Pecan Breeding Overview – Part 2

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In the previous article I discussed the first steps of the breeding process which included choosing parents, making crosses, and collecting the seed from those crosses. In this section I will talk about growing the seedlings to maturity and selecting the few superior trees that you wish to test more thoroughly. In some ways this is the most difficult part of the process. Out of the thousands of seedlings you grow, only a few can be kept for further evaluation. Every seedling has a mix of good and bad traits, and deciding those to keep can be challenging.

To start the process the nuts from our crosses are stratified for at least 90 days and then planted in the greenhouse, usually sometime in late January. By planting in the greenhouse we can get an early start on the season, and we can also eliminate those that grow very poorly or don't germinate. We average about 70-80% germination over all our progenies. However, for various reasons, some seed lots will get a lot of rot and germinate at a low rate. It is easier and more space efficient to remove these quickly in the greenhouse, rather than having empty pots on the pot lot. Toward the end of March the seedlings will go outside. In the past we have grown our seedlings in the ground. This was primarily done because our pot-grown seedlings would have serious problems with mouse ear. However, now that we can control this problem with nickel applications, we have gone back to growing them in pots the first year. I feel that pot grown seedlings experience less transplant shock when planted, and they are much more convenient to handle at planting time.

Dr. Patrick Conner

Another advantage to growing seedlings in pots is the ability to screen the seedlings for pecan scab before planting them in the orchard. We have always screened our

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seedlings the first year or two before planting them in the seedling orchard. However, when planted in the ground, in dry years we often didn't get enough scab to be able to eliminate many seedlings. Now, the potted seedlings are under overhead irrigation and are shaded for the first half of the year with a shade cloth providing a humid environment conducive to the growth of scab. In addition, I collect scabbed leaves from our seedling orchards and wash off the spores and spray them onto the seedlings a couple of times a year. Using this method we are able to observe scab on a large percentage of seedlings. Depending upon the cross, we have removed anywhere from 20-80% of the seedlings due to scab susceptibility in the first year. How strongly we select for resistance depends upon the cross. When resistant parents are used and resistance is the objective, we select very strongly. Where susceptible parents are used and we have other goals, early harvest for instance, we may only remove the very susceptible. It also depends upon the number of seedlings in the cross. If we have several hundred seedlings, we tend to be more stringent on the seedlings we keep.

I can't over emphasize how important it is to be able to select seedlings at this stage. For every seedling we remove before planting out, we have room in the orchard for another seedling that may have the traits we desire. We can easily grow more potted trees, however we are limited in our seedling orchard space and that is where the bottleneck in the process occurs. So, if we remove 50% of a cross as potted seedlings, we have room in the seedling orchard for more trees that might be what we want, and we have doubled our chances of finding a good selection.

At the end of the first year we discard the seedlings that have been flagged due to leaf scab susceptibility and plant the remainders in the seedling orchard. At this stage the seedlings are about 2 feet tall. Trees in the seedling orchard are planted at 10 feet between trees in the row and 15 feet between the rows (Figure 1). The purpose of the seedling orchard is to give the trees enough room to

Figure 1. A seedling orchard after a few years of growth. The seedlings are just coming into bearing.

enable them to grow large enough to bear nut crops for 3-4 years allowing us to make initial selections. Seedling trees are different from grafted trees in the time it takes to bear nuts. In general, a seedling tree takes longer and must get much bigger than a grafted tree before it will produce nuts. This is because a seedling tree starts out as a juvenile tree, and juvenile trees do not flower. Seedlings only begin to flower after the transition from a

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juvenile to a mature phase takes place. This makes sense because in its native environment a young pecan tree must grow quickly and establish its position in the forest canopy before it spends resources on nut production. In contrast, a grafted tree has mature wood grafted onto a juvenile rootstock. The transition to flowering is quicker in this case. The time from planting to flowering varies and can take from 6 to more than 10 years. I have found that parentage makes a big difference. Seedlings from some of the older traditional cultivars like 'Van Deman' and 'Alley' take a long time to flower. Seedlings from newer more precocious cultivars like 'Sioux' and 'Cheyenne' take a few years less time.

When we first started growing the progenies we gave them a lot of water and nitrogen in the hopes that bigger trees would flower sooner. We got bigger trees, but flowering was not quicker. We now cut back on nitrogen after about year 3 and seem to get quicker flowering on smaller trees. Tree size is important as smaller trees don't shade out as quickly giving you more bearing surface. Maintenance of the trees in the seedling orchard is as minimal as possible. Weeds are controlled and irrigation is provided. We try to limit the spraying that is done. However, towards the end of the year we spray for shuckworm and put one or two fungicide sprays on to control brown spot. We also will spray for black aphids once they get to high numbers. Without these measures the trees will defoliate early and we don't see the nut set that we need in order to evaluate the trees. We also set up propane cannons to discourage crows.

Once trees begin to produce nuts the fun part begins. Starting in September I begin riding a lift up and down the rows looking for trees with open shucks. Once a tree is found an initial judgment is made whether the seedling has value or is a discard. Discards are based on small nut size, too much nut scab, late harvest date, poor tree vigor, or poor foliage. If the tree appears to have value a nut sample of about 20 nuts is taken and the tree is evaluated for scab, shuck decline, cluster size, sooty mold, black aphid damage, leaf health, harvest date, and crop load. The nut sample is then brought into the lab and dried down. A sample is cracked out and the nut sample is evaluated for nut size, percent kernel, shelling ability, kernel appearance, kernel color, kernel defects, and the adherence of packing fuzz.

The majority of seedlings are quickly discarded due to obvious defects. The most common reasons for elimination are small nut size, scab susceptibility, and low kernel percentage. The real challenge is deciding what to keep from the remaining seedlings. Generally a rule of

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thumb in fruit breeding programs is you want to keep about 1% of your seedlings for further testing. Most of the superior seedlings will have a combination of good and bad traits, making a final decision difficult. Another issue is that the seedling trees are often fairly crowded and thus you aren't seeing a large crop and the trees aren't at their best. Year to year variation is also quite noticeable. Time is a factor and we want to cut out trees as quickly as possible so that the land can be replanted with new trees. In general, we try to make a decision on whether to further evaluate a seedling in replicated trials within four years of it fruiting. However, there is an intermediate decision that can be made where a seedling is grafted onto a single orchard tree for further evaluation. This is a midpoint between discarding the seedling and entering the seedling in replicated yield trials, and it allows us to keep the seedling for use in the breeding program as a new parent.

We manage the seedling orchards by removing seedlings as soon as they are discarded for any reason. This gives us more space for the remaining seedlings and reduces shading. In the past, trees were removed by cutting them down and dragging them out and burning them. In the last year we experimented with hiring a land clearing service to come in and chip the trees in place (Figure 2). We were quite pleased with the process as the tree could be chipped down to ground level and even the branches were ground up. The tree then becomes mulch on the orchard floor which was low enough that we could still mow the grass. Once most of the trees have been removed, the land can be replanted. So far, we have kept

Figure 2. Discarded trees being removed from the seedling orchard. Trees with a red flag have been selected and will be kept.

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all of the original seedlings of our selections and planted around them. However, this may not be practical in the long run and we may move towards removing the original parent tree once new grafted trees are available. While it would be desirable to have the original tree to observe, this tree will likely hamper the growth of the new seedlings around it, making it difficult to evaluate the next generation.

Currently we have planted all our available land with pecan seedlings. All our new seedlings are going out into land that has been cleared from previous generations. Thus if we want to plant new seedlings we must get rid of old seedlings. This is not all bad as it forces us to make decisions and move forward with the program. For the most part, if you are undecided about a selection it is not likely to be successful in the long run. Probably the hardest situation is when a seedling has a large number of good traits, but one flaw. These are hard to give up on because they are so close to what you want. Your natural inclination is to keep watching them in the hopes that the problem will go away, but it usually won't. Probably the best thing to do with these seedlings is to propagate them and use them as parents to try and eliminate the flaw in the next generation.

Once a seedling has been chosen to propagate and further evaluate it goes from being a seedling to being a selection. You may have noticed that all our selections have a 3-part number like 99-2-108. This numbering system is commonly used in breeding programs. The first two digits of the number represent the year the cross was made. 1999 was the first year crosses were made in our program, so our oldest seedlings start with 99. They then start with 00 for year 2000 and on up to 12 for this year's crosses. The second number represents the cross number. In 1999 we made 13 different crosses, so the second number goes from 1 through 13. The second cross we made in 1999 was 'Oconee' x 'Elliott', thus any other selection that starts with 99-2 have the parentage of 'Oconee' x 'Elliott'. The final number represents the seedling number. So, 99-2-108 is the 108th seedling grown from the cross 'Oconee' x 'Elliott' made in 1999.

In the final part or our series we will discuss the testing of our selections and the methods of deciding when to release a selection as a new cultivar.

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