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Pecan Scion Cultivar Effects on Freeze Susceptibility of the Rootstock

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Abstract

Unusual freezes occurred in 3 of 5 years following planting of a pecan orchard. Observations on the damage caused by these freeze events are reported. In one freeze event, scions of cultivar 'Pawnee' were less susceptible to being killed by moderately low temperatures than were nine other cultivars or ungrafted 'Elliott' seedlings. The 'Pawnee' scion appeared to impart some resistance to freeze damage to its rootstock.

Introduction

Cold injury to pecan trees has been reported from freezes during the fall, winter, and spring (3, 7, 11, 12, 15, 16). Differences in cultivar response to early fall freezes has been in the form of tree death or injury to the limbs and the trunk (3, 12, 15, 16). Even though fall freeze damage occurs frequently (14), few published reports document the damage. Reports of damage caused by severe winter freezes are more frequent (2, 7, 9, 14, 17). Reports of damage to pecan trees induced by early fall freezes have been made from Oklahoma, Alabama, and New Mexico (3, 12, 16). Some of the more freeze susceptible cultivars reported include 'Mahan,' 'Desirable,' 'Wichita,' 'Kiowa,' 'Mohawk,' 'Houma,' and 'Melrose.'

Cultivar susceptibility to cold temperatures varies with specific weather conditions, tree size, crop load, nutritional status, and other stress factors (2, 9, 12, 15, 16, 17). Generally, cultivars that originate in the northern area of the native pecan range are more cold tolerant than cultivars originating in the southern region. However, 'Stuart,' which originated in southern Mississippi, has a high tolerance to cold (5, 8, 12, 13).

Rootstock source is reported to affect cultivar susceptibility to freeze damage of pecan trees. Cultivars grafted onto 'Apache' seedling rootstock were damaged less by cold than the same cultivars grafted onto 'Riverside' seedling rootstock (6). Damage caused by a spring freeze to 1-year old grafted trees was influenced by rootstock and scion; and was directly correlated with stage of bud growth at the time of the below freezing temperatures (4). Similar effects of a spring freeze were reported on 4-year old seedlings (10). In both grafted and ungrafted cultivar seedlings, freeze damage was most severe on trees in advanced stages of bud growth (4, 10).

Trunk tissue type may have a greater influence on susceptibility of young trees to freeze damage than even cultivar type (14). Trees grafted 30 or more cm above ground level were more resistant to freeze damage than trees grafted at the soil line (14). On young deciduous trees the trunk tissue near the ground line is the most susceptible to freeze damage from early fall freezes (1). Thus the presence of juvenile tissue near the ground line can provide some freeze protection because it is less susceptible to damage than mature tissue (14).

Information about the effects of fall or winter freezes on pecan has come from observations made after natural freezes and not from planned experiments. Thus the information is incomplete on the effects of freezes. Whenever freeze damage to pecans does occur it is useful to document the results to increase the understanding of the effects of abnormal freezes on tree health.

This report addresses the effects of freezes on a replicated pecan planting of recently grafted scions.

Materials and Methods

A 16-acre orchard of grafted pecan trees was planted in Mar. 1989. The orchard was located at the Louisiana State University Agricultural Center Pecan Research-Extension Station near Shreveport, LA. The experimental design consisted of 23 blocks with 10 cultivars planted in a randomized complete-block design. There were two trees of each cultivar per block (N = 46). The trees were spaced 11.9 X 11.9 m in the orchard. Cultivars used in the planting are listed in Table 1. The trees were produced by a commercial nursery. All trees were on 'Elliott' rootstock and were whip-grafted.

Prior to planting, a drip irrigation system was installed to aid in orchard establishment. The system consisted of one emitter per tree with flow rate of 5.7 liter/emitter/hour.

The land consisted of a homogenous Moreland clay soil that had been laser-planed with a slope of 0.3 feet per 100 feet to provide water drainage. Alfalfa had been grown on the land for two years prior to planting the trees to improve soil fertility and water percolation.

Results and Discussion

Effect of 1989 freeze.

Survival of the trees during the first year of growth was good. At the end of Nov. 1989, only 18 trees had died (4%). The coldest 10-day period ever recorded by the National Weather Service at Shreveport, LA occurred during the first Dec. after transplanting. From 16-25 Dec. the average minimum was –8.6° C, and the average maximum was 1.1° C. Record lows were set for five days during this time period with the coldest temperature of –15° C on 23 Dec. other lows were –8° and –10° C. The following Mar 101 trees were dead and an additional 72 had dead limbs or injured cambium. By the end of May 1990, there were 231 dead trees (50%). There were no cultivar differences, but there was an obvious gradient in number of dead trees from the northeast to the southwest side of the orchard. This pattern of tree death followed a trend that had been prac-

Table 1. Effect of an early fall freeze in 1993 on the mortality of two-year old pecan trees near Shreveport, LA.[z]

Cultivar	Num. trees alive Oct. 1993	Num. trees dead Apr. 1994	Percent killed[y]	Num. trees with scion only killed
Cherokee	30	13	43[b]	2
Curtis	32	19	59[b]	4
Desirable	28	18	64[b]	2
Kiowa	39	21	54[b]	2
Moreland	37	25	68[b]	1
Pointe Coupee	26	17	65[b]	2
Pawnee	38	03	08[a]	1
Sumner	39	26	67[b]	3
Success	37	16	43[b]	3
Schley	29	15	52[b]	2
Elliott Seedling	124	68	55[b]	–

[z]Early fall freeze dates were: 30-31 Oct. and 01 Nov. 1993. Average first frost date is 15 Nov.
[y]Mean separation by Duncan's new multiple range test, 1% level.

ticed during planting. The healthiest trees with the best root systems were planted first in a selective manner beginning with the lowest block numbers on the north side and progressing to the higher block numbers on the south side of the orchard. As block number increased the quality of the trees decreased. There was a linear relationship of trees remaining alive in May 1990 with block location in the planting (Fig.1). As tree vigor decreased, the percentage of trees killed increased. This observation supports previous reports that weak and stressed trees are more susceptible to freeze damage than are vigorous trees (15).

Most damaged trees regrew from the root system. Thirty trees that did not re-

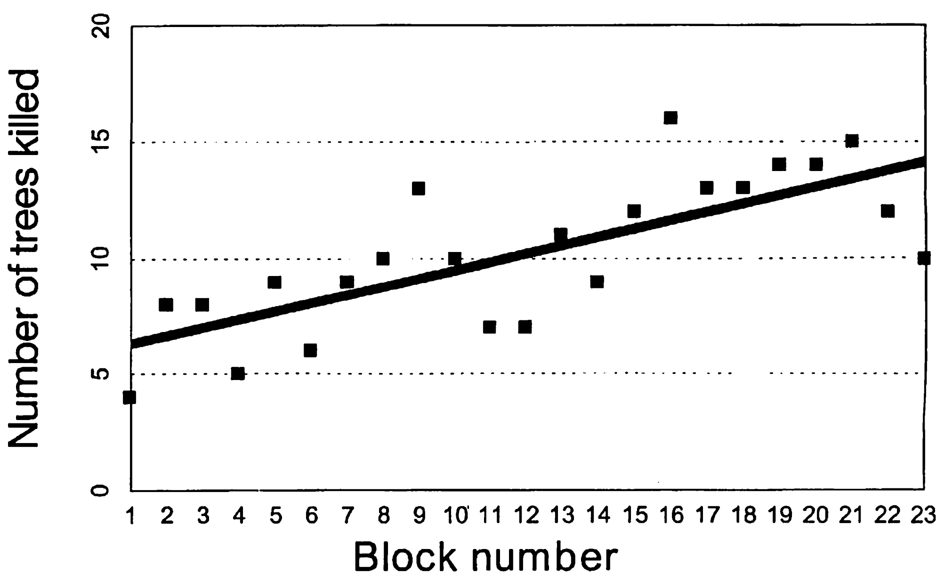

Figure 1. Relationship between tree vigor at planting in Mar. 1989 and trees killed by a severe freeze the following Dec. Tree vigor at planting decreased as block number increased (Trees killed = 5.94 + 90.36 X Block) R square = 0.55, P = 0.0001).

Table 2. Relationship of graft height to tree death caused by an early fall freeze in 1993.

			Graft height above ground (cm)			
Cultivar	Status[z]	Num of Trees	Minimum	Maximum	Mean	S.D.[y]
Cherokee	Alive	10	29.5	160.8	68.6	40.4
Cherokee	Dead	10	31.8	98.0	57.4	20.5
Curtis	Alive	08	50.3	104.2	75.2	18.7
Curtis	Dead	10	54.5	146.5	89.2	29.0
Desirable	Alive	07	48.8	113.7	79.0	22.5
Desirable	Dead	10	36.4	131.4	100.8	28.8
Kiowa	Alive	10	26.7	176.5	74.2	47.0
Kiowa	Dead	12	17.6	170.2	83.6	40.2
Moreland	Alive	10	26.5	177.5	101.3	49.8
Moreland	Dead	10	60.9	158.6	99.1	36.5
P. Coupee	Alive	06	30.6	177.9	66.3	33.0
P. Coupee	Dead	09	44.4	103.7	64.8	19.4
Pawnee	Alive	16	22.8	186.2	68.8	40.7
Pawnee	Dead	03	41.5	68.6	51.6	14.9
Summer	Alive	10	47.7	114.5	82.8	23.0
Summer	Dead	14	50.8	158.2	96.0	33.0
Success	Alive	10	48.9	192.6	96.8	43.0
Success	Dead	10	25.2	136.6	85.1	85.0
Schley	Alive	10	31.7	160.6	78.2	40.3
Schley	Dead	10	24.5	143.7	82.3	38.6

[z]Grafts were made in Apr. 1993. Early fall freezes occurred on 30-31 Oct. and 01 Nov. 1993. Tree status was recorded in Apr. 1994.
[y]S.D. = Standard Deviation.

generate were replaced with greenhouse grown 'Elliott' seedlings in Apr. 1991.

Effect of 1991 freeze.

A premature freeze occurred in early Nov. 1991. Prior to this, temperatures had been unusually warm. Trees still had vigorous green foliage and showed no signs of dormancy. The average first frost date is 15 Nov. normally after a cooling period in Oct. On 3 Nov. the low was –2.8° C, and on the 4th and 5th it was –4.0° and –5.0° C, respectively. This freeze killed almost all of the trees to ground level.

Effect of 1993 freeze.

In 1992, the trees regrew from the roots, and in Apr. 1993 the seedlings were grafted. The same experimental design was followed with the same cultivars as in the original orchard establishment. Trees were grafted with the 4-flap method using scions collected at the LSU Pecan Research-Extension Station in Jan. The majority of the grafts were successful and the orchard was growing well when a third unusual freeze period occurred. An early freeze occurred on the nights of 30 Oct., 31 Oct., and 1 Nov. 1993. Temperatures were not as low as in the previous two killing freezes. The low was –2.8° C on 1 Nov., with 12 hours at or below freezing on 31 Oct., and 7 hours on 1 Nov. Approximately half of the trees were killed to ground level. The scion only was killed on a few others. The data collected on tree survival the next spring indicated that one cultivar, 'Pawnee,' was essentially undamaged by this freeze which killed about half of the trees of each of the other nine cultivars.

Table 1 indicates the number of trees that were alive in Oct. 1993 prior to the early freeze, and the trees killed by the freeze as recorded in Apr. 1994. The trees had been grafted in Apr. 1993 onto 'Elliott' seedlings in their second year of growth on roots that were mostly in their sixth year of growth. There were 30 to 40 trees grafted of each cultivar out of a possible 46. In Apr. 1994, 43 to 67% of each of nine of the cultivars were dead at ground level. However, the 'Pawnee' cultivar had only 8% killed, and differed significantly from all other cultivars (Table 1). The ungrafted seedlings that were of the same age and size as the grafted trees had a similar percentage killed (55%) as the nine cultivars. All cultivars had 1 to 4 trees in which only the scion died (Table 1).

The relationship of height of juvenile trunk tissue to freeze damage was examined by measuring the graft position of a representative number of live and dead trees for each cultivar (Table 2). Only 16 of these trees had graft heights of 30 cm or less. Six of these were dead (38%), while 93 of 180 (52%) trees with grafts above 30 cm were dead. The majority of the grafts were 0.5 to 1.0 m above ground (Table 2), well above the 30 cm distance needed to obtain the benefits of juvenile trunk tissue for freeze protection (14). There was no indication of an effect of juvenile tissue providing freeze protection.

A previous report indicated that 'Pawnee' exhibited resistance to early fall freezes (3). The resistance was probably inherited from the 'Starking Hardy Giant' parent which originated in north central Missouri. Seedlings of 'Starking Hardy Giant' have shown resistance to spring freeze damage (10, 13). 'Pawnee' and 'Elliott' cultivars were similar in freeze damage susceptibility in the previous report (3); however, in the case reported here, trees grafted to 'Pawnee' were much more resistant to damage than ungrafted 'Elliott' seedlings (Table 1). This apparently is a previously unreported observation for pecans. The scion increased the freeze resistance of the juvenile tissue rootstock.

In young trees the most vulnerable tissue to cold damage in fall is at or near the ground line. Presumably because this tissue still contains a high level of moisture (1), and the coldest air will usually be at the ground line. The 'Pawnee' scions which had an average graft height of 69 cm (Table 2) apparently affected the freeze susceptibility of the trunk tissue at ground level. Cultivars that exhibit tolerance to early freezes are apparently more advanced in the dormancy process than freeze susceptible cultivars. In the present study, 'Pawnee' trees were still in full leaf with healthy green foliage just like the other cultivars, when the freeze occurred in Oct. Nonetheless, the dormancy process with 'Pawnee' must have already started, and that process was affecting the rootstock. Just as rootstock can effect cultivar susceptibility to freeze damage (6), scion type appears to affect rootstock susceptibility.

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Host Plant Resistance to Blackmargined Aphids on Pecan

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Abstract

The blackmargined aphid is a major insect pest of pecan. Host plant resistance to this insect was tested in two NPACTS (National Pecan Advanced Clone Testing System) tests in California in 1998. Number of aphids per leaf were determined 16 times at weekly intervals. 'Pawnee,' which had been shown to be resistant in Texas and Georgia, also demonstrated resistance in California. Aphid populations varied greatly, with the Lagomarsino Test averaging 4.10 aphids per leaf for the season, and the Clark Test averaging 8.52. Temporal variation in each test was great, with significant clone X date interactions. Level of host plant resistance in clones was generally unpredictable, based upon parentage. In pecan breeding programs, this makes testing of potential clone releases imperative, since predictability of performance based on pedigree has limitations.

Host plant resistance to the blackmargined aphid (*Monellia caryella* (Fitch)), yellow aphid (*Monelliopsis pecanis* Bissell), and the black pecan aphid (*Melanocallis caryaefoliae* Davis) in 'Pawnee' (7) and some other pecan clones (*Carya illinoinensis* (Wangenh.) K. Koch) has been known for some time (3, 6, 9). Host plant resistance to these insects is proving to be valuable when used in conjunction with other orchard management techniques, such as maintenance of aphid predator populations. As insecticide resistance within these aphid species becomes more apparent, host plant resistance will become even more important (2).

Of these three aphid species, the blackmargined is a major pest, and accounts for most of the damage attributable to the yellow aphid complex (yellow and blackmargined aphids) in pecan (1, 10).

In the U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS) Pecan Breeding Program, crosses are made and clones are initially selected at College Station, Texas. The best clones from this initial selection process are further tested in NPACTS (National Pecan Advanced Clone Testing System). The USDA-ARS conducts NPACTS tests in cooperation with state agricultural experiment stations, state extension services, and private individuals. Much aphid resistance data have been collected in NPACTS tests designed to determine adaptability of new breeding selections to different U.S. geographical areas. After NPACTS testing, superior clones are released as new USDA cultivars with Native American names. Here we report results from two California NPACTS test sites where clones were sys-

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