Proc. Fla. State Hort. Soc. 103:55-59. 1990.

A HIGH DENSITY CITRUS PLANTING

T. A. WHEATON, W. S. CASTLE, J. D. WHITNEY,
D. P. H. TUCKER, AND R. P. MURARO
Citrus Research and Education Center
University of Florida, IFAS
700 Experiment Station Road
Lake Alfred, FL 33850

Additional index words: spacing, rootstocks, freeze damage, economics.

Abstract. **A citrus planting of 4 varieties on 15 rootstocks and own-rooted cuttings was spaced approximately 5 ft in the row and 11 ft between rows, providing 800 trees/acre. The rapid growth and early productivity desired in a high density planting were delayed by several freezes. Trees were near containment size after 7 yr, however, and yield was 593, 537, 1009, and 722 boxes/acre for 'Hamlin', 'Valencia', 'Redblush' grapefruit, and 'Murcott', respectively, averaged over 6 of the better rootstocks. Rootstock affected tree size, yield, fruit quality, and cold tolerance. Variety and rootstock combinations of moderate vigor and good fruiting characteristics were most desirable. Production and harvesting equipment must be reduced in size or redesigned to operate in a high density planting. Suitable variety and rootstock combinations can be grown successfully at 800 trees/acre, but long-term production potential and economic return for this high density may be similar to yield and return from moderate density plantings of 140 to 300 trees/acre.**

Planting density of Florida citrus has nearly doubled in the last 50 yr (3). The average tree density for new orange plantings in 1989 was 139 trees/acre. Factors contributing toward increased planting density include land cost and availability, improved management techniques with greater resource efficiency in higher density plantings, and the need for earlier fruit production resulting in earlier economic return. Concepts involved in higher density plantings have been established (8) and previous experiments support the benefits of moderate densities in the 140 to 300 tree/acre range (6, 10). Are even higher densities possible, practical, and economically justifiable? Which variety and rootstock combinations may be best adapted in such a planting?

Experimental citrus plantings at high densities have been established outside of Florida. Experiments in Japan included tree densities ranging from 500 to 4000 trees per acre (7). Time required to attain maximum yield decreased with increasing tree density. Maximum yield, however, ranged from 500 to 700 boxes/acre for all densities. An experiment in Australia produced similar results (5) with tree densities ranging from 270 to 2000 trees/acre. Average annual yield for 6-yr-old 'Valencia' orange trees at 1000 or 2000 trees/acre was 600 boxes/acre. In these and other experiments (1), early yield increased with increasing tree density, but maximum yield of high density plantings generally did not exceed 600 boxes/acre.

Florida Agricultural Experiment Station Journal Series No. N-00334. The authors express appreciation to Chaplin Groves, Ft. Pierce, Florida for the loan of the TOL pruning machine and Massey Ferguson tractor, to Bridges Equipment Co., Plant City, Florida for the loan of the Berthoud sprayer, and to Griffin Grove Service, Bartow, Florida, for hedging the planting in 1989. Trade and company names mentioned in this article are solely for providing specific information and do not constitute an endorsement over other products not mentioned.

A planting at 800 trees/acre was established to determine the potential for a high density planting under Florida conditions. The objectives of this experiment were to select desirable variety and rootstock combinations, to establish equipment requirements, and to determine the economic feasibility for high density plantings. Tree growth and cumulative yield data for all the rootstocks included in this experiment were published previously (9). In the present report, yield and fruit quality information is provided for selected rootstocks that performed well. Information is included on the effects of all rootstocks on cold tolerance. A cash flow budget is developed for planting densities of 140, 272, 360, and 800 trees/acre.

Materials and Methods

The 4 varieties were propagated on a range of rootstocks (Table 1) and planted in the field at Lake Alfred, FL, in 1981. There were 4 replications with variety as the main plot and rootstocks as subplots. Each subplot was 4 by 4 trees with data taken from the center 4 trees. Trees were spaced 4.9 ft in the row and 10.8 ft between rows providing 818 trees/acre, or approximately 5 ft by 11 ft and 800 trees/acre. Irrigation and fertigation were provided as needed to maintain adequate water and nutrient levels. The irrigation system provided one microsprinkler for 2 trees with the sprinkler placed equidistant (2.5 ft) from the trees in the row. Initially, a dual 40° vineyard spray pattern was used to wet a narrow strip in the row. The spray pattern was converted to a 280° fan pattern as the trees increased in size.

Table 1. Rootstocks used for 'Hamlin' and 'Valencia' sweet oranges, 'Redblush' grapefruit, and 'Murcott' tangor (9).

Common name	Scientific name
Carrizo citrange	*Citrus sinensis* (L.) Osb. x *Poncirus trifoliata* (L.) Raf.
Changsha mandarin	*C. reticulata* Blanco
Cleopatra mandarin	*C. reticulata*
Flying Dragon trifoliate	*P. trifoliata*
Jacobsen trifoliate	*P. trifoliata*
Koethen sweet orange x Rubidoux trifoliate	(See Carrizo)
Macrophylla	*C. macrophylla* Wester
Milam	*C. jambhiri* Lush., variant
Morton citrange	(See Carrizo)
Own-rooted	Rooted cuttings of each scion cultivar
Palestine sweet lime	*C. limettioides* Tan.
Rangpur x Troyer citrange	*C. limonia* Osb. x (See Carrizo)
Rubidoux trifoliate	*P. trifoliata*
Rusk citrange	(See Carrizo)
Sour orange	*C. aurantium* L.
Swingle citrumelo	*C. paradisi* Macf. x *P. trifoliata*

Trees were hedged to maintain a 5 ft alley between rows and topped at a height of approximately 8 ft. Trees were hedged and topped for the first time in the summer of 1987 and hedged again in the summer of 1989. The equipment used to manage the planting was small, tractor-mounted equipment that moved in the 5 ft alley for herbicide and spray applications, and for hedging and topping. In the experimental planting, a 20 ft cross middle was left at the end of every 2 plots for fruit handling equipment. However, in a commercial planting, continuous rows would require other approaches to fruit handling.

Data collected included tree growth, yield, fruit quality, and freeze damage assessments following the 1983, 1985, and 1989 freezes. All results were analyzed using ANOVA statistics. Economic comparisons reported here were based on average production costs adjusted for tree density and an estimate of potential yield in the absence of severe freezes. Production losses due to freezes in the actual experiment precluded use of data from the experiment in the economic analyses.

Results and Discussion

The freezes of the 1980s reduced tree growth, lengthened the time required for trees to fill their allocated space, and reduced productivity during the early years of the planting. Thus, the improved early yield anticipated from a high density planting was not achieved. The relative performance of scion and rootstocks allowed selection of variety and stock combinations that appeared suitable for a high density planting. In a previous report, tree size and cumulative yield for the 4 varieties on all rootstocks were described (9). The rootstocks, listed in Table 1, induced considerable variation in vigor, tree size, yield, and fruit quality of the varieties. Generally, rootstocks considered to be of moderate vigor (2) and producing good fruit quality were better than rootstocks of either very low or high vigor. Six stocks that performed well for all 4 varieties were sour orange, Swingle citrumelo, Carrizo citrange, Koethen x Rubidoux, Morton, and Rusk citranges.

Yield, fruit quality, and tree size. Results are presented for these 6 stocks during the 1988/89 season as representative of the potential of a high density planting. Maximum yields were obtained this season as most trees had filled their allocated space (trees 7 yr old) and there were no negative weather factors for this crop. Crop loads were heavy but not excessive except for 'Murcott' where an excessive crop load caused some tree decline.

Average yields for the 6 selected rootstocks were 593, 537, 1009, and 722 boxes/acre for 'Hamlin', 'Valencia', 'Redblush', and 'Murcott' respectively (Table 2). Yield was similar for trees on these 6 stocks except for 'Murcott' where yield was lower for trees on Rusk. All fruit from trees on these stocks was of good quality with only minor and inconsistent effects of stock on fruit size, juice percent, soluble solids, and juice acid. Effects of stock on tree size (canopy volume) were also minor except trees on Rusk were significantly smaller than some other stocks for 'Hamlin' orange and 'Redblush' grapefruit.

Other stocks included in the experiment and reported previously (9) were less satisfactory. Vigorous stocks such as Macrophylla and Palestine sweet lime produced large trees but poor fruit quality. The comparative performance of these vigorous stocks may have been better in the absence of severe freezes. Less vigorous stocks such as the trifoliates are generally considered desirable for high density, but performed poorly in this experiment.

Table 2. Yield and fruit quality for 1988/89 season of 4 varieties on 6 rootstocks planted at 800 trees/acre.

Stock	Yield box/acre[z]	Fruit size g/fruit	Juice %	Sol. solids %	Acid %	Canopy vol. ft^3/tree
			Hamlin orange (harvested 16 Feb. 1989)			
Sour	585	155	58.7 b[y]	11.6	0.71	313 a
Swingle	632	148	58.3 b	11.6	0.75	311 a
Carrizo	651	169	57.4 b	11.2	0.67	290 a
K x R[x]	587	174	57.7 b	11.7	0.70	257 a
Morton	655	162	57.9 b	11.8	0.71	290 a
Rusk	445	164	60.1 a	11.9	0.73	174 b
Avg.	593	162	58.3	11.6	0.71	273
			Valencia orange (harvested 30 Mar. 1989)			
Sour	573	154 c	57.4	12.1	0.97 a	289
Swingle	654	170 bc	58.0	12.1	0.94 ab	290
Carrizo	583	174 abc	56.0	12.3	0.88 bc	258
K x R	430	172 abc	56.9	12.5	0.85 c	214
Morton	479	198 a	56.8	12.0	0.85 c	241
Rusk	502	196 ab	57.6	12.2	0.83 c	236
Avg.	537	177	57.1	12.2	0.88	255
			Redblush grapefruit (harvested 16 Feb. 1989)			
Sour	1173	364 c	60.8	9.3 b	1.24 a	395 a
Swingle	900	430 ab	60.7	9.5 b	1.19 ab	353 ab
Carrizo	817	462 a	57.5	9.2 b	1.11 c	287 bc
K x R	1208	431 ab	59.9	9.4 b	1.09 c	286 bc
Morton	974	394 bc	61.3	9.6 b	1.11 c	254 c
Rusk	979	351 c	60.9	10.0 a	1.15 bc	207 c
Avg.	1009	405	60.1	9.5	1.15	297
			Murcott tangor (harvested 15 Feb. 1989)			
Sour	880 a	137	58.0	12.9	0.73	195
Swingle	680 ab	156	56.8	12.9	0.70	195
Carrizo	775 a	148	57.6	12.9	0.67	204
K x R	785 a	151	56.7	13.0	0.70	185
Morton	743 a	140	57.6	12.9	0.74	191
Rusk	471 b	156	57.2	12.2	0.69	112
Avg.	722	148	57.3	12.8	0.70	180

[z]A box of oranges weighed 90 lb, grapefruit 85 lb, and 'Murcott' 95 lb.
[y]Mean separation within variety and columns by Duncan's multiple range test (P = 0.05).
[x]K x R is Koethen x Rubidoux.

In comparing varieties, 'Murcott' appeared to be particularly suitable for high density because of its smaller tree size and upright growth habit. Both orange varieties also adapted well to high density. Because of its greater vigor, grapefruit trees migh prove difficult to maintain within their allocated space. On the other hand, the production of considerable inside fruit by grapefruit may be advantageous in a high density planting. 'Redblush' was a suitable variety in this experiment.

Yield and fruit quality of these trees at 7 yr of age was satisfactory which demonstrated the horticultural feasibility of high density plantings. Production exceeding 500 boxes/acre would be expected in less than 7 yr in the absence of damaging freezes. We anticipate that production levels similar to the 1988/89 season could be maintained for a number of years in the absence of adverse weather. However, continuing production at these levels could not be verified because most of this planting was killed by the Dec. 1989 freeze.

Cold tolerance. Rootstock affected freeze damage and tree survival during the freezes of the 1980s. Visual freeze damage ratings following the Dec. 1983, Jan. 1985, and Dec. 1989 freezes indicated substantial diiferences among rootstocks in scion cold tolerance. With a few exceptions, the relative effect of rootstock was similar for all 3 freezes. Also, with a few exceptions, the effect of rootstock on cold tolerance was similar for the 4 varieties.

Freeze damage ratings after the Dec. 1989 freeze reflect severity of the freeze. Using a scale of 0 for a dead tree and 10 for an undamaged tree, most trees received ratings of less than 5 (Table 3). Trees on vigorous rootstocks including Macrophylla and Palestine sweet lime were most severely damaged. Trees receiving the least damage were on Changsha, Swingle, Morton, and sour orange. Generally, the effect of rootstock was similar for each of the varieties. Exceptions included own-rooted 'Valencia' which received more damage than other own-rooted varieties, and 'Valencia' on Flying Dragon which received less damage than other varieties on this stock.

Freeze damage was less severe in the 1983 and 1985 freezes, but the relative protection provided by rootstock was similar to the 1989 freeze (data not shown). Thus, Changsha, Swingle, Morton, and sour orange received less freeze damage in each freeze than the vigorous-type stocks. Cleopatra exhibited little cold tolerance during the 1983 and 1985 freezes but did relatively well in 1989, and Koethen x Rubidoux provided very cold hardy trees in the 1983 and 1985 freezes but was average in 1989. Damage from the 1989 freeze was so severe that few trees could be salvaged. Several months after the freeze, a number of trees on Changsha and Swingle were in satisfactory condition. Many other trees were killed or damaged so severely that maintaining the experiment was not practical.

These observations are generally consistent with previous reports of the effect of rootstock on cold tolerance (2) and provide additional information on some less common stocks. The vigorous lemon-type stocks provided the least protection. The trifoliate and citrange stocks were mostly intermediate. However, Morton and Koethen x Rubidoux performed well for cold tolerance, yield, and fruit quality. Own-rooted varieties were above average in cold tolerance. Swingle and sour orange also provided cold hardiness as expected. Cleopatra mandarin did not do as well as expected based on previous reports. Trees on Changsha mandarin, however, received relatively little damage during any of the freezes. This stock also provided desirable yield and fruit quality for 'Murcott' and grapefruit, but not for the oranges.

Equipment requirements. Conventional equipment was used in the planting for the first 4 or 5 yr because space was adequate due to reduced tree canopy development as the result of the 1983 and 1985 freeze damages. Subsequently, narrower equipment was required to prevent tree limb and fruit damage. In 1987, the trees were hedged, topped, and skirted with a TOL Model HS-650 pruning machine mounted on a Massey Ferguson Model 174S 4-wheel drive tractor (52 inch overall width). Pesticides were applied with a Berthoud Model 1000S pto sprayer towed by the Massey Ferguson tractor. Herbicides were applied with an applicator mounted on a Kubota Model L 175 tractor (overall width 56 inches) but could have been mounted on the Massey Ferguson tractor. For harvesting, the fruit handling truck and fruit containers were moved through the 20 ft wide middles perpendicular to the tree rows while the pickers (without ladders) moved the harvested fruit no more than 20 ft down the row to the fruit container.

In continuous hedgerows, the above narrow equipment is commercially available and could be utilized satisfactorily. Conventional fruit handling equipment, however, could not be utilized. One possible solution is to develop narrow equipment to handle fruit containers in the row middle (aisle) and have the pickers move up and down the middles. Without ladders, the pickers could probably move by existing 8-box tubs and 10-box pallet bins in a 5-ft middle, or smaller containers could be developed. Harvesting costs might be reduced for this planting because fruit could be picked from the ground without ladders or while riding on simple platform.

Economic analysis. Economic analysis indicated there may be little advantage in planting oranges in Florida at

Table 3. Effect of stock on freeze damage during the Dec. 1989 freeze. Rating scale: 0 = dead tree; 10 = no damage. Rating made on 27 Feb. 1990.

	Variety							
	Hamlin		Valencia		Grapefruit		Murcott	
Rootstock	Rating	(Rank)	Rating	(Rank)	Rating	(Rank)	Rating	(Rank)
Carrizo	2.5	(12)	2.5	(13)	1.0	(15)	2.0	(6)
Changsha	6.3	(1)	5.0	(4)	6.5	(1)	4.0	(2)
Cleopatra	3.3	(8)	3.3	(10)	3.5	(6)	3.5	(4)
Flying Dragon	2.8	(11)	5.3	(3)	2.8	(12)	1.0	(9)
Jacobsen	3.5	(7)	3.3	(10)	3.3	(9)	0.5	(15)
Koethen x Rubidoux	3.3	(8)	4.0	(6)	3.3	(9)	0.8	(11)
Macrophylla	0.8	(15)	0.5	(15)	1.8	(13)	0.8	(11)
Milam	2.0	(14)	2.0	(14)	1.8	(13)	0.5	(15)
Morton	4.5	(3)	6.0	(1)	4.0	(4)	1.0	(9)
Own-rooted	4.0	(4)	3.0	(12)	4.5	(2)	4.8	(1)
Palestine sweet lime	0.0	(16)	0.0	(16)	0.5	(16)	0.8	(11)
Rangpur x Troyer	2.3	(13)	4.0	(6)	3.3	(9)	1.5	(7)
Rubidoux	3.8	(6)	4.0	(6)	4.5	(2)	1.3	(8)
Rusk	4.0	(4)	3.8	(9)	3.8	(5)	0.8	(11)
Sour orange	3.3	(8)	4.3	(5)	3.5	(6)	4.0	(2)
Swingle	6.0	(2)	5.8	(2)	3.5	(6)	2.3	(5)
CV%	37.3		39.4		47.1		65.5	
LSD 0.05	1.7		2.0		2.2		1.7	

800 trees/acre. In this analysis, cost and yield data (4) were adjusted for density and used to construct cash flow budgets for 'Hamlin' oranges planted at 140, 272, 360, or 800 trees/acre. Because of the delayed production due to freezes in the present experiment, it was not possible to use actual yield information in an economic analysis. Instead, analyses were performed using yield information developed for individual trees at wider spacings (4) and extrapolated to plantings of higher densities. In these analyses, we assumed that yield per tree was independent of spacing until a maximum yield of 700 boxes/acre was reached and that maximum yield was the same and could be maintained for all 4 spacings. This results in the yield curves for different spacings shown in Fig. 1. The yield curve for 140 trees/acre is representative of better groves in Florida today. The cash flow budget assumed trees were planted in year 2 and the price received by growers was $1.25 per pound solids delivered in with a pick and haul cost of $1.75 per box.

A number of assumptions must be made in constructing an economic model for the effect of spacing on profitability. Some costs vary with tree density and others are independent of spacing. Costs varying with density include irrigation investment, trees, planting, wraps, material cost for fertilizers and pesticides for young trees, and costs associated with equipment travel since closer row spacing results in more miles of row per acre. Costs independent of tree density include land purchases and preparations and fertilizer and pesticide material costs at maturity when these are applied on a per acre basis.

Cumulative cash flow over the 15-yr period showed small differences among the 4 spacings (Fig. 2). Plantings at 272 or 360 trees/acre returned slightly more than 800 or 140 trees/acre. Negative cash flow during the early years is much greater for 800 trees/acre, however, which is an important factor in risk analysis of possible catastrophic loss during the first few years. Based on this analysis, a planting at 800 trees/acre would be feasible but would offer no economic advantage over more moderate densities.

Potential for high density planting. A citrus planting at 800 trees/acre in Florida appears to be horticulturally and economically feasible. Success depends on the selection of

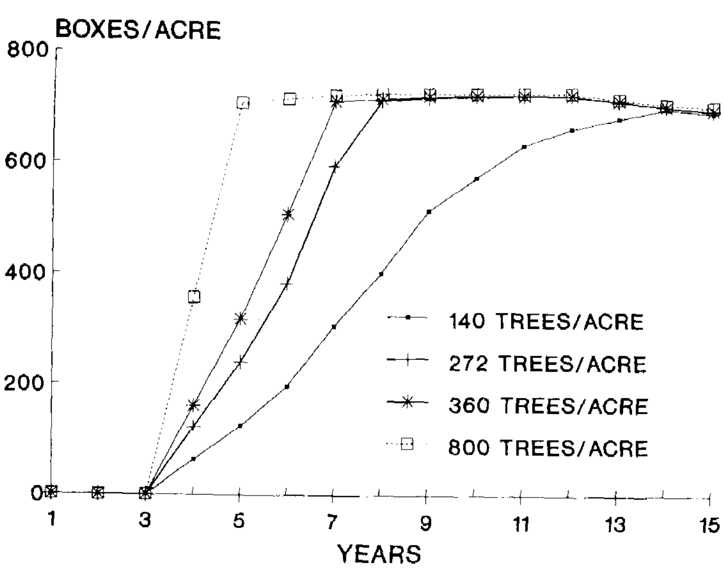

Fig. 1. Yield curves assumed for the cash flow analysis.

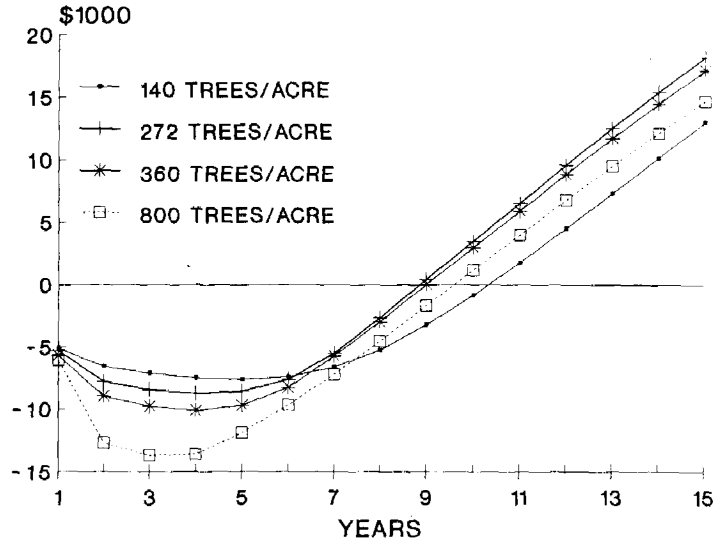

Fig. 2. Cumulative cash flow for orange trees at 4 densities. Calculations assumed planting trees in year 2; yield curves from Fig. 1 and average costs described previously (4).

suitable variety and rootstock combinations. Rootstocks of moderate vigor and producing satisfactory crops of good quality fruit in this study included sour orange, Swingle, Carrizo, Rangpur x Troyer, Morton, and Rusk. Other stocks might be considered for particular varieties or environments.

There appear to be few advantages in such a high density planting. Although high density plantings reach maximum productivity at a very young age, yield at maturity does not exceed yield for mature plantings at lower densities. Investment costs are higher for high density plantings, leading to higher initial risks in the event of a catastrophic loss. Equipment modifications for management and harvesting are required for rows at close spacings. One advantage of high density is shorter trees so all harvesting may be done from the ground. However, fruit handling from the grove would require different equipment than exists today.

The trend in tree spacing throughout the state is toward increased but moderate densities. With Florida's climate and the intensive management practices being used today, trees at moderate densities grow rapidly to their desired size and reach excellent productivity at an early age. With existing plant materials and technology, plantings in the range of 140 to 300 trees/acre may be optimal for most situations.

Literature Cited

1. Cary, P. R. 1981. Citrus tree density and pruning practices for the 21st century. Proc. Int. Soc. Citriculture 1:165-168.
2. Castle, W. S., D. P. H. Tucker, A. H. Krezdorn, and C. O. Youtsey. 1989. Rootstocks for Florida citrus. Univ. Fla. Ext. Bull. SP42.
3. Florida Agricultural Statistics Service. 1990. Commercial citrus inventory. 109 pp.
4. Ford, S. A., R. P. Muraro, and G. F. Fairchild. 1989. Economic comparison of southern and northern citrus production in Florida. Proc. Fla. State Hort. Soc. 102:27-32.
5. Hutton, R. J. and B. R. Cullis. 1981. Tree spacing effects on productivity of high density dwarf orange trees. Proc. Int. Soc. Citriculture 1:186-190.
6. Koo, R. C. J. and R. P. Muraro. 1982. Effects of tree spacing on fruit production and net returns of 'Pineapple' oranges. Proc. Fla. State Hort. Soc. 95:29-33.

7. Tachibana, S. and S. Nakai. 1989. Relation between yield and leaf area index in different planting densities under different cultural treatments in Satsuma mandarin (*Citrus unshiu* Marc. var. *praecox*) tree. J. Japan Soc. Hort. Sci. 57:561-567.
8. Wheaton, T. A., W. S. Castle, D. P. H. Tucker, and J. D. Whitney. 1978. Higher density plantings for Florida citrus - Concepts. Proc. Fla. State Hort. Soc. 91:27-33.
9. Wheaton, T. A., W. S. Castle, J. D. Whitney, and D. P. H. Tucker. Performance of citrus scion cultivars and rootstocks in a high density planting. HortScience (In press).
10. Wheaton, T. A., J. D. Whitney, W. S. Castle, and D. P. H. Tucker. 1986. Tree spacing and rootstock affect growth, yield, fruit quality, and freeze damage of young 'Hamlin' and 'Valencia' orange trees. Proc. Fla. State Hort. Soc. 99:29-32.

Proc. Fla. State Hort. Soc. 103:59-61. 1990.

FUNGI IN RIO GRANDE GUMMOSIS LESIONS AND PATTERNS OF GUMMOSIS-AFFECTED GRAPEFRUIT TREES IN INDIAN RIVER AREA GROVES

R. M. SONODA AND R. R. PELOSI
University of Florida, IFAS
Agricultural Research and Education Center
P. O. Box 248
Ft. Pierce, Florida 34954-0248

Additional index words. Diplodia natalensis, salt tolerance, rootstocks, vegetative compatibility, ordinary runs analysis.

Abstract. **Reports of gummosis symptoms on trunks and limbs of grapefruit trees planted in the 1960's and 1970's in the Indian River citrus-growing area have increased as trees have grown older. Most affected trees have symptoms corresponding to descriptions of Rio Grande gummosis, a disease of yet unclear etiology. *Diplodia natalensis* Pole-Evans (*Lasiodiplodia theobromae* (Pat.) Griffon Maubl.) often associated with Rio Grande gummosis lesions, was not consistently isolated from gumming lesions. Also, *D. natalensis* genotypes, distinguished on the basis of vegetative incompatibility reactions on Difco Potato dextrose agar, differed within the same Rio Grande gummosis lesion and occasionally within the same area of a lesion. Analysis of a planting of grapefruit scion on different rootstocks indicated no relationship between rootstock tolerance to salinity and incidence of Rio Grande gummosis. Ordinary runs analysis, a technique used to analyze spatial patterns, indicated that Rio Grande gummosis-affected grapefruit trees were often random or sometimes aggregated downrow or across rows.**

Planting of grapefruit in the east coast citrus growing area of Florida increased in the 1960's and 1970's. As these grapefruit plantings have aged, the incidence of trunk and limb gummosis have increased. Most of the gummosis observed on grapefruit trees in groves in the Indian River area conform to descriptions of Rio Grande gummosis (RGG) (8). RGG continues to be a disease of unclear etiology, although several hypothesis have been advanced as to causal factors.

A fungus, *Diplodia natalensis* Pole-Evans, is often associated with RGG lesions in Florida (3). The fungus has a wide host range and the names applied to it have changed frequently. Currently the most acceptable name seems to be *Lasiodiplodia theobromae* (pat.) Griffon and Maubl. Another name used for the fungus when associated with citrus is *Physalospora rhodina* Cooke (7). We will use *D. natalensis*, the most commonly used name in recent literature on citrus diseases (8), in our report.

Florida Agricultural Experiment Station Journal Series No. N-00314

In Texas, RGG is attributed to infection by *D. natalensis* (5). Although *D. natalensis* is frequently found in RGG cankers in Florida, Childs (4) felt that *D. natalensis* was not the initiator of the syndrome. No effort has been made to determine the make-up of *D. natalensis* in RGG lesions. The presence of different genotypes of *D. natalensis* within RGG lesions would support the hypothesis that it is a secondary invader. Voorhees (7) in 1942, reported that *D. natalensis* isolates from different sources can be distinguished on agar medium by the formation of a zone of dark colored mycelia where colonies meet. No dark zones are formed between subcultures from the same isolate. These dark zones between colonies of other fungi have been used to indicate differences in genetic makeup.

Childs (4) reviewed work by others that indicated that incidence of RGG lesions increased with increasing amounts of KCl applied to grapefruit trees. He also reported an increase in RGG symptoms with increase in applied $CaCl_2$.

Fewer RGG lesions occurred when $K+$ was applied as K_2SO_4 (4). Childs (4) work suggests that with increase in Cl^- applied, RGG incidence increases. It could not be determined from Childs' study (4) whether Cl^- can initiate RGG. Different rootstocks are considered to have different sensitivities to Cl^-. Observations made by the authors suggested that differences in salt tolerance may coincide with RGG tolerance. No associations of differences in RGG incidence with rootstock differences was found in a search of the literature.

Patterns of disease incidence can frequently provide clues as to etiology of a disease. No studies of RGG spatial patterns have been reported.

The objectives of this study were to determine the composition of *D. natalensis* within individual RGG lesions, document the incidence of RGG in a rootstock study and analyze patterns of RGG incidence in several Indian River area groves.

Materials and Methods

Bark or wood samples (0.5-1.5 cm x 2-3 cm) were chiseled from RGG lesions on grapefruit trunks. One lesion each on selected trees were sampled. In sample set 1, wood samples from 10 locations within each of 7 lesions, with obvious wood discoloration, were obtained from grapefruit trees in a planting on sour orange rootstock. In sample set 2, lesions were sampled from 10 trees in a grove of mixed rootstocks. In set 2, bark and wood segments were obtained from newly gumming lesions. The tissue samples were surface-sterilized in 0.5% NaOCl and cut into