**Scion bud removal delays leaf development but decreases graft success in pecan four-flap graft.**

Pecan is a highly heterozygous outcrossing species which is normally propagated by grafting or budding onto seedling rootstocks. The four-flap or banana graft is commonly used by growers or researches because of its high percentage of success, especially when employed by novice grafters. We removed scion buds before grafting in an attempt to delay budbreak, thus providing more time for vascular connections to form before leaf development and its associated demand for water takes place. Removal of buds from the scion wood was successful in delaying bud and leaf development, but did not increase graft success, and in one treatment actually lowered graft success. Pecan is a highly heterozygous outcrossing species which shows wide variation in nut and tree quality when propagated from seed. The majority of pecan nuts are harvested from orchards of clonally propagated cultivars, although significant production is still obtained from seedling orchards and native groves. 'Centennial' was the first pecan to be successfully propagated in 1846 or 1847 by an unknown method (Taylor, 1905). However, it was not until 1885 that grafted trees began to be sold by nurserymen for orchard establishment (Sparks, 1992). The development of reliable methods of clonal propagation was one of the keys to the development of the pecan industry (Wood et al., 1990).

Currently, pecan cultivars are budded or grafted onto seedling rootstocks which are typically dug and sold as bareroot trees. The type of propagation method employed is dependant upon the skills of the nurseryman and to a certain extent on the location of the nursery. Pecan nurseries in the Southeast often whip graft seedlings, while those in the western pecan region more frequently use a patch bud. Both of these methods require a fair amount of skill, and can be difficult for amateurs to use successfully. An alternative method is the four-flap graft, which is sometimes called a banana graft (Vanerwegen, 1975). This method is commonly practiced in the early spring shortly after the rootstock has begun growing and the cambial layer is actively dividing allowing the bark to slip from the wood. This method tends to be easier for novices to employ successfully because of the large contact area of the cambial layers of the scion and rootstock.

In the pecan breeding program we often employ the four-flap graft to propagate promising selections for use in cultivar trials. In order for the graft to be successful, a graft union of actively dividing callus cells must form and differentiate into vascular tissues that cross the graft interface (Beeson and Proebsting, 1988; Hartmann et al., 1997). Pecan grafters often avoid using scions with swollen buds because of the belief that swollen buds may commence growth before a callus bridge has formed (Nesbitt et al., 2002). We have also noted that when scions leaf out very quickly after grafting the graft often fails. We hypothesized that in these cases that leaves developed before a vascular connection had formed between the rootstock and scion, leading to desiccation and death of the scion. The objective of this study was to determine if removal of scion buds could delay leaf formation, thereby providing more time for formation of a vascular connection between the rootstock and the scion and increasing graft success.

## Materials and Methods

Dormant, stage 1 (Wetzstein and Sparks, 1983) 'Desirable' pecan scions were harvested in early February of 2003. Scions were cut to 20-30 cm in length with at least 2 nodes with buds. Scions were stored at 4 C in damp cedar shavings in a plastic bag.

Three treatments were applied to the scions prior to grafting. In the first treatment the primary buds were removed from all nodes. In the second treatment, primary, secondary, and tertiary buds were removed from all nodes. The third group was a control where no buds were removed. Each treatment was applied to a group of 30 randomly chosen scions.

To evaluate treatments, ten scions of each treatment were randomly chosen and grafted into the upper branches of each of three 12 year old 'Desirable' trees in Tifton, Ga on May 6, 2003. Trees were irrigated using a solid set irrigation system to prevent water stress during the graft evaluation period. Grafting methods were as described by Vanerwegen (1975) except that the plastic bag covering was omitted. Grafts were done by 2 people, with each person doing ½ of the grafts on each tree. Caliper of each scion stick was determined when the grafts were made. Caliper was taken at the centermost internode of the scion. Scions were evaluated every 4 days for budbreak and leaf development for a period of 44 days after grafting. Scions were evaluated a final time on 5 Sept. 2003 to determine final graft success or failure. Budbreak and leaf development were rated according to the Carya descriptor scale of 1-9 with 1 = dormant buds, 2 = bud swell, 3 = scale split, 4 = leaf burst, 5 = leaf separation, 6 = 25% leaf expansion, 7 = 50% leaf expansion, 8 = 75% leaf expansion, 9 = 100% leaf expansion (http://extension-horticulture.tamu.edu/carya/Manual/BUDBRK.html). Scions which did not survive were excluded from the bud development rating analysis.

Differences between treatments for final graft success were determined through $\chi 2$ goodness of fit tests with data classified according to grafter and scion treatment. There were no differences among the 3 trees for graft success so the data for the trees were pooled together. A difference in mean scion caliper of successful and failed grafts was evaluated with the t-test.

## Results and Discussion

Scion bud removal was successful in delaying the onset of bud and leaf development. Scions with the primary bud removed showed a delay in bud swell

8 days after grafting, but by day 13 and thereafter were similar to the control (Figure 1). Scions with the primary, secondary, and tertiary buds removed had a greater delay in bud development (Fig. 1). In this treatment bud swell did not occur until day 17, as compared to day 8 for the control and day 13 for treatment with primary buds removed. Thereafter, bud development in this treatment was delayed about 1 developmental stage compared to the control and removal of the primary bud.

The effect of scion bud removal on final graft success depended upon the grafter. For grafter number 1, removal of primary, secondary, and tertiary buds reduced graft success as compared to the control treatment and the removal of only the primary buds improved success by 8% (Table 1). Grafter number 2 had less success overall (62%) than grafter 1 (75%), and scion treatment had no effect on final graft success (Table 1). Graft success may be influenced by pressure applied to the graft union. In this experiment, the pressure was applied by the stretching and wrapping of polyethylene tape around the graft union. Although large pressure differences were not noted between grafters, small differences may have influenced grafter success rates.

Removal of scion buds delayed bud and leaf development, but was ineffective or even detrimental to final graft success. New wound-repair xylem is influenced by the activities of the scion rather than the rootstock (Hartman et al., 1997). Stoddard and McCully (1980) found that leaves and buds near the graft union are an important source of xylem-inducing stimuli, and an auxin gradient is necessary for vascular tissue regeneration (Jacobs, 1952; Sachs, 1968). Removal of scion buds may have thus delayed xylem formation, lowering graft success. The removal of scion buds, especially when all the visible buds were removed, also forced the scion to develop less advanced buds, reducing valuable energy reserves that may have otherwise been used for the formation of the graft union. The average developmental stage scions reached before death was 2.5. This stage is prior to leaf burst and its associated large water demand, thus desiccation may not be the primary cause of scion death. In any case, removal of scion buds should not be employed.

The four-flap grafting method typically makes use of larger scion wood than is used for whip-grafting. Scion caliper was measured at the time of grafting to determine if scion size affected graft success. Scion caliper of successful grafts was significantly larger than that of failed grafts (Table 2). These results indicate that the use of scion wood smaller than about 1 cm reduces graft success.

**Literature cited**

Beeson, R.C. and W.M. Proebsting. 1988. Scion water relations during graft union development in Colorado blue spruce. J. Amer. Soc. Hort. Sci. 113:427-431.

Hartmann, H.T., D.E. Kester, F.T. Davies, and R. L. Geneve. 1997. Plant propagation principles and practices. 6th ed. Prentice Hall, Englewood Cliffs, N.J.

Jacobs, W.P. 1952. The role of auxin in differentiation of xylem around a wound. Amer. J. Bot. 140:20-24.

Nesbitt, M.L., W.D. Goff, and L.A. Stein. 2002. Effect of scionwood packing moisture and cut-end sealing on pecan graft success. HortTechnology 12:257-260.

Sachs, T. 1968. The role of the root in the induction of xylem differentiation in peas. Ann. Bot. 32:391-399.

Sparks, D. 1992. Pecan Cultivars: The Orchards Foundation. Pecan Production Innovations. Watkinsville, GA.

Stoddard, F.L. and M.E. McCully. 1980. Effects of excision of stock and scion organs on the formation of the graft union in coleus: a histological study. Bot. Gaz. 141:401-412.

Taylor, W.A. 1905. Promising new Fruits. Pecan, p. 405-416. In: G.W. Hill (ed.). Yearbook of the USDA, 1904, Gov. Print. Off., Washington, D.C.

Vanerwegen, J. 1975. A new grafting procedure. Pecan South 2(2):70-71.

Wood, B.W., J.A. Payne, and L.J. Grauke. 1990. The rise of the U.S. pecan industry. HortScience 25:594, 721-723.

Table 1. Effect of scion bud removal on final graft success

| Grafter | Scion treatment | Final graft result # Live | # Dead | $\chi^2$ Value | Sig. |
|---|---|---|---|---|---|
| 1 | Control | 13 | 2 | | |
| | 1° bud removed | 14 | 1 | | |
| | 1°, 2°, 3° buds removed | 7 | 8 | | |
| | Total | 34 | 11 | 10.3 | 0.01 |
| 2 | Control | 10 | 5 | | |
| | 1° bud removed | 9 | 6 | | |
| | 1°, 2°, 3° buds removed | 9 | 6 | | |
| | Total | 28 | 17 | 0.172 | n.s. |

Table 2. Effect of scion caliper on graft success

| Graft success | Avg. scion caliper (mm) |
|---|---|
| Live | 10.1 |
| Dead | 8.9 |
| Significance | 0.005 |

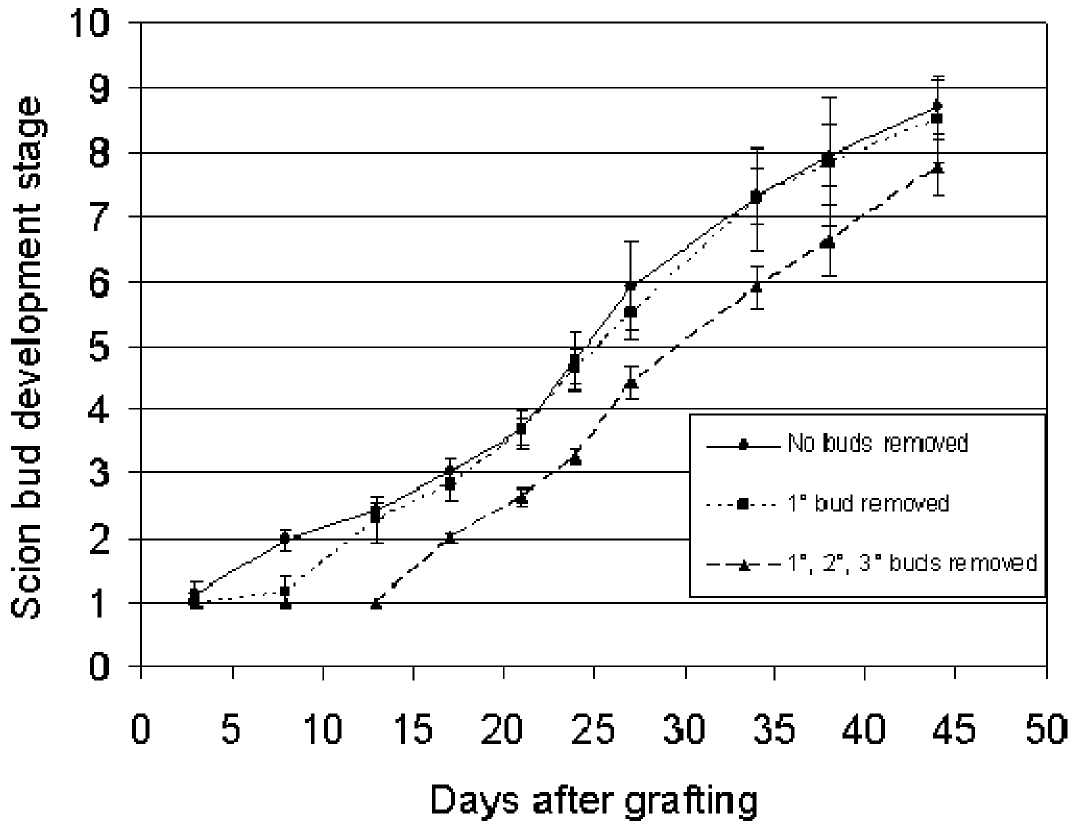


Figure 1. Effect of scion bud removal on bud development