Forest Management for Small Landowners

Tree Improvement

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Tree Improvement Programs

Contents

Introduction

Tree Improvement Programs, Genetically Improved Stock, and Plus Tree Stock all are terms to describe a program of:

- Selecting trees with desired characteristics.
- Breeding them with similar high-quality trees.
- Developing improved seedlings that will outperform trees from wild seed.

Plant and animal breeders have been using the principles of inheritance discovered by Gregory Mendel for over 100 years. Tree breeders started much later, but used the same methods used by breeders on other crops to improve the production of food plants.

How Does a Tree Improvement Program Work?

The following is an example of a Tree Improvement Program I worked on as a new forester in the early 1970s.

- Selection:
  - First, high-quality trees 50-100 years old were selected in the field, in pre-determined field checked areas.
  - This can be as simple as foresters walking through stands selecting a few trees that fit the criteria they are given, such as fast-growing, straight bole, 3-4 foot gap between limb whorls, no excess limbs per whorl, no ramicorn branching (*spike knots*), and no sinuosity (*wavy bole growth pattern*).
  - A more elaborate process is to number each tree and record various information (*such as above)* of every tree in a given sized plot. In the program I was involved with, we also took increment borings to measure growth and wood density (*specific gravity*). We collected the information on acre-sized plots at about 25 locations. There were five regions in western Washington and all followed the same process.
  - The recorded data was entered in an early computer (*1970s*) and a list of the best trees was produced to be field checked. If the field check confirmed the computer listing, then the selected trees were re-numbered with a more permanent marking, and left for a later collection of small branches from the top of the tree crowns.

- The field collection process of crown branches was conducted during the winter and spring months and one of two methods was employed.
    1. The trees were climbed with climbing spurs and the ends of the top branches were cut, bagged, and labeled to identify which tree they came from; or
    2. A small-caliber but very high-velocity bullet was used to shoot some of the limbs, typically on trees that we could not climb. The high-velocity round shattered the branch, allowing the severed limb to fall. However, for every five limbs shot out of the tree only one or two would make it to the ground. The rest got hung up along the way! The bagging and marking process was the same.
- At the nursery or greenhouse facility, the bags were opened and small 2-3 inch branchlets were cut from the limbs. These were grafted onto seedlings that had been selected and grown specifically as a rootstock and planted into pots. Cuttings or grafted seedlings from each parent tree would be given the same number because they were genetically identical from the root graft up.
- The potted seedlings were raised for a year and then outplanted into a seed orchard. The purpose of the seed orchard was as the name implies - to produce seed for future plantings. These orchards were isolated from other Douglas-fir stands so the orchard pollen production would not be contaminated. For many years the seedlings in the grafted seed orchard looked like tree limbs growing out of the ground – genetically they still thought of themselves as limbs. Over a 20 year period they began to look more like trees.
- Because these young planted seedlings still thought of themselves as limbs on a 50-100 year old tree, they still produced a very high-quality cone crop.
- Once the seed orchard trees began to produce seed, selective cross-breeding began.
    - The cones were bagged and pollen from other selected trees was injected into the bag. Each cone was labeled with its parent numbers for tracking purposes. For instance, a seed orchard cone might be labeled as 145 x 798. The parents in this case were tree #145 crossed with tree #798. This process was replicated so that tree #798 (*and all others*) would be cross-bred with all the other trees in the seed orchard. Is this starting to sound like a lot of work?
    - The seeds that resulted from these crosses were planted and grown into seedlings, all the time maintaining their genetic identity.
    - These young cross-bred seedlings were outplanted in a fenced “progeny site” with multiple seedlings of the same cross, randomly placed throughout the fenced site.
- Field data was collected from the progeny sites over many years.
    - If within a few years it was learned that every time tree #457 was crossed with another tree it produced a runt seedling, then that tree *(#457*) would be rogued (*removed*) from the seed orchard. Over time the seed orchard was made up of only trees that expressed the criteria the company was looking for.

- Later the seed orchard was allowed to randomly cross-breed the trees through wind-blown pollination. The offspring of this first seed orchard with randomly pollinated cones would become the first generation seedlings available to the companies that owned the program. Seedlings from programs such as this are currently being raised and sold to small forest landowners with an expected 5 to 10% growth increase over wild seed.

Second Generation Seed Orchard

Once the co-op or forest products company managed to get the first generation seeds, they began another round of testing based on the offspring of the first generation. The process was very similar to the original process, but all selections were made from controlled tree crosses from the original seed orchard. The results of this testing would lead to a new seed orchard that would become the second generation orchard, producing an average growth increase over the first generation seed of 10-20%.

This process has been replicated in many company and association seed orchards, and with many different species. There is no fancy gene splicing or other magic voodoo involved, just a lot of hard work and tremendous amounts of computer time to generate the recommended selections and analyze the growth.

Seed Zone Maps

In the early years of nursery seedling production, there were a lot of issues around seedling quality. Research showed that a combination of selection sites (*both elevation and location*) and quality of trees the cones came from, led to a lot of the problems. Out of this a Seed Zone map was produced that was used until the genetically improved seed was in use. A seed zone would typically be given a number such as 241 (*basically Lewis County*) and 241-10 for 1,000 foot elevation (*elevations were in 500 foot increments)*. When higher-quality seed started being used, the research showed there was a lot of leeway in how genetically improved seedlings could be moved, both in elevation and location. I don't know how all of the small independent nurseries are classifying their nursery stock, so you should ask the nursery you are purchasing from about the zone groupings they use. Once you know and understand how the nursery defines the source for the different areas within western Washington, you will be able to order the correct stock then and in future years.

See Chapter 5, "Planting" for additional information on seedling handling and planting quality tips.