

INTERSTOCK EFFECTS ON TOPGRAFTING IN LOBLOLLY PINE

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Grafting scions of new selections of loblolly pine (*Pinus taeda* L.) into the crowns of sexually mature seed orchard ramets has been a very effective tool for stimulating both male and female flowers (Bramlett et al. 1995, Bramlett 1997). Two years after grafting, an average of 9 females per scion were stimulated on the new grafts in the upper crown and 11 pollen clusters per graft in the lower crown. With relatively little effort, breeding could be completed on these selections in only two or three years (Bramlett and Burris 1998). Many orchard managers in the South have experimented with topgrafting, and in general have had success with the methods. The opportunity to shorten the breeding cycles to less than five years is a very strong incentive to utilize this technique.

In 1996, we initiated a study at the Smurfit-Stone Container Corporation (S-SCC) Escambia Research Station Seed Orchard in Brewton, AL to evaluate various aspects of topgrafting. Our primary objective was to assess the impact of grafting on to different seed orchard clones; is there a strong influence of the interstock clone on the number of flowers produced by the topgrafts? In horticultural orchard crops, the influence of rootstocks and interstocks on growth and reproduction is well documented (Garner 1979, Hartmann and Kester 1983). In general, the influence of rootstock on reproduction has not been great in most forest trees (Jayawickrama et al. 1991), but little information is available on the influence of interstocks.

The study was conducted in S-SCC's experimental seed orchard grafted in 1988. Six different second-generation clones were used as ramets in the trial. For cone production, the six clones ranged from extremely high to almost sterile over the eight years of assessment. Will these differences be related to the reproductive capacity of the topgrafts made in the crown of these trees?

METHODS

Grafting was carried out over a two year period. The 1996 study utilized the same six clones in the seed orchard both as topgrafts and interstocks, and clones were grafted in all possible combinations. In 1997, ten third-generation selections were used as topgraft clones. Standard dormant-season grafting procedures for loblolly pine were used with a few modifications. Cleft grafts were made in dominant branches in the upper quarter of the crowns. Rather than cover the graft union and scion bud with wax (the standard procedure), prior to grafting, scions were dipped in paraffin at 190°F to cover the bud. After grafting, the graft union was covered with Parafilm^R to prevent desiccation.

Each scion clone was grafted into the crown of three different ramets of the six interstock clones. In addition to grafting on to the ramets in the orchard, large ungrafted seedlings within the orchard were also used as "interstocks". We wanted to evaluate the potential of using large ungrafted seedlings for topgrafting; is it necessary to utilize grafted trees? A total of 126 grafts (6 scion clones x 7 interstocks x 3 grafts) were made in 1996, and 210 grafts (10 scion clones x 7 interstocks x 3 grafts) were made in 1997. In addition to the topgrafts, each scion clone was also grafted on to two or three one-year-old rootstocks. Female flower counts were made each spring in 1997 to 1999, and the number of male pollen clusters were counted only in 1999.

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Flowers were also counted on two "check" branches in each crown and were used as ungrafted controls. These counts and the flower and cone counts from the Rootstock Study data were combined to give an index of the flowering tendency of each clone. This index of a clone's flowering tendency was then correlated with the clonal means when the clone was used as an interstock.

RESULTS AND DISCUSSION

In both the 1996 and 1997 studies, there were strong topgraft clonal effects (data not presented) and interstock clonal effects for number of flowers. Rather than present all the data, the total number of females over the 2 or 3 years of each study and the number of males in 1999 are presented in Table 1. As has been found in other trials, topgrafting was very effective at stimulating both female and male flowers two and three years after grafting. In the conventional grafts made on young seedlings, there were very few flowers produced (average of 2.1 total females in 1996 grafts, 4.7 females in 1997 grafts), and these were all in 1999 which was an exceptional flowering year. The effect of grafting into crowns of different clones was generally significant and important (Table 1).

There are differences between the two different studies, but some general trends are apparent. When used as interstocks, clones 071095, 111154, and 181210 appear to be very effective at stimulating female flowers. Clones 081166 and 111135 tend to be poor clones to use as interstocks, but the effect in the 1997 trial was not as large. The effect on male flowers was not as great as for females; there were no clonal effects in the 1996 trial, and the significant differences in the 1997 trial were not very large. Fortunately, there was no significant interaction between the interstock clonal effect and the topgraft clonal effect for any of the flower counts. Interstocks that are effective at stimulating flowers on one clone tended to be effective at stimulating flowers on all clones.

Although there were strong clonal effects, the flowering tendency of the clone was not related to its flower stimulation capacity as an interstock. The low correlations ($r=0.19^{NS}$ in 1996, and $r=0.31^{NS}$ in 1997) indicate that choosing good flowering clones to use as interstocks will not necessarily result in the best flowering in the topgrafts.

Another concern is the impact of the interstock clone on survival. While clone 071095 was very effective at stimulating female flowers (Table 1), the survival of topgrafts made on ramets of 071095 in the 1997 trial was only 67% compared to 80% for all the other clones. Clone 111154 was a particularly interesting clone in the trials. The clone itself is a very poor cone producer, but would be an excellent choice to use as an interstock. Survival of topgrafts on 111154 was 100%, and it was very effective at stimulating female flowers (Table 1).

Although the topgrafts made on the large seedlings did not produce many flowers, there were enough females and males to be useful for breeding. Some orchard managers do not have excess seed orchards or clone banks that can be used as topgrafting orchards, but some have thinned existing plantations to wide spacings and will use these as topgrafting orchards in the future.

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Table 1. Clonal means for flowering tendency (combination of branch counts in current study and flower and cone counts from the experimental orchard) and for the number of female and male flowers for each clone when it was used as an interstock*.

Clone	Flowering Tendency Index	1996 Study Total Number Female (3yrs)	1996 Study # Males in 1999	1997 Study Total Number Females (2yrs)	1997 Study # Males in 1999
071095	177.8	23.7ab	33.9'	29.5'	15.7'
081166	72.0	7.9b	26.0'	13.1b	9.0bc
081218	93.7	24.1ab	29.8'	13.4b	8.3bc
111135	298.1	8.8b	24.9'	14.6b	10.0b
111154	38.7	38.6'	31.3"	16.2b	12.3ab
181210	466.9	38.7'	35.8'	21.1ab	10.6b
Large Seedling		18.7ab	20.8'	12.4b	5.1c

* Flower counts within a column followed by the same letter are not significantly different at p .05.

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