FIELD EVALUATION OF GRAPE ROOTSTOCK RESPONSE TO NATURAL INFECTION BY PIERCE'S DISEASE

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ABSTRACT
To understand the adaptation of grape rootstocks commonly used in major grape production areas worldwide to Florida, where Pierce's dsease (PD) is the primary limiting factor in grape production, ten important grape rootstocks were cultivated at the experimental vineyard, Florida A&M University, Tallahassee, Florida. Disease resistance and symptoms and growing performance were evaluated. PD symptoms were scored in September and October 2002 and 2003, with leaf symptoms the basis of scoring. None of the grape rootstocks was completely resistant to PD and the severity of PD varied with rootstock cultivar. Ramsey and St George showed least PD symptoms, while Freedom and 3309C had the highest PD scores. Vine vigor was evaluated in the fall of 2002 and 2003, and varied among the rootstocks as evidenced by trunk diameter, annual shoot length, annual shoot node number, internode length, and shoot diameter. Shoot death rate in 2002 ranged from 7% to 56%, with Freedom the highest and O39-16 the lowest. The overall growth performance suggested that St George and Ramsey are the most suitable rootstocks in northern Florida environment where natural infection by PD is very high and vectors and inoculum are abundant.

INTRODUCTION
Rootstocks are used widely in viticulture to provide resistance against soil pests and pathogens and improve scion performance. Choice of rootstock depends on pest populations, soil, and growing conditions. The grape rootstocks in common use world wide are deployed primarily to provide phylloxera and nematode protection (Bouquet 1980, Einset and Pratt 1975, Winkler et al 1974). In contrast, Pierce's disease (PD), caused by gram-negative bacterium *Xylella fastidiosa* (Wells et al), is the primary limiting factor of growing *Euvitis* grape in the southeast United States (Lu and Ren 2002, Chen et al 2001). Pierce (1905) reported that rootstock variety affected expression of "California vine disease" (now known as Pierce's disease) in grape. Grape rootstock trials in Mississippi showed a large effect of rootstock trial on vine longevity in a region recognized for high Pierce's disease pressure (Loomis 1965, 1952, Magoon and Magness 1937). In humid and hot regions of the United States, such as Florida, bunch grapes often are highly susceptible to pests and diseases (Olien and Hegwood 1990). When the Florida hybrid bunch grape cultivar Blanc du Bois was grafted on to muscadine, which is relatively tolerant or resistant to the bunch grape pests and diseases common in North America, the scion showed a reduction in both PD and anthracnose symptoms and fruiting improved (Ren and Lu 2003). Growing conditions in Florida are harsh-successful rootstock for grape industry in that area must be tolerant to PD and adapted to the environment. Evaluation of rootstock performance and survival in Florida would provide useful information on rootstocks performance for humid tropical and subtropical environments, especially where PD is prevalent. Greenhouse screening has been used to investigate the PD resistance, tolerance, and susceptibility of grape cultivars. However, field screening is more applicable, since conditions closely match those in a commercial vineyard. When relying on natural infection in the vineyard, there is no need to inoculate vines or maintain colonies of *Xf* or insect vectors. Field screening is cheap, requires no specialized equipment and can be accomplished quickly, with symptom expression being used as the main criterion. Northern Florida is an ideal test environment due to heavy PD pressure, with abundant vectors, including glassy-winged sharpshooter, and inoculum, in contrast to many other locations, especially California, which demonstrate substantial cycling of PD incidence.

OBJECTIVES
Evaluate the response of grape rootstocks to natural field infection by Pierce's disease.

RESULTS AND CONCLUSIONS
Ten grape rootstocks (five replicates of two vines each, ten vines total per rootstock cultivar) were planted in the spring of 2001. Vines were bilaterally cordon trained and spur pruned. Pierce's disease (PD) symptoms were scored in 2002 and 2003, with symptoms on leaves assessed in a numerical scale from 0 to 5. For PD, 0 represented no symptoms, 1 = minor symptoms up to 15% of leaves with marginal necrosis (MN), 2 = 15-30% of leaves with MN, 3 = 30-50% of leaves with MN, 4 = 50-75% of leaves with MN, 5 = over 75% of leaves with MN or vine dead. Vine vigor was surveyed later fall in 2002. The annual shoot and node growth was recorded from ten randomly sampled shoots per plant, and shoot diameter was taken in the middle of 4^{th} node. Node length was calculated with total node numbers and the length of each shoot. Twenty (4 x 5) random shoots were investigated for shoot death rate from each vine: 5 shoots in each canopy quadrant area divided by the main trunk and trellis wire. shoot was considered as dead if more than half of the shoot had died. Trunk diameters were measured 50 cm above the ground in fall 2003.

All rootstock vines developed PD symptoms, although the severity varied. The least severe PD scores were seen on Ramsey and St George, with average PD scores of 1.1 to 1.4 in 2002, and 1.0 to 1.7 in 2003. Freedom (3.7 – 5.0), 3309C (3.6 - 4.2) and O39-16 (3.1 - 3.8) had the most severe PD symptoms, and 5C (2.2 – 1.9), 5BB (2.7 – 1.6), 44-53 (2.6 – 2.3), 110R (2.2 – 1.8) and 101-14 (2.2 – 2.4) showed a moderate PD syndrome in the 2 year period (Table 1). The PD score of these rootstocks might be considered as light to severe. These preliminary evaluation data suggested that some of the rootstocks, such as Ramsey and St George, could be used as PD resistant rootstocks in the southeast United States. Interestingly, the muscadine / *Euvitis* hybrid O39-16 showed relatively high PD score. After three growing seasons in Floridas harsh environment, the survival rate was very different among the rootstocks. 101-14, 5BB, Ramsey and St. George showed 100% survival, while Freedom had 10% vine survival (Table 3). It is noted that the vines greatly deteriorated in the third growing season. For example, from 2002 to 2003, the vine losses of Freedom, 44-53 and 3309C were 87%, 70%, and 50%, respectively. Shoot death rate varied significantly among cultivars. Very little shoot death was observed on O39-16, while the shoot death rate of Freedom and 44-53 was as high as 56%. For the remaining rootstocks, shoot death rate ranged from 13% (St George) to around 40% (5BB and 3309C) (Figure 2).

Trunk diameters were different after three growing season. The largest trunks were found in St George, O39-16 and 3309C, with diameters averaging 3.1-3.9 cm. The smallest trunks were found in 44-53, at 1.9cm (Table 2). Annual shoot growth ranged from 66 cm (Ramsey) to 230 cm (5BB) (Table 2). 5BB and 5C grew significantly longer annual shoots than the rest of rootstocks tested, while Ramsey, St George and O39-16 had significantly shorter shoots. Node numbers per shoot differed among the rootstocks, with node numbers of 5BB (27.9 per shoot) and 5C (27.7 per shoot) about 70% more than Ramsey (Table 2). Shoot length is a factor of node numbers and internode length. Here longer shoots generally resulted from more nodes, although internode length did vary (Table 2). Shoot diameters varied among the cultivars. The larger shoot diameters were found in 5BB and 5C, and 3309C, while Ramsey had the smallest shoots (Table 2). In general, higher PD scores coincided with higher shoot death rate and vine death, except 039-16, which showed higher PD scores, but had the lowest shoot death rate (Figure 2). Severe PD symptoms typically related to significant numbers of dead shoots. Similarly, the overall vine survival was correlated to PD severity; rootstocks demonstrating high survival rates had lower PD scores, while the lower survival percentage rootstocks had higher PD ratings (Figure 1).

Rootstock performance in north Florida primarily is a factor of PD response. Cultivars differed in their performance and some were markedly superior—these should be further investigated for their influence on scions. The evaluation of rootstock cultivars in PD limited viticultural regions is important—much PD management research is focusing on augmenting PD resistance and or tolerance in scions, but rootstocks are a critical component of viticulture. As demonstrated here, several rootstocks have substantial levels of PD resistance that should permit their cultivation in PD prone regions, allowing concentration of effort on scion improvement. Field evaluation of PD resistance in Florida is easy due to high PD pressure resulting from high populations of vectors and bacteria in the area and should be continued as a technique to test PD management strategies and screen plant material.

REFERENCES

Bouquet, A. 1980. *Vitis* x *Muscadina* hybridization: a new way in grape breeding for disease resistance in France. Proc. 3rd Intl. Symp. On Grape Breeding. p 177-197.

Chen, J., W.E. Copes, R.M. Walker, and O. Lamikanra. 2001 Diseases. p189-239. In: Basiouny, F.M. and D.G. Himelrick, (eds). Muscadine Grapes. ASHS Press, Alexandria, Virginia.

Einset, J., and C. Pratt. 1975. Grapes. p 130-153. In: Janick, J. and J.N. Moore (eds). Advances in fruit breeding. Purdue University Press, West Lafayette, Indiana.

Loomis, N.H. 1952. Effect of fourteen rootstocks on yield, vigor, and longevity of twelve varieties of grapes at Meridian, Mississippi. Proceedings of the American Society for Horticultural Science. 52: 125-132.

Loomis, N.H. 1965. Further trials of grape rootstocks in Mississippi. Proceedings of the American Society for Horticultural Science 86: 326-328.

Lu, J., and Z. Ren. 2002. Evaluation for Pierce's disease among Muscadine grapes. XXVIth International Horticultural Congress. p 173.

Magoon, C.A., and J.R. Magness. 1937. Investigations on the adaptability of grape root stocks to Gulf Coast conditions. Proceedings of the American Society for Horticultural Science 35: 466-470.

Olien, W.C. and C.P. Hegwood. 1990. Muscadine—a classic southeastern fruit. HortScience, 25(7): 726

Pierce, N.B. 1905. The Vineyard: Mr. Pierce and the Lenoir. Pacific Rural Press, 69: 79.

Ren, Z., and J. Lu. 2003. Muscadine rootstock increased the resistance of Florida hybrid bunch grape cv. Blanc du Bois to Pierce and Anthracnose diseases. Proc. Fla. State Hort. Soc. 115 (in press).

Winkler, A.J., J.A. Cook, W.M. Kliewer, and L.A. Lider. 1974. General Viticulture. University of California Press, Berkeley.

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Table 1. PD symptom scores of the ten grape rootstocks during the 2^{nd} and 3^{rd} growing seasons.

Rootstock	PD score	
	2002	2003
O39-16	3.1bc	3.8b
101-14	2.2d	2.4c
110R	2.2d	1.8cd
3309C	3.6b	4.2ab
44-53	2.6cd	2.3c
5BB	2.7cd	1.6cd
5C	2.2d	1.9cd
Freedom	3.7b	5.0a
Ramsey	1.1e	1.0d
St. George	1.4e	1.7cd

Table 2. Vine vigor, means of 2002 and 2003 growing seasons.

Rootstock	shoot[z]				trunk diameter[y] (cm)
	length (cm)	node #	diameter (cm)	internode (cm)	
O39-16	67.2e	23.4b	56.9abc	2.9f	3.4ab
101-14	99.1cd	20.8bc	54.7bcde	4.9c	2.6c
110R	75.7e	19.4bc	54.7bcde	3.9e	2.6c
3309C	81.0de	19.3bc	47.2cde	4.2de	3.1bc
44-53	120.2c	23.6b	53.2bcde	5.1c	1.9d
5BB	230.8a	27.9a	66.1a	8.1a	2.9bc
5C	176.5b	27.7a	60.3ab	6.2b	2.8bc
Freedom	99.5c	21.4bc	54.6bcde	4.7dc	2.9bc
Ramsey	66.1e	17.4c	45.9de	3.8e	2.6c
St. George	83.2de	20.7bc	55.0bcd	4.1e	3.9a

z. measured in the end of 2002 growing season   y. measured in fall of 2003

Table 3. Vine survival of the ten grape rootstocks after three growing seasons.

Rootstock	Number of living vines			Survival %
	2001	2002	2003	2003
O39-16	9	9	6	67
101-14	10	10	10	100
110R	10	10	9	90
3309C	10	10	5	50
44-53	10	10	3	30
5BB	10	10	10	100
5C	10	10	9	90
Freedom	10	8	1	10
Ramsey	8	8	8	100
St. George	10	9	9	90

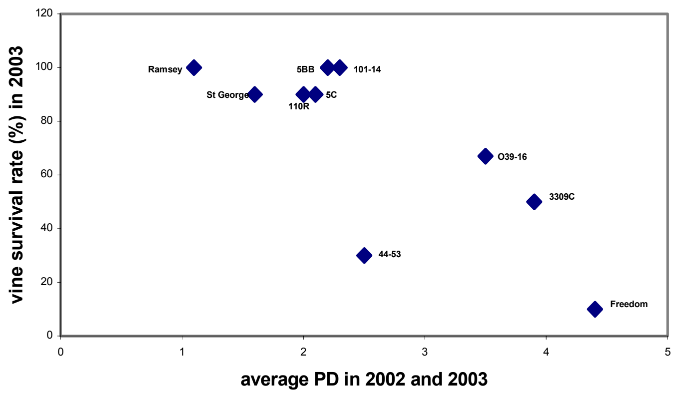

Figure 1. PD score effect on vine survival rate after three growing seasons.

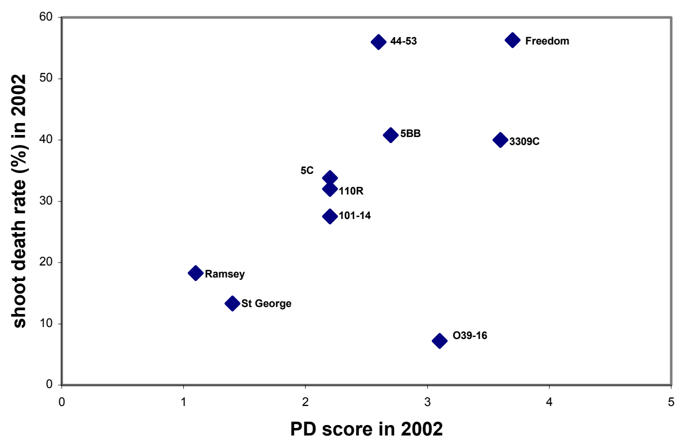

Figure 2. PD scores and shoot death rate (%) in 2002 growing season.