Piñon Pine Seedling Production and Genetics

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I will center my talk around the piñon pine seedling production we have at Mora Research Center in conjunction with New Mexico State Forestry. I will also discuss some of the piñon pine genetics and seedling research that we have been conducting over the past four to five years. Due to time constraints and the number of topics I will attempt to cover, I will not present much data. Rather, I will talk about the concepts associated with these topics. The topics I will discuss will be piñon pine plantings associated with our seedling production program, seedling production and handling research, projects involving piñon pine as a component in windbreaks in New Mexico, and finally some of the piñon pine progeny tests we've been working on.

The Mora Research Center produces approximately 100,000 conifer seedlings each year for the public seedling distribution program. Piñon pine was introduced as a species to be included in the public seedling distribution program in 1985. In 1986 the initial order for piñon pine seedlings was 5,000 seedlings. In subsequent years the order averaged around 6,500 piñon seedlings until this year when it reached an all-time high of 9,000 seedlings. One reason why the order numbers are increasing is the growing concern for the environment and native plant conservation. As we saw earlier, piñon pine occurs over a wide range of New Mexico so there are a lot of native areas to plant piñon.

This flow chart provides a generalized model of how we produce seedlings. It is a very simplified model. First we start with the seed source and genetics of our seed. We are selective about where we obtain our seed and the selections we make because of their impact on the final product. The seedlings are put through a growing culture which is separated into two categories. In the growing phase, we encourage height growth of the seedling. During the second phase, we acclimate the seedling to cold temperatures and water stress, (i.e. building up their stress tolerance). The growing phase is conducted in the greenhouse and the hardening phase is conducted both outdoors and in a cold frame. Following this, the seedlings are given to Dave Brown of New Mexico State Forestry who ultimately delivers them to New Mexico residents. This latter process describes what I have labeled here as the handling phase of seedling production.

Now that I have discussed how we produce a seedling and illustrated how the production of impacts quality, the next logical question is how to improve the product, the seedling. This leads us to the topic of seedling quality. I could ask everyone in this room for a definition of seedling quality and I will get 75-100 different definitions. In the reforestation literature, we define seedling quality as the ability of seedling to achieve management's objective for that seedling in the shortest period of time. This is what we have been researching quite a bit over the past four or five years from various conifers, including piñon pine.

We know what seedling quality is but how do we measure it? There are a lot of ways you can look at a tree and say whether it is a good tree or a bad tree. When doing that you need to take into consideration the site where you are planting the tree. The physiological measures we use to evaluate our seedlings and do some research to evaluate our production techniques include root growth potential, dormancy, and mitotic activity which are suspected to be related to stress tolerance. Root growth potential is simply the ability of a seedling to produce new roots. Also we use cold tolerance, which is to say how cold a temperature the seedlings can withstand. The water relations of piñon pine seedlings is quite important information to have because of the type of sites they are

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frequently planted in. The second area of seedling quality measures we evaluate are morphological measures. These seedling attributes include caliper, how thick the stem is, seedling height, root fibrosity or the amount of branching in the roots and how they are distributed, root biomass, shoot biomass, and root:shoot ratio.

We raise our conifer seedlings in containers so when the seedlings go out they have a root ball with them. We also have the ability to manipulate the physiology and morphology to a greater extent than do bareroot nurseries. How do we measure seedling quality and how does it fit into the research we have been conducting? Here is the flow chart of seedling production again and you can see the dashed lines from the various stages of production all lead to seedling quality.

It has been well documented in conifers that different seed sources produce different quality seedlings. Piñon pine grows over a wide range of sites in New Mexico. For a long time when I was living in Las Cruces my vision of piñon pine was that of a tall round-topped bush. Since I have been in northern New Mexico, my vision of piñon pine has changed dramatically. This is to say there is a lot of genetic variability in piñon pine. Another aspect of seedling production we have been examining is modification of the growing regime of seedlings. One aspect we've been examining is moisture stress conditioning, or exposing the seedlings to sublethal periods of moisture defects. Plants do not have a nervous system or a brain to have memory: rather, they use physiochemical memory system. In other words they develop certain physiological processes and even morphological attributes which allow them to perceive and withstand certain stress. However, in order to do so they need to be exposed to those stresses gradually. We have also been looking into photoperiod manipulation during the growing and hardening phases and its effects on dormancy and stress tolerance. We have been looking at modifications of seedling nutrition throughout the production system. To measure the effects of these treatments we measure attributes of the seedling and their outplanting performance or how well they grow when they are outplanted.

Some of the more interesting work we have been doing involves research in the area of seedling handling. You can use the best gene source in the world, grow it under the most favorable conditions, and kill the seedling if you don't handle it properly. Unfortunately this scenario happens quite frequently. We have been testing different growing regimes to increase the tolerance of seedlings to withstand harsh handling as well as examine the handling process and seeing how it can be improved.

The next section of my talk will deal with the use of piñon pine as windbreaks in New Mexico. I serve on the Interagency Windbreak Task Force as a representative of NMSU. This task force is responsible for designing windbreaks and training professionals in windbreak design and establishment. We planted a lot of the windbreaks on the eastern plains. Ranchers now realize that by having the windbreaks, the feed cost is starting to drop, and the mortality rate is decreasing. Here is a picture of a piñon pine windbreak in Santa Fe. Windbreaks have a lot of inherent benefits. Some of these attributes include slowing down the wind, reducing erosion and energy costs, improves aesthetics and wildlife habitat, and reduces livestock costs. You would not think windbreaks are necessary in cities, but that is not the case. There are several reasons we are promoting piñon pine in windbreaks: 1) the thick well-structured crowns of piñon pine (fairly dense mats slow down the wind); 2) the large nut production of piñon for both economics and wildlife benefits; and 3) piñon pine is well adapted to dry areas where windbreaks are frequently essential. If you finally convince someone to put in a windbreak, they are going to find a bunch of little seedlings which they expect to provide a windbreak in two years. This is the one drawback to using piñon pine in a windbreak. Piñon pine is not known for its fast growth, which leads me to the final section of my topic—the piñon pine progeny test that the Mora Research Center is involved with.

We have established several piñon pine progeny tests. I am going to discuss one which we (and Jim Fitch of the United States Forest Service) have been involved. This test involved looking at the height growth of piñon pine. The initial selections (four) were based on two factors: height growth and crown form. The crown form selected was conical crown rather than round crown. You can see in this picture a conical crown form has one main stem and few main lateral branches growing at narrow angles from the main stem. Jim had made the selections and established the three progeny test sites before I had arrived at the research center. We examined the locations earlier this spring; unfortunately the local wildlife destroyed much of the tests. What was remaining appeared to be growing well and in a few years we will return to see if there is much selection difference.