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Journal American Pomological Society 55(2):124-128 2001

Rootstock and Scion Affect Cold Injury of Young Pecan Trees

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Abstract

An exceptionally early Autumn freeze on 8 and 9 October 2000 injured young pecan trees [Carya illinoinensis (Wangenh.) C. Koch]. There was less injury to current season's growth on 'Kanza' than on 'Mohawk', 'Mount' and 'Creek'. Trees on rootstocks of 'Peruque', 'Giles', 'Colby', 'Apache', and native seedlings from Stillwater, Okla. and Brunswick, Mo. were among the least injured by the fall freeze. Trees on 'Starking Hardy Giant' and natives from Chetopa, Kans. were the most severely injured by the freeze. Cold hardiness imparted to the scion by the rootstock was not closely related to the climate at

Introduction

Cold injury of pecan is a frequent problem. One form occurs in the Autumn before trees have acclimated to cold temperatures (3, 9, 14), another form during winter usually after trees have met their chilling requirement (1, 7, 13, 16), and another in the spring when damage is done to buds or developing shoots (4, 5, 12). A cultivar or rootstock resistant to one type of cold injury is not necessarily resistant to all types of cold injury. For instance, 'Pawnee' is resistant to both fall and mid winter cold injury, but is among the first cultivars to break bud in the spring, and therefore is highly susceptible to spring freeze damage. Cultivar and rootstock dramatically affect cold injury (1, 2, 3, 7, 11, 13, 16). During a freezing event it is common to find certain cultivars uninjured while others are severely damaged or killed (11), and certain rootstocks impart sufficient cold hardiness for a cultivar to escape injury on one rootstock genotype while being killed on another (2). This emphasizes the importance of selecting the correct cultivars and rootstocks for each production area.

Pecan cold hardiness is largely based on the effects of cold on field plantings. Controlled freezing tests have generally been unsuccessful (8). Substantial information has been amassed on the cold hardiness of older cultivars, but little is known about recently released cultivars. Also, little information is available concerning how the rootstock affects cold hardiness of the scion. Hinrichs (2) reported that cold fall temperatures killed 1-year-old 'Stuart's cions on certain rootstocks, while similar 'Stuart' scions on other rootstocks were not injured. Low Autumn temperatures damaged more 4-year-old 'Wichita' and 'Choctaw' trees on 'Riverside' rootstock

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than those on 'Apache' rootstock (4).

An exceptionally early Autumn freeze in October 2000 damaged several trees in an existing cultivar/rootstock trial. We report cold injury observations on young pecan trees with various rootstocks and scions.

Materials and Methods

The trial included six cultivars and five native pecan populations (closely related individuals from a native stand, seed from at least 10 native trees were pooled) used as rootstocks. These included five cultivars considered to be northern cultivars, 'Chetopa', 'Colby', 'Giles', 'Starking Hardy Giant' and 'Peruque', and one cultivar considered southern, 'Apache'; although it is more cold hardy than most southern rootstocks (3). The five pecan populations were from Brunswick, Missouri; Chetopa, Kansas; Sapulpa, Oklahoma; Stillwater, Oklahoma; and DeLeon, Texas. Container-grown rootstocks were planted in October 1993 on a 10.7 m by 10.7 m spacing. Trees were irrigated annually as required with a traveling gun, and fertilized following Oklahoma Cooperative Extension recommendations (6). A weed free strip 1 m wide on each side of the trees was maintained with selected herbicides. Rootstocks were grafted to four cultivars beginning in 1998. The cultivars chosen were 'Mohawk', 'Mount', 'Kanza', and 'Creek'. There were ten replications of each rootstock/scion combination in a randomized complete block design.

On 8 October 2000 the low temperature reached -2°C and on 9 October the low was -5°C at the Pecan Research Station near Perkins, Okla. This freeze set a new record for the earliest fall freeze recorded in Oklahoma. The average date of the first freeze (≤0°C) is 1 November, and for a killing freeze (≤-2°C) is 21 November at this site. All trees were fully foliated when the freezing event occurred. Current season's shoot growth was rated on 16-18 October for visual injury by removing a 3-cm section of bark and observing discoloration of the vascular and cambial tissue. Three current season shoots were rated on each tree. A rating of 1 indicated no visible injury, 2 indicated that brown discoloration was obvious, but the shoot would survive, and a rating of 3 indicated extensive tissue browning and that the shoot would probably die. Only trees with 2- to 3-year-old scions were included in the evaluation; therefore, the number of replications for each rootstock/scion combination ranged from three to ten, with a harmonic mean cell size of 22 for the main effect of rootstock and 64 for the cultivar main effect. Data analysis was by general linear models with mean separation by Waller-Duncan K-ratio test.

Results and Discussion

There were no significant interactions among cultivars and rootstocks; therefore, only main effects will be discussed. 'Kanza' had less cold injury than the other three cultivars in the trial (Fig. 1 and 2). During a previous severe fall freeze 'Kanza' (USDA 55-11-11) was not injured when several other cultivars were severely damaged (11). These tests confirm that 'Kanza' acclimates rapidly and was among the most cold hardy cultivars when exposed to potentially damaging cold temperatures in the fall. 'Kanza' was also among the least damaged cultivars when exposed to damaging winter temperatures

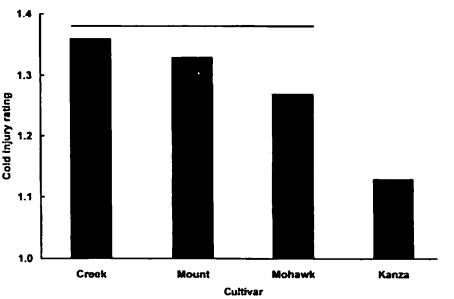

Fig. 1. Cold injury ratings of current season's growth for four cultivars following an early October freeze. Data are pooled over eleven rootstocks. Damage ratings are 1 = no injury, 2 = vascular and cambial tissue browning, and 3 = extensive vascular and cambial tissue browning with shoot death likely. Data bars under the same horizontal line are not significant at the 5% level by the Waller-Duncan K-ratio test.

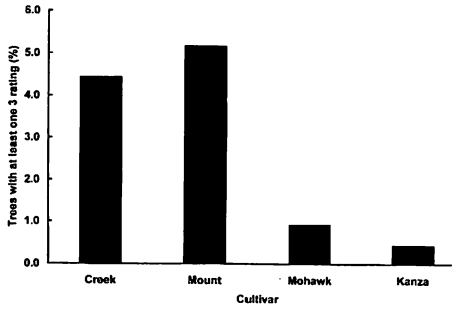

Fig. 2. The percentage of trees by cultivar that received at least one injury rating of 3 out of the three injury ratings on each tree. A 3 rating indicates that the current season's shoot is dead. Data are pooled over eleven rootstocks.

(10), and is one of the last cultivars to break bud in the spring. There were no significant differences in cold injury among 'Mohawk', 'Mount' and 'Creek'. Fall cold hardiness of 'Mohawk', a cultivar that frequently crops excessively, is closely related to crop load (11). 'Mohawk' trees that had been overloaded were severely damaged by an exceptionally cold Autumn freeze, but those with a moderate to small crop had little to no freeze injury. 'Creek' (USDA 61-6-67) was released by the USDA-ARS in 1996 (15), and there is little information related to its cold hardiness. It has a strong tendency to overload, even more so than 'Mohawk'. 'Creek' had more trees with at least one rating of 3 than 'Mohawk' (Fig. 2) indicating substantial shoot dieback. This suggests that bearing 'Creek' trees may experience frequent and severe fall cold injury in Oklahoma and similar locations. In an earlier damaging Autumn freeze, 'Creek' had damage similar to 'Tejas' and 'Shoshoni', but more than 'Kanza' (11). 'Mount' also had more trees with at least one 3 rating than 'Mohawk' and 'Kanza' (Fig. 2), and an injury rating similar to 'Mohawk' and 'Creek' (Fig. 1). 'Mount' was selected as a native

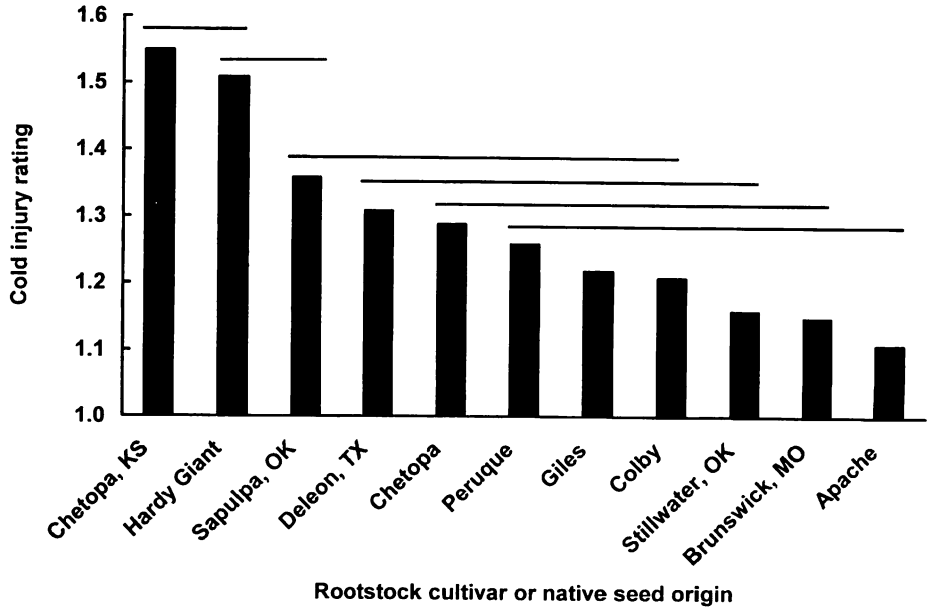

Fig. 3. Cold injury ratings of current season's growth for eleven rootstocks following an early October freeze. Data are pooled over 4 cultivars. Damage ratings are 1 = no injury, 2 = vascular and cambial tissue browning, and 3 = extensive vascular and cambial tissue browning with shoot death likely. Data bars under the same horizontal line are not significant at the 5% level by the Waller-Duncan K-ratio test.

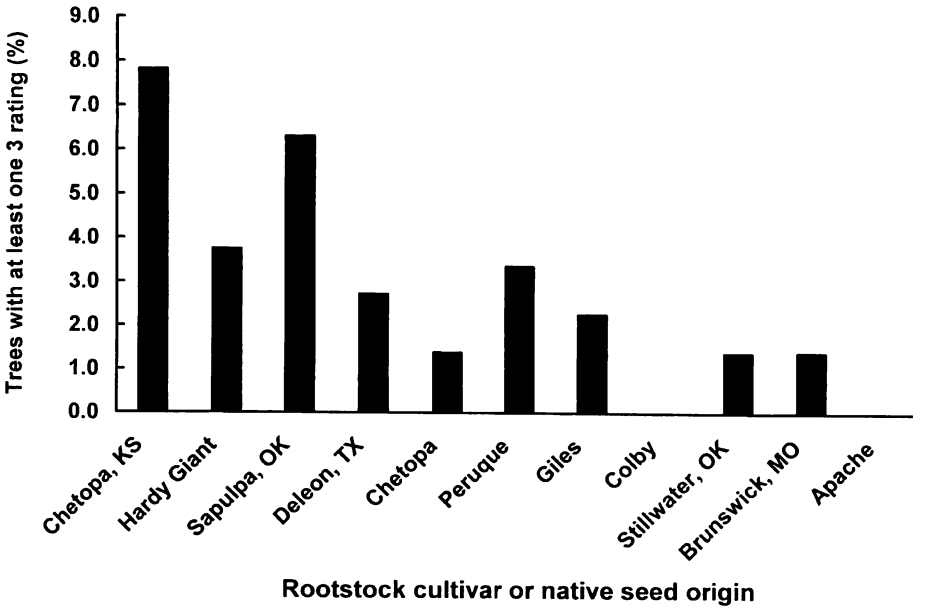

Fig. 4. The percentage of trees by rootstock that received at least one injury rating of 3 out of the three injury ratings on each tree. A 3 rating indicates that the current season's shoot is dead. Data are pooled over 4 cultivars.

seedling from Okmulgee, Okla. Although it is native to this area, it has an exceptionally early budbreak, similar to 'Pawnee', and has experienced fall cold injury in the past.

The amount of cold injury associated with the various rootstocks was rather surprising. First, 'Apache' was among the group of rootstocks with the least cold injury (Fig. 3 and 4). 'Apache' is considered a southern rootstock, and we expected delayed acclimation of scions on this rootstock and therefore greater fall cold injury, but this was not the case. Trees on 'Apache' were reported to be substantially more cold hardy than on 'Riverside' (3); however, trees on 'Riverside' typically lack sufficient cold hardiness to survive in Oklahoma. Therefore, a comparison of 'Riverside' and 'Apache' was of little value when assessing 'Apache' cold hardiness in a harsh environment. Another surprise was the severe injury of trees on natives from Chetopa, Kans. and on Starking Hardy Giant (native selection near Brunswick, Mo.). We expected cold hardiness of trees on rootstocks derived from native seed to be closely related to the typical climate of the seed's origin. If this were the case, then cold hardiness of rootstock populations should rank Brunswick > Chetopa > Stillwater ≥ Sapulpa > DeLeon. However, cold injury did not follow this pattern, indicating that individual cultivars or selections must be tested since cold hardiness is not necessarily highly predictable based on the climate of the seed's origin.

'Giles' and 'Peruque' are recommended rootstocks for Oklahoma. Both rootstocks were among the group with the least injury (Fig.3). 'Colby' also had little injury, but is not recommended as a rootstock because of its slow growth rate compared to 'Peruque' or 'Giles' (12). 'Apache' has typically been recommended only for southern Oklahoma. If it proves to be cold hardy in future injurious freezing events, recom-

mendations for its use will be extended further north.

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