'Rossana' is a medium to tall plant with high primocane densities. Its productivity is nearly non-existent in our climate because it is so late in developing. The few fruit that we were able to harvest had the best flavor of any of our cultivars, though. It has a strong raspberry flavor (some tasters thought too strong).

'Ruby' is a tall plant with fairly low cane densities in our planting. This may have been due to crown gall infections in the plants which appeared in the second year. Productivity is low, and the season fairly late. Fruit is large, but slightly rough looking. Flavor is described by some as very mild, but we feel it is better described as flavorless.

In summary, 'Autumn Bliss' and 'Redwing' were the heaviest producers, followed by 'Caroline' and 'Polana.' Heavy yields were largely a function of earliness. 'Rossana,' 'Anne,' 'Goldie,' 'Ruby' and 'Heritage' yielded little, mostly because they yielded late, with more than 70% of the fruit produced never ripening. 'Anne,' 'Ruby,' 'Autumn Britten' and 'Autumn Bliss' all produced large berries.

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Growth Characteristics of Selected Pecan Rootstocks Prior to Grafting

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Abstract

Six pecan (*Carya illinoinensis* (Wangenh.) K. Koch) cultivars and five pecan families (closely related individuals from a native stand, seed from at least 10 native trees were pooled) were evaluated for use as rootstocks. The evaluation period was from seed planting through 4-years-old, but before the rootstocks were grafted. 'Apache' rootstocks grew more rapidly than the other rootstocks tested during the first two years. However, by the fourth year 'Apache' and 'Peruque' trees were similar in height, and trunk diameters of 'Apache,' 'Giles' and 'Peruque' were not significantly different. Coefficients of variation for tree heights and trunk diameters indicated that variability between individuals was similar within most cultivars and families. Budbreak date was strongly influenced by rootstock source, with up to a 14 day difference between the first and last rootstocks to attain 90% budbreak. An April freeze damaged current season's growth on 90% of the 'Apache' trees, but only 10% of the 'Giles,' 'Starking Hardy Giant,' and natives from Chetopa, KS and Sapulpa, OK were injured. Freeze damage was dependent on the bud developmental stage. Several significant differences in leaf elemental concentrations between rootstocks were identified.

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Introduction

Commercial pecan production is from native stands of pecan trees or from grafted or budded cultivars. Cultivars are a compound tree consisting of an open-pollinated seedling rootstock and the scion (cultivar). Both native and seed-grown rootstocks are used for pecan. Native rootstocks in wild stands are used where the trees are grafted in place to develop an orchard that is frequently a mixture of cultivar and native trees. In nurseries, open-pollinated seed of selected cultivars are planted (field or container), grafted, then transplanted to the orchard (3- to 4-year-old rootstock and 1- to 2-year-old scion). Clonal rootstocks are not available for pecan since acceptable methods to root pecan have not been developed. Rootstocks most commonly used by nurseries include 'Elliott,' 'Curtis' and 'Moore' in the southeast and 'Riverside,' 'Burkett,' 'Apache,' and 'VC-168' in the southwest (6). 'Giles,' 'Peruque,' 'Major,' and 'Colby' are recommended for the northern pecan region, but few nurseries are currently producing cultivars on these rootstocks. Occasionally, seed from native trees are planted for rootstocks, especially when desirable attributes of the native trees, such as cold hardiness, have been identified.

There has been very little research that supports the selection of certain cultivars for rootstocks based on their orchard performance. Instead, nurseries have selected cultivars for rootstocks based on performance and economic characteristics important in the nursery. Occasionally, small nuts are preferred by nurseries, particularly those purchasing their seed, since smaller seed size reduces the cost per seed (2). However, seed weight within a cultivar (10) or between families (1, 8), specific gravity (5), and kernel percentage (3) are positively correlated with tree growth the first year. Among cultivars, seed weight is not closely related to initial seedling growth (19). This is because initial growth characteristics are highly heritable (8), making it possible to select cultivars with small seed that produce vigorous seedlings.

Vigorous growth is highly desirable for nurseries since grafting can begin at a younger age than if the rootstock grew slowly, and a vigorous rootstock is likely to produce a marketable tree in a shorter time. However, budbreak date is negatively correlated with growth; therefore, nurseries are indirectly selecting for early budbreak. In areas where spring temperatures are erratic, early budbreak is an undesirable characteristic. Rootstock growth rate is also weakly correlated with fall leaf retention (8). Rootstocks that promote late leaf retention may reduce alternate bearing since research has shown that early defoliation decreases return bloom (9, 26). However, a negative aspect of late leaf retention may be delayed cold acclimation in the fall. Severe fall freezes are a common cause of cold injury (10, 13).

Uniformity in growth is another rootstock characteristic that is desirable for the nursery and the orchard. Cultivars with incomplete dichogamy are usually avoided for seed stock, since self-pollinated seed produce stunted seedlings compared to those from cross-pollinated seed (12). 'Apache' is one seed source that has been recommended because seedlings grow rapidly and are somewhat uniform (14).

There appears to be substantial potential to ameliorate orchard performance with improvements in rootstocks. Sitton and Dodge (20) reported that 8-year-old 'Schley' trees on 'Moore' rootstock were 1.15 times larger and yielded 1.5 times more than 'Schley' trees on 'Waukeenah' rootstocks. Seven-year-old 'Schley' and 'Stuart' on 'Moore' rootstock were also larger and 'Schley' yielded more than on 'Waukeenah' rootstock. Hanna (7) found that 14-year-old trees on 'Riverside' rootstock were 12% larger than those on 'Burkett' rootstock. Wood (25) reported that rootstock influenced yield, yield efficiency, and alternate bearing of pecan. His study indicated that superior rootstocks have greater January root starch concen-

trations, an observation that is consistent with improved return bloom (26, 27). He projected a frequency of about 5% for the occurrence of superior rootstocks (greater yield with less alternate bearing) using open-pollinated seedling rootstocks from an unknown source.

Hinrichs (10) reported rootstock affected fall cold damage of 1-year-old 'Stuart' trees. Damage ranged from 0% to 83% of the trees injured depending on the rootstock. Low fall temperatures damaged more 4-year-old 'Wichita' and 'Choctaw' trees on 'Riverside' rootstock than those on 'Apache' rootstock (13).

There are substantial differences in budbreak date of the various rootstocks (5, 17, 19). Budbreak characteristics of the rootstock can apparently affect budbreak of the scion. Grauke and Pratt (5) reported that budbreak of ungrafted 'Curtis,' 'Elliott,' 'Apache' and 'Souix' rootstocks was more advanced than 'Moore,' 'Riverside,' and 'Burkett.' When grafted to 'Candy,' budbreak was more advanced using 'Curtis' and 'Elliott' rootstocks compared to 'Apache,' 'Sioux,' 'Riverside,' and 'Burkett' rootstocks.

In Oklahoma, growers frequently plant seedling rootstocks, then graft the trees to the desired cultivar after they are established. This allows the grower a wider selection of cultivar/rootstock combinations and decreases tree costs compared to nursery grafted trees. Also, nursery trees are normally grafted near or below the soil line. Trees are more cold hardy if trees are grafted at least 45 cm above the soil line (23). We report here growth characteristics of selected pecan rootstocks prior to grafting.

Materials and Methods

Six cultivars and five pecan families were chosen for the rootstock trial. Five of the six cultivars we included in the study are considered northern cultivars: 'Chetopa,' 'Colby,' 'Giles,' 'Starking Hardy Giant' and 'Peruque.' The other cultivar, 'Apache,' was chosen because it is more cold hardy than other southern rootstocks (13), is frequently used in Oklahoma because northern rootstocks from nurseries are not readily available, and is widely used in the south central and southwestern U.S. The five pecan families were chosen from a wide range of climatic conditions. The five families were from Brunswick, Missouri; Chetopa, Kansas; Sapulpa, Oklahoma; Stillwater, Oklahoma; and DeLeon, Texas.

Seed for each rootstock, except 'Chetopa,' were collected during the fall of 1992, then stratified by soaking in water 24 hours, and placing them in moist vermiculite at 4°C for about 4 months. Seed were then germinated in a water bath (22) and planted during April 1993 in 3.8 liter plastic pots filled with a commercial soil mix (MetroMix 300, Scotts Co., Marysville, OH). Eighty trees of each rootstock were grown on nursery beds with overhead irrigation. Trees were fertilized monthly from April through September with 14g/pot 14 N B 6 P -11.6 K (Osmocote, Grace-Sierra International, Milpitas, CA), and at 45 day intervals using 0.6 g/liter of a soluble trace element mix (Peters Soluble Trace Element Mix, Grace-Sierra International, Milpitas, CA). On 30 September tree height and trunk diameter 2.5 cm above the soil line were measured.

The forty largest trees of each rootstock, except 'Chetopa,' were selected for transplanting to the orchard near Perkins, Oklahoma. 'Chetopa' rootstocks were obtained from a commercial source. Trees were planted on 4 October 1993 at a 10.7 m by 10.7 m spacing. Each rootstock was replicated ten times with four trees per replication in a randomized complete block design. Soil was a Teller sandy loam (fine loamy, mixed, thermic, Udic Argiustolls, Mollisols). Trees were irrigated as required using a traveling gun, and fertilized according to Oklahoma cooperative Extension Service recommendations (16). Pesticides were applied as needed with a hand gun sprayer.

Tree height and trunk diameter 2.5 cm above the soil were measured annually while trees were dormant. Each tree was monitored for budbreak on alternate days

during the appropriate time of the year. Budbreak date for each tree was when the first bud reached stage 4 of bud development (24). Dates for 10%, 50%, and 90% of the trees at developmental stage 4 or greater were calculated for each rootstock selection. Leaf samples were collected in July each year, using the middle pair of leaflets from the middle leaf on current season's growth as the index tissue. Leaves from the four trees per replication of each rootstock were pooled into a single sample. Samples were analyzed for N by macro-Kjeldahl (11), P colorimetrically (18), and other elements using atomic absorption spectroscopy. Data were analyzed using analysis of variance with mean separation by Duncan's multiple range test.

Results and Discussion

'Apache' trees were tallest with the largest trunk diameter in 1993 and 1994 (Table 1). In 1995, 'Apache' trees were taller than the other rootstocks, but their trunk diameter was similar to 'Giles,' 'Peruque,' and native trees from Stillwater. In 1996, 'Apache' and 'Peruque' were not significantly different in height, with no significant difference in trunk diameters of 'Apache,' 'Giles,' and 'Peruque.' Trunk diameter is more important than height in determining when a tree can be grafted. Although initial growth of 'Apache' was faster than the other selections, by the time trees were large enough to graft (4-flap method; 15) in the orchard, 'Apache,' 'Giles' and 'Peruque' were similar in diameter.

Only two other studies report growth characteristics for any rootstocks used in this study. Hinrichs (10) reported that 5-year-old 'Stuart' on 'Giles' rootstock was among the tallest of 18 rootstocks tested. However, 3-year-old 'Giles' trees were among the shortest with the smallest trunk diameter and 'Apache' one of the largest of eight rootstocks tested in another study (19). These conflicting results may be caused by the rootstocks compared in the studies, differences in tree age between the studies, tree growth habit, or variability associated with open pollinated seed. The first year's growth is closely associated with cotyledon size (1, 8). This initial growth advantage is likely to be minimized as the trees become older, and genetic growth potential becomes dominant. In our study 'Apache' (large seed) trees were taller than 'Giles' (small seed) throughout the study, but by the third year trunk diameters were not significantly different (Table 1). In the study where 'Giles' was among the largest, trees were 5-years-old (10), and where they were the smallest trees were only 3-years-old (19). This suggests that growth potential of 'Giles'

Table 1. The influence of rootstock cultivar/source on tree height and trunk diameter.

Cultivar/source	Year 1993[z]	1994[y]	1995	1996
	Tree height (cm)			
Apache	42a[x]	68a	85a	96a
Chetopa	—	26f	39f	50c
Colby	30b	47c	55de	55c
Giles	28c	48bc	61bcde	71bc
Hardy Giant	26c	44cd	53e	54c
Peruque	27c	46c	65bcd	80ab
Brunswick, MO	21e	36e	50ef	58bc
Chetopa, KS	23de	37e	50ef	55c
Stillwater, OK	26c	45c	67bc	67bc
Sapulpa, OK	23d	40de	56cde	65bc
DeLeon, TX	31b	52b	69b	69bc
	Trunk diameter (mm)			
Apache	7.6a	10.8a	16.0a	19.5a
Chetopa	—	5.0f	8.7d	10.0d
Colby	7.0bc	8.2cde	10.9cd	11.9cd
Giles	7.2b	8.7bcd	14.1ab	16.1ab
Hardy Giant	6.9bc	7.6de	10.8cd	11.3cd
Peruque	6.9bc	9.5b	14.7ab	16.7ab
Brunswick, MO	5.9de	7.0e	11.2cd	11.7cd
Chetopa, KS	5.8e	7.4e	10.5cd	11.0cd
Stillwater, OK	6.8bc	9.1bc	14.3ab	14.3bcd
Sapulpa, OK	6.2d	7.6de	12.2bc	14.1bc
DeLeon, TX	6.7c	8.6bcd	13.1bc	14.5bc

[z]Tree height and diameter after grown in 3.8 liter containers for 6 months.
[y]Tree height and diameter after first growing season in the orchard.
[x]Mean separation within years by Duncan=s multiple range test, 5% level.

Table 2. The influence of rootstock cultivar/source on the coefficients of variation of tree height and trunk diameter.

Cultivar/source	1993	1994	1995	1996
	Tree height coefficient of variation (%)			
Apache	26	16	26	42
Chetopa	—	20	28	41
Colby	23	18	29	53
Giles	22	16	21	42
Hardy Giant	23	18	20	41
Peruque	20	25	35	52
Brunswick, MO	18	17	25	41
Chetopa, KS	21	21	35	58
Stillwater, OK	22	18	36	72
Sapulpa, OK	19	21	35	53
DeLeon, TX	21	16	27	56
	Trunk dia. coefficient of variation (%)			
Apache	17	21	26	36
Chetopa	—	25	29	35
Colby	16	19	33	44
Giles	17	13	27	40
Hardy Giant	18	16	25	40
Peruque	17	29	35	39
Brunswick, MO	19	13	27	39
Chetopa, KS	21	21	34	42
Stillwater, OK	16	27	40	65
Sapulpa, OK	18	28	33	36
DeLeon, TX	19	21	32	51

may be relatively high once cotyledon reserves are not a dominant factor affecting growth. Tree growth habit is also likely to affect the outcome of these studies. In one study the rootstocks were grafted to 'Stuart'; thus all trees should have a similar upright growth habit (10). In Hinrichs' (10) study, 'Giles' rootstocks produced trees that were among the largest. In our study and the other study (19) rootstocks were not grafted. 'Giles' has a spreading growth habit, while 'Apache' has a rather stiff upright growth habit. This suggests that if both trees are not grafted, 'Apache' will likely be taller than 'Giles,' as is the case in these two studies. However, we found that by the third year trunk diameters of 'Apache' and 'Giles' were similar, suggesting that cultivars grafted on 'Giles' rootstock may have similar growth potential to those on 'Apache.' Since seed are open pollinated genetic variability is great. The male parent and female parent likely have a similar influence on seedling growth rate, particularly after the first year when the effect of cotyledon reserves (seed size is primarily controlled by the female parent) is minimized. This source of variability will continue to be a problem in identifying superior rootstocks until suitable asexual propagation techniques are identified.

Coefficients of variation for tree height and trunk diameter were similar each year for all rootstocks, except in 1996 for trees from seed collected at Stillwater (Table 2). This suggests that seeds from a family are as likely to produce trees that are homogenous as are seeds from a single cultivar. Seed from open pollinated cultivars are very heterozygous, resulting in variability similar to seed from a family. Therefore, if superior rootstocks were identified from a particular native family, performance would be about as predictable as from a single cultivar. One exception is using seed from a cultivar with incomplete dichogamy, such as 'Western.' Seedlings from these cultivars are normally quite variable in their growth rates since some seed are from self-pollination and others are from cross-pollination (12).

Late budbreak is a desirable characteristic in some areas to avoid spring frost damage. Substantial differences were observed in budbreak dates of the rootstocks tested (Table 3). In 1995, the date for 10% of the trees at budbreak was similar for all rootstocks, except 'Chetopa.' However, by the time 50% of the trees reached budbreak 'Chetopa,' 'Giles' and 'Starking Hardy Giant' were clearly developing slower than the other rootstocks. 'Apache' and the natives from DeLeon were the first to reach 90% budbreak, followed closely by 'Peruque' and natives from Chetopa and Sapulpa. 'Apache' and natives from DeLeon were the most uniform in budbreak (10 days between 10% and 90% budbreak), and 'Colby' was the most variable (19 days).

Table 3. The influence of rootstock cultivar/source on date of 10%, 50%, or 90% of the trees reaching stage 4 budbreak.

	Budbreak date								
	1995			1996			1997		
	Percent trees at budbreak								
Cultivar/source	10%	50%	90%	10%	50%	90%	10%	50%	90%
Apache	3/23	3/26	4/2	4/12	4/18	4/23	3/25	4/3	4/9
Chetopa	3/28	4/6	4/11	4/16	4/20	5/5	3/31	4/6	—
Colby	3/23	3/31	4/11	4/13	4/18	4/28	3/30	4/6	—
Giles	3/24	4/4	4/10	4/13	4/18	4/24	4/4	—	—
Hardy Giant	3/24	4/5	4/10	4/14	4/18	4/26	4/1	—	—
Peruque	3/23	3/26	4/6	4/12	4/17	4/25	4/1	4/9	—
Brunswick, MO	3/25	4/1	4/9	4/14	4/18	4/25	4/2	4/6	—
Chetopa, KS	3/23	3/30	4/7	4/13	4/21	5/7	4/2	—	—
Stillwater, OK	3/24	3/31	4/9	4/13	4/18	4/25	4/1	4/8	—
Sapulpa, OK	3/23	3/27	4/7	4/12	4/19	5/1	4/1	—	—
DeLeon, TX	3/23	3/25	4/2	4/12	4/17	5/5	3/24	4/1	—

In 1996, most rootstocks achieved 10% and 50% budbreak about the same time, except 'Chetopa' and natives from Chetopa reached 50% budbreak later than the others (Table 3). 'Apache' was the first to reach 90% budbreak, followed closely by 'Giles,' then 'Peruque' and natives from Brunswick and Stillwater. Natives from Chetopa were the last to reach 90% budbreak. In 1996, budbreak of 'Apache,' 'Giles,' and natives from Brunswick were the most uniform (11 days), and natives from DeLeon and Chetopa the most variable (23 and 24 days, respectively).

Freezing conditions (–6°C) on 11 April 1997 killed all growth at budbreak stage 4 or more. Similarly, Grauke and Pratt (5) reported that injury caused by a May freeze was directly related to bud development. Growth that had not reached budbreak stage 4 was not damaged. At the time of the freeze, 90% of the 'Apache' trees were susceptible to injury, and 50% of the 'Chetopa,' 'Colby,' 'Peruque,' and natives from Brunswick, Stillwater and DeLeon were susceptible to freezing temperatures (Table 3). However, only 10% of the 'Giles,' 'Starking Hardy Giant,' and natives from Chetopa and Sapulpa were susceptible to the spring freeze.

Reighard (19) reported 'Giles' was the last of eight rootstocks to initiate growth in the spring. 'Giles' is typically considered a northern rootstock, and the other rootstocks in his test are considered southern rootstocks. Grauke and Pratt (5) also found substantial differences in spring bud development among seven rootstocks tested, and that rootstock could affect budbreak date of the scion.

Leaf elemental concentrations were affected by rootstock (Table 4). However, in most cases elemental concentrations were within acceptable concentration ranges (21). Nitrogen concentrations ranged from 2.63% to 2.98% in 1995 and 2.53% to 2.94% in 1996. These concentrations tended to be related to the tree growth rate, with larger trees having lower concentrations. Presumably, nitrogen was diluted over more mass, resulting in a lower concentration, although total nitrogen absorbed was most likely greater for the larger trees.

Phosphorus concentrations were similar between years with the lowest concentration being 0.13% (Table 4). Although there were significant differences between rootstocks during both years, they are probably of little practical importance.

Potassium concentration ranged from 0.67% to 0.96% in 1995 and 0.60% to 0.87% in 1996 (Table 4). The minimum

Table 4. The influence of rootstock cultivar/source on leaf elemental concentration during 1995 and 1996.

Cultivar/source	Dry weight (%)					Dry weight (µg/g)		
	N	P	K	Ca	Mg	Zn	Fe	Mn
				1995				
Apache	2.63d[z]	0.14bc	0.82abc	1.12a	0.44a	328a	58bc	1714ab
Chetopa	2.89abc	0.16a	0.76bc	1.00a	0.39a	296a	61abc	1118b
Colby	2.87abc	0.14abc	0.74bc	1.17a	0.47a	391a	64abc	1174ab
Giles	2.82abcd	0.16ab	0.76bc	1.07a	0.44a	325a	59abc	1169ab
Hardy Giant	2.98a	0.16ab	0.96a	1.13a	0.43a	360a	65ab	1470ab
Peruque	2.81abcd	0.14bc	0.85ab	1.21a	0.43a	303a	58bc	1763ab
Brunswick, MO	2.98a	0.15abc	0.79abc	1.09a	0.46a	322a	68a	2161a
Chetopa, KS	2.93ab	0.15abc	0.91ab	1.05a	0.39a	330a	59abc	1155ab
Stillwater, OK	2.72cd	0.14bc	0.85ab	1.07a	0.41a	328a	59abc	1413ab
Sapulpa, OK	2.77bcd	0.13bc	0.78bc	0.94a	0.39a	293a	56c	1674ab
DeLeon, TX	2.72cd	0.13c	0.67c	1.23a	0.46a	310a	55c	1596ab
				1996				
Apache	2.53d	0.14bc	0.83ab	1.28ab	0.42ab	59a	56a	1275abc
Chetopa	2.94a	0.16ab	0.82ab	1.14b	0.42ab	46ab	69a	844c
Colby	2.72c	0.14bc	0.62bc	1.34ab	0.44ab	57ab	51a	962bc
Giles	2.90ab	0.17a	0.74abc	1.28ab	0.45ab	52ab	66a	1035abc
Hardy Giant	2.75bc	0.15bc	0.74abc	1.36ab	0.46ab	43b	63a	1177abc
Peruque	2.68cd	0.14bc	0.85a	1.43a	0.49a	55ab	63a	1720a
Brunswick, MO	2.66cd	0.15bc	0.83ab	1.32ab	0.42ab	53ab	69a	1602ab
Chetopa, KS	2.72c	0.13c	0.71abc	1.25ab	0.39b	46ab	69a	1379abc
Stillwater, OK	2.64cd	0.13c	0.87a	1.17ab	0.43ab	51ab	69a	1323abc
Sapulpa, OK	2.70cd	0.14bc	0.85a	1.25ab	0.42ab	48ab	55a	1465abc
DeLeon, TX	2.62cd	0.13c	0.60c	1.31ab	0.48a	47ab	52a	1316abc

[z]Mean separation within columns and years by Duncan's multiple range test, 5% level.

recommended sufficiency level for K is 0.75% (21). Native trees from DeLeon were substantially below the sufficiently level in both years. Several other rootstocks were either slightly above or below the sufficiency level during one or both years. 'Apache' and 'Peruque' had among the highest K concentrations during both years. When the rootstocks were transplanted from the containers to the orchard, 'Peruque' had noticeably more fibrous roots than the other cultivars. If this characteristic persisted while growing in the orchard, it might contribute to the greater K concentrations noted in 'Peruque.'

Calcium, Mg, and Zn concentrations were not affected by rootstock in 1995. In 1996, there were significant differences among the rootstocks, but they appear to be of little practical importance. Similarly, there were no significant differences in Fe concentration in 1996, but in 1995 there were some significant differences among the rootstocks. Iron concentrations during both years were above the minimum sufficiency concentration (21). Manganese concentrations were significantly different between rootstocks during both years. However, there were not consistent patterns from one year to the next in absorption or exclusion of Mn by a particular rootstock.

These data suggest that 'Apache' rootstock initially has a faster growth rate than the other rootstocks tested, a trait that may reduce nursery production time by one year. However, 'Peruque' and 'Giles' grew rapidly after field establishment, and by the time they were 4-years-old all three

rootstocks could be grafted in the orchard using grafting techniques commonly used by producers. 'Apache' is a commonly used rootstock in the southwest, but while trees are young, fall or winter cold damage is frequently observed using this rootstock in the northern pecan production areas. Research (10) and field observations indicate that 'Giles' rootstock reduces cold damage when compared to several other rootstocks. Additionally, budbreak of 'Giles' was among the latest of the rootstocks in this test, a desirable characteristic in Oklahoma to escape spring freeze damage. Results of this study and other studies cited suggest that 'Giles' rootstock is the preferred rootstock for northern pecan production because of greater cold hardiness than many rootstocks (10), late budbreak (Table 3), with an adequate growth rate (Table 1), even though growth may be slower than using 'Apache.' Four cultivars will be grafted on the eleven rootstocks in this study to evaluated selected performance characteristics of bearing trees.

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Susceptibility of Southern Blueberry Cultivars to *Botrytis* Blossom Blight

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Abstract

The susceptibility of blueberry flowers at various developmental stages was evaluated by inoculating potted blueberry bushes of the rabbiteye cultivars, Climax, Premier and Tifblue, and the southern highbush cultivars, Magnolia and Jubilee, during bloom with a conidial suspension of *Botrytis cinerea*. Inoculated plants were then incubated in a dew chamber for two days at 20°C and 100% RH. Flower stage was rated at the beginning of the study and two weeks after inoculation. *Botrytis* disease symptoms were scored two weeks after inoculation on a visual scale of 0 to 7. Susceptibility to *Botrytis* blossom blight was greatest on more developed flowers. Buds inoculated at stage 2 through stage 3 (prebloom) developed few disease symptoms, while flowers inoculated at stages 5 to 7 (full bloom) developed more severe symptoms. 'Magnolia,' 'Premier,' and 'Tifblue' flowers at stage 6 were very susceptible. When averaged over the more susceptible flower stages (5, 6 and 7), 'Jubilee' and 'Premier' had the lowest disease severity scores. 'Tifblue' had higher disease scores than 'Magnolia' and 'Climax.' The two southern highbush cultivars did not differ as a group from the three rabbiteye cultivars in their susceptibility to *Botrytis* blossom blight. Since susceptibility of blueberry flowers is greatest at or near full bloom, fungicide applications for *Botrytis* blight control of southern blueberries should begin at flower stage 4 and continue though stage 6.

Southern highbush blueberry cultivars (hybrids between northern highbush blueberry (*V. corymbosum* L.) and various native southern *Vaccinium* spp.) are being planted throughout the southeastern United States. Since many of the newer southern highbush cultivars flower later but ripen earlier than rabbiteye (*Vaccinium ashei* Reade) cultivars (5), they are less likely to be injured by the late spring freezes which have caused major crop losses in the rabbiteye industry. Little is known about the susceptibility of the southern highbush cultivars to diseases (6, 8, 10, 11).

Botrytis blossom blight (caused by the fungus *Botrytis cinerea* Pers.:Fr.) occasionally causes severe crop loss of rabbiteye blueberries, but usually is unimportant on highbush blueberry (2, 3, 4, 9, 13). The fungus attacks blossoms, tender green twigs, and leaves in early spring causing symptoms on rabbiteye blueberry that are often mistaken for freeze injury. Infected flowers and twigs quickly turn brown or black and die. The fungus pro-

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