can take place within one season. Very vigorous growth often occurs above extensively damaged limbs. Such limbs may die in time of moisture stress or break off in high winds.

Size and quality of fruit.—Table 4 describes some of the important characteristics of the varieties tested. 'Winter Mexican' and 'Brogdon' have commercial potential in the central Florida area of Highlands and Polk Counties and possibly other counties. 'Brogdon' is a beautiful pear-shaped, purple fruit of acceptable size and

Table 4.--Avocado fruit characteristics.

Variety	Color ¹	Quality ²	Growth cracks ³	Weight (g) ⁴	
				Fruit	Seed
Mexicola	P	E	M	110	28
Topa Topa	P	P	S	124	35
Gainesville	G	P	S	89	30
Young	P	E	M	108	30
Young Slipskin	P	F	VS	?	?
Duke	G	P	S	122	36
Brogdon	P	G	R	243	51
Winter Mexican	G	E	F	285	47

¹P, purple; G, green.

²E, excellent; G, good; F, fair; P, poor.

³On fruit maturing on the tree, growth cracks develop anthracnose. VS, very severe; S, severe; M, moderate; F, few; R, rare.

⁴Mean of 50 fruit selected at random from trees with a satisfactory but not heavy crop. Fruit size of Mexicola, which may set excessively, would be smaller with a larger crop.

quality that rarely shows growth cracks or anthracnose even when not sprayed. The skin is thin and it is not known how well 'Brogdon' would ship. 'Winter Mexican' is a pear-shaped, green fruit of excellent quality and appearance. It is about the same size or slightly larger than 'Brogdon'. It has more of a tendency to be infected with anthracnose at the bloom end but it is still quite satisfactory in this respect. It would probably be more acceptable as a commercial fruit than any of the others.

All of the other varieties should be limited to dooryard use only. Of these, 'Mexicola' is the best. This variety consistently produces large crops of very fine quality, pear-shaped, purplish-black fruit. Fruit and seed size are small. There is appreciable flesh. Fruit cracks develop at both the stem and blossom ends and become infected with anthracnose but the problem is less severe than on any but 'Winter Mexican' and 'Brogdon'. 'Young' is so similar to 'Mexicola' as to be considered identical. 'Topa Topa' produces an elongated, purple, pear-shaped fruit that cracks very badly and is severely infected with anthracnose. Quality of the flesh is not as good as 'Mexicola' and the seed is larger than desirable. The 'Gainesville' produces a small, oblong fruit with a seed that is large in comparison with the flesh. Quality is poor and the fruit develops growth cracks and anthracnose almost as badly as 'Topa Topa'. 'Duke' is a small, green, pear-shaped fruit that is similar in quality and

tendency to growth cracks and anthracnose as the 'Gainesville' but has a larger proportion of flesh.

'Young Slip-Skin' is a small, teardrop-shaped fruit that gets anthracnose so badly it does not warrant further description or testing. It is somewhat unique in that it bears early from seed and the fruit from seedlings are fairly similar.

Season of ripening.—Avocado fruits are usually harvested when mature but still hard. Thus, some determination must be made of the proper stage for harvest. No systematic research has been conducted on maturity of Florida-grown Mexican varieties. Several pertinent observations were made on trees at Gainesville. Coloration and maturation of the purple colored varieties starts first at the blossom end and at times both the blossom and stem ends. The fruit can be picked and ripened satisfactorily when the purple color has covered $\frac{1}{8}$ to $\frac{1}{2}$ of the fruit. Fruit picked at this stage and ripened in a cool room, such as an air-conditioned home, have fewer growth cracks than those left to color fully on the tree or those ripened at high temperatures. A ripening temperature of about 70°F has been suggested from very limited trials in Texas (9). The green colored varieties must be harvested on the basis of size. No data on which to establish maturity criteria are available, as they are for commercial varieties. Ripening fruit at 70°F reduced or delayed the development of anthracnose.

None of the varieties tested at Gainesville were sprayed to control diseases or insects because spraying large avocado trees is difficult in dooryard culture.

CONCLUSIONS

1. 'Winter Mexican' and 'Brogdon' varieties have sufficient commercial potential in the central citrus area to warrant further testing there; however, commercial trials should be small because little is known of their shipping quality and market acceptability. They are recommended as dooryard fruit throughout all but the coldest parts of the citrus area.

2. 'Mexicola' rates far above any other variety tested for areas too cold for 'Brogdon' and 'Winter Mexican'. This is a small but fine quality fruit that should fruit most years when winter temperatures range no lower than 15 to 20°F. It is recommended for dooryard culture.

3. No well established criteria for harvesting the fruit have been established but it has been observed that picking the purple colored fruit when $\frac{1}{3}$ to $\frac{1}{2}$ of the surface fruit is colored and ripening at about 70°F results in good quality and minimal anthracnose.

4. There is a good possibility that other superior cold-hardy types will be found but evaluation takes a number of years.

5. Cold-damaged trees should not be pruned until late summer. Recovery from freeze damage is rapid and major replacement of damaged parts can occur within one season.

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EFFECTIVENESS OF COPPER WHEN COMBINED WITH NU FILM 17 FOR CONTROL OF AVOCADO SCAB

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ABSTRACT

Nu Film 17 (poly-l-p Menthen-8,9-diyl) and Triton B 1956 in combination with tribasic copper and Kocide 101 sprays were evaluated for control of avocado scab (*Sphaceloma perseae* Jenkins). Nu Film 17 had a significant effect on the copper fungicidal sprays enhancing disease control and increasing marketable fruit yields.

INTRODUCTION

Florida avocado production costs continue to rise relentlessly. It is increasingly important for the avocado grower to make every tree produce its utmost. Production costs must be reduced whenever possible without sacrificing quality and yield.

One of the most persistent expenses to the grower is disease control. Avocado diseases such

as *Cercospora* spot (*Cercospora purpurea* Cke), *Anthracnose* (*Colletotrichum gloeosporioides* Penz.) and Avocado scab (*Sphaceloma perseae* Jenkins) can cause sizable losses to Florida avocado growers. Most of these diseases are adequately controlled by various rates of some form of copper (2). Unfortunately complete disease control is never obtained with the fungicide since coverage is never complete and unsprayed tissue is exposed during growth of the leaves and fruit. Disease control is further reduced through loss of fungicide due to wind and rain.

Blazquez and McGrew (1) have shown that tomato plants sprayed with fungicide and Nu Film 17 combinations had better foliage with less cucumber target spot than the plants sprayed with fungicides alone.

The purpose of this experiment was to evaluate two copper fungicides for the control of avocado scab and to determine the effect of two spreader stickers, Triton B 1956 and Nu Film 17, on the efficacy of the copper fungicides tested.

MATERIALS AND METHODS

The commercial avocado variety 'Lula' was used because it is very susceptible to avocado scab.