FIELD HANDLING AND PLANTING

PLANTING

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ABSTRACT

A program was initiated in the USDA Forest Service Intermountain Region in 1968 which significantly improved performance of forest tree plantations on National Forest lands within the Region. A substantial part of this improvement can be attributed to the application of quality control procedures to the field planting operations.

INTRODUCTION

I am sure you wonder why discussions of field handling and planting of forest tree seedlings have been included in your agenda.

Our purpose is to extend and increase your concern for quality reforestation beyond the nursery gate and through the field storage, handling, and planting process. To do this we will point out the need for a high level of quality control in outplanting operations, and describe some handling, planting, and quality control techniques which have proven effective in the Intermountain Region of the U.S. Forest Service. We hope to thereby encourage you to become involved in the reforestation efforts of those who use your seedlings - visiting ongoing and past projects, making observations, asking questions, offering suggestions, and monitoring performance. The goal is better survival and growth, and greater satisfaction for all concerned.

Those who purchase or use the seedlings you produce expect and deserve good survival and growth from those trees. Poor plantation performance, regardless of cause, reflects adversely on your facility and degrades the image of artificial reforestation in general. It is costly in terms of monetary and resource values.

However, the very best trees, grown, packaged, and stored under strict controls, will not perform properly if planted "offsite" or subjected to improper field handling and planting procedures. The need for quality control does not cease when the trees leave the nursery--it becomes more acute.

Seedlings in the nursery are under intensive care. They are tended, for the most part, by a small group of skilled technicians and professionals whose primary concern, yearlong, is the well-being of the trees.

On the other hand, the skill levels and concerns of those who handle and plant the trees in the field vary greatly. Some are aware of and apply excellent field

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storage, handling, and planting procedures. Others want to do the job right--but don't know how--and fail to ask someone who does. And some consider tree planting a futile, unpleasant task to be disposed of as quickly as possible. In any event, problems develop on even the best organized projects. People develop bad habits as work progresses; they become tired, erroneous beliefs surface and are applied, important details are overlooked in the rush to get the job done, and equipment malfunctions occur. Murphy's Law never fails!

These are but a few of the general situations I have repeatedly encountered in 20 years of intensive involvement with forest tree planting. I mention them to emphasize the need for effective quality control after the trees leave the nursery. Some of you have had similar experiences.

THE INTERMOUNTAIN REGION, U.S. FOREST SERVICE EXPERIENCE

The U.S. Forest Service Intermountain Region experienced good survival and growth of planted ponderosa pine (Pinus ponderosa Laws.) seedlings through the late 1950's and early 1960's. Most of this was early season (low elevation) machine planting on machine terraced, stripped, or furrowed sites. Plantation performance declined as work progressed to more difficult terrain and higher elevations. It became necessary to depend on hand tools for site preparation and planting; seedling storage periods increased from weeks to months; seed source, species, and site coordination became more difficult. - Hot, dry weather during planting became common as planting seasons extended into the summer. The limited data available indicates that Regional average first-year survival had slumped to 65 percent or less in the 1966-1969 period.

A program to improve plantation performance was started in 1968. This included betterment of conditions and operations at Lucky Peak Nursery as well as improvement of field storage, tree handling, and planting procedures.

The following is a tabulation of the Regional average first-year plantation survival as summarized from reports of each National Forest in the Region for each year since 1971 (U.S. Forest Service, 1979):

Year	Percent Survival
1971	70
1972	75
1973	88
1974	88
1975	86
1976	83
1977	89
1978	80
1979	73

These data represent, with few exceptions, survival determined from individually staked trees on about 900 of the acreage planted each year. The depressed survival in 1979 may be attributed, at least in part, to weather conditions. Data from many weather stations show that 1979 was the driest year on record for 40 years or more (U.S. Forest Service, 1979) over much of the Region. Fire weather conditions were the worst in the history of the Region (U.S. Forest Service, 1980).

1/ Species commonly planted include ponderosa pine (Pinus ponderosa Laws.), lodgepole pine (Pinus contorta Dougl.), Rocky Mtn. Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn) Franco.), Engelmann spruce (Picea engelmannii Parry.), blue spruce (Picea pungens Englem.) , and western larch (Larix occidentalis Nutt.) .

The "Wyoming Utilization Study" (Lotan and Perry, 1977), (Schmidt and Lotan, 1980), was initiated in 1971 on the Bridger-Teton National Forest in western Wyoming. The study area was at an elevation of about 9,300 feet (2,850 m) above sea level. Trees planted in 1973 in the reforestation phase of the study demonstrate the results obtainable when trees from the proper seed source are properly stored, handled, planted, and protected:

> Only seven of the 1,560 staked 2-0 lodgepole pine sample trees died the first season after planting. Initial survival for all harvest/fuel treatment methods was thus over 99.55 percent.
>
> Fifth-year survival on the broadcast burned and tractor piled and burned fuel treatments was over 87 percent. Average height of these trees was over 45 centimeters; some trees were over 90 centimeters tall.

The performance achieved cannot be attributed solely to the tree handling and planting procedures used. Work by Research Foresters Russell A. Ryker and Raymond J. Boyd of the USDA Forest Service Intermountain Forest and Range Experiment Station, former Lucky Peak Nurseryman Frank E. Morby, and more recently your host, Richard H. Thatcher, were essential to these successes.

Glenn Jacobsen has already discussed the field storage and handling procedures which we found essential to success. I will now try to explain what we consider good planting quality and how we obtained it in the Intermountain Region. Many of these ideas and procedures have been around for decades, people just weren't using them. Others developed as work progressed. The program benefited from the inputs of many technicians and foresters, and several USDA Forest Service Contracting Officers! We hope you and others may find this information useful.

THE BASIS FOR QUALITY TREE PLANTING

Quality control involves more than conducting inspections to determine whether certain tasks have been done to specifications. It must be designed into the project in the form of tools and procedures that simplify the work, are relatively easy for the workers to use, and which minimize the probability that things will be done incorrectly. Training must be appropriate and adequate at all levels. Skilled supervision/contract administration must be provided. Finally, inspectors must be thorough, fair, and work closely behind planting crews. Subsequent follow-up on plantation performance provides data on overall program success, and often helps identify procedures that need improvement.

The biological and physical needs of the trees, insofar as we were aware of them, dictated the planting standards which evolved. The eleven inspection elements commonly recognized, and a synopsis of standards applicable to each, are as follows (for the full standard, please see the USDA Forest Service "Westwide" Tree Planting Contract developed J in 1978.):

1. Tree spacing - prescribed to fit site requirements; limited variation permitted.

2. Planting spot selection - where local features provide best protection from hazards.

3. Site preparation - at least 24" x 24" to mineral soil, configuration as specified.

4. Tree location on spot - near center of site-prepared spot if applicable, no less than 9" from live vegetation.

S. Planting depth - soil shall be even with original ground line of trees; no roots exposed; no branches or needles covered.

6. Stem position - at an angle between perpendicular to the slope and true vertical.

7. Planting hole orientation - same as stem position.

8. Root configuration and orientation - roots aligned along the axis of the planting hole, extending downward in a near natural arrangement; not doubled, spiraled, bunched, or bent.

9. Root damage - roots shall not be shortened, pulled, stripped, crushed, or abraded.

10. "Foreign" material in the hole - moist mineral soil only around the tree roots Dry soil, ash, organic matter, rock, and other material shall be kept out of the holes.

11. Soil firmness around roots - soil shall be filled in and firmed progressively so no loose soil or air pockets remain, and tree is as firmly planted as soil conditions allow.

Certain procedural requirements must also be adhered to. Some of these are listed here:

1. Snow or ice must be kept off of trees that have been acclimatized.

2. Trees must be kept in a shaded location, out of the wind when not being carried by a person actively engaged in planting. This applies during rest and lunch breaks as well as in stockpiles.

3. Trees must not be exposed to the fumes of petroleum products or other harmful substances.

4. Trees shall be gently removed, one at a time, from the planting bag or tray, and quickly and gently inserted in the planting hole.

5. "Slit" planting will not be permitted. Planting holes must be "broken out on three sides" or drilled with a 4" diameter auger capable of making a hole 14" deep. (Tree roots are 12" long.)

6. Planting holes must be filled and firmed by hand only. Sticks, trowels, and other tools must not be used to fill or firm the soil. The soil may not be

firmed with the boot heel.

PLANTING METHODS

Planting machines best meet the criteria mentioned earlier for promoting quality planting. They are simple and easy to operate once they have been attached to the tractor and essential adjustments properly made. Few people are involved, and operators need not learn difficult or complex procedures, even on the nonautomatic machines, which

are best for stoney ground. Additional firming of soil around the tree roots may be necessary on heavy soils. However, this is seldom a problem, and an extremely high percentage of properly planted trees can be obtained on machine planting projects.

A variety of planting hoes, planting bars, dibbles, modified tile spades, and shovels have been used for tree planting. These tools require considerable skill and physical strength of the user. In addition, many people must be trained to properly select (and often site prepare) planting spots, drive the tools into the ground, open the planting hole, insert the tree (often into a tangle of roots), make sure the tree roots are straight, and close the hole so the soil is in firm contact with the tree roots. Proper planting by these methods is quite complex and is physically difficult for many people. There are a great many opportunities for error since each planter is repeatedly faced with a variety of problems and obstacles to good planting. Very close supervision/contract administration and inspection procedures must be exercised to maintain planting quality in most situations where these tools are used.

Powered soil augers meet the criteria for promoting quality planting. Although this method is not nearly as automated as machine planting, it is applicable to a much wider range of soil and terrain conditions. Auger planting has an advantage over machine planting in that it does not create artificial burrows which may promote gopher damage. The use of soil augers breaks the planting operation into two components: hole making and planting.

The auger operators select the planting spot (unless already selected by the "scalping" crew) and drill the planting hole to the proper depth at the correct angle. The auger excavates the soil and small rocks, cuts small roots, and pushes larger rocks aside, depending on soil conditions. The result is a clean four-inch diameter hole to the proper depth. The excavated soil is neatly deposited around the hole. Well coordinated people with reasonable strength are easily trained to be good auger operators.

The planters have a fairly uniform situation at every planting spot: a clean planting hole to specifications with a supply of replacement soil close at hand. They need only pull aside the small amount of loose soil in the bottom of the hole, insert the tree to the proper depth (straightening its roots as they do so), and progressively replace and firm the soil around the roots. Modest strength and reasonable dexterity is required for this work.

Auger planting quality is greatly enhanced when preceded by suitable machine or hand site preparation. This treatment should, in addition to reducing competing vegetation, remove ash, organic matter, and dry soil that might get into the planting hole; provide a smooth surface on which the excavated soil may be deposited; and provide a convenient work surface for the planter.

High quality durable equipment is available for planting trees with powered soil augers. The "Cannon DH-2W"' auger transmission quickly turns a chainsaw into a very good auger power unit. The 4" "Carbide-1000" and "Thomas Loc-Tip" augers are durable and efficient digging tools which will fit several different auger transmissions. These tools have greatly expanded the range of soil conditions in which auger planting can be used.

There is no magic involved in auger planting. It is subject to poor workmanship as is any other method. However, it is easier for people to plant properly with soil augers, on suitable sites, than with hand tools, if given good equipment, training, and supervision.

The use of soil augers is strongly encouraged throughout the Intermountain Region. i:xtended (to 16") KCB, or similar planting bars are recommended on sites that are too

stoney for augers. A planting hole broken out on three sides and hand replacement of soil is then required. Planting machines may be used when site conditions, project size, and machine availability make it practicable.

I recently prepared a pamphlet "Planting Tree Seedlings with Powered Soil Augers." It explains in detail some of the requirements and procedures for successful auger planting. It will soon be available from International Reforestation Suppliers, Inc., P.O. Box 5547, Eugene, Oregon 97405. This firm also handles the "Cannon" transmissions and "Carbide" augers. The "Thomas" augers are available from Southern Oregon Reforestation, Inc., 6517 Pioneer Road, Medford, Oregon 97501.

PLANTING QUALITY INSPECTIONS

Planting quality inspections are required on all plantations. Inspections are conducted concurrently with planting operations. The project foreman or the contractor is promptly advised of any inadequate planting quality, or any unsatisfactory procedures that are detected. A two-phase system of inspection has proven most effective.

The first inspection phase is aimed at preventing errors before they occur--or at least confining them to only a few trees. One or more inspectors circulate throughout the planting operation. They watch to see that site preparation, hole opening, and tree handling and planting procedures are correct. They are especially alert to see that trees are properly protected and handled before and during planting, and that forbidden procedures are not used. Errors observed are immediately reported to the foreman or contractor and documented if appropriate.

The second inspection phase is the basis for evaluating project crew performance and for possible adjustment of the per unit bid price for planting contracts. These inspections consist of detailed examinations of the planted trees on a series of 1/50or 1/100-acre sample plots, aggregating one percent or more of the area planted. All trees on each plot are checked for compliance with elements 1 through 6 as listed in the section "Basis for Quality Planting." The number of trees on the plot which meet this test is the basis for determining the number of trees which are excavated to determine compliance with elements 7 through 11. Trees not in compliance with all 11 elements, as appropriate, are declared "unsatisfactory." Results are documented on a special form for subsequent summary and analysis.

Little variation from prescribed tree care and planting standards is tolerated. For example, trees are considered "wasted" and are discarded if they have been contaminated by petroleum products or fumes. The same applies to those whose roots are exposed to sun and wind by planters carrying them in their hand from one planting hole to another. Experience has shown such trees will die or do poorly. A charge is made for "wasted" trees on tree planting contracts.

Compliance with inspection elements 1 through 6 is easily determined by examination and measurement of surface conditions. Elements 7 through 11 can only be adequately inspected by digging a hole (a round pointed tile spade is preferred) immediately adjacent to the planting hole and gently removing the soil around the tree roots without disturbing the tree. A bulb trowel and an ice pick or awl are excellent tools for this work. Voids (air pockets) are easily detected, and general soil firmness ("as firmly planted as soil conditions allow") is indicated by soil resistance to tools and fingers.

The only deviations from a "near normal" root configuration that is acceptable are those which developed in the nursery. This may be tested by removing the newly planted tree from the planting hole. If the abnormality persists without being held in place by soil, it is accepted.

All roots must extend downward (except as described above), and no degree of "J" or "L" configuration is acceptable.

Trees that are found to be properly planted may be left in place, and moist mineral soil replaced and firmed around the roots. Others should be removed and planted properly.

Inspectors must be well trained and impartial. Each one should plant and then inspect a few trees every few days to maintain a feel for soil conditions. Doubtful situations (is it good or bad?) may be settled on an alternating basis. Foremen and contractors are invited to observe inspections.

The often-used firmness test of tugging on a few needles is inadequate. The top of the planting hole may be easily crimped to hold the tree very tightly, masking loose soil and voids around the roots. Similarly, lifting the tree out in a "plug" of soil, which is then removed to expose the roots, masks errors in planting hole orientation, root configuration, and soil firmness around the roots.

TRAINING

Region-wide tree planting training sessions are held to improve planting quality and, hopefully, plantation performance. The program that evolved has several objectives, including:

Develop a success-oriented attitude about tree planting throughout the Region.

Make all concerned personnel aware of the Seed Zone Program and the need to get the proper species and seed source on each planting site.

Replace incorrect tree handling and planting practices with proven correct standard procedures.

Encourage use of soil auger planting on suitable sites.

Gain acceptance and conformity to the Region-wide standard tree planting contract (now the so-called "Westwide" tree planting contract).

Improve and gain uniformity in planting contract preparation, administration, and inspection.

Increase cooperation between nursery people, contracting personnel, and field technicians and Foresters.

Create opportunities for exchange of ideas and experience across administrative boundaries.

Teach people how to teach successful tree handling and planting techniques.

Attendance at one of these training sessions every 3 years (two or more are held annually at convenient times and locations) is required of all who are responsible for some phase of the planting program. This includes contracting officers and the Lucky Peak nurseryman and assistant as well as reforestation specialists, work supervisors, inspectors, contracting officers' representatives, and Silviculturists. Repeated attendance is required so that those involved can keep current with changes, contribute from their experience, and correct any bad habits they have developed.

Training is conducted by the most qualified reforestation and contracting specialists available. The one-day classroom session consists of a slide presentation depicting the consequences of inadequate consideration of seed source, planting techniques, and plantation protection. Emphasis is placed on the fact that well-grown, handled, planted, and protected seedlings will survive and grow very well. The program is followed by presentations on contracting and administration authorities, project and contract planning and preparation, project supervision, contract administration, inspection, and training.

The second day is devoted to field demonstrations of proper tree handling, site preparation, planting, and inspections. Trainees are required to practice all procedures demonstrated. They also must inspect a plot of trees that contains specific planting errors and report on their findings.

FOLLOWUP

Plantation performance must be monitored. Regional policy requires that at least 25 trees be staked on each plantation when established. More staked trees are required on larger areas. Survival of these sample trees is determined after September 15 of the first, third, and fifth seasons. Survival data, by species, is analyzed for each planting area, Ranger District, Forest, and for the Region as a whole. Costs per acre, per planted tree, and per live tree are derived. Summaries of the data, under a cover letter by the Regional Forester, are circulated to Forests, Ranger Districts, the Lucky Peak and Coeur d'Alene Nurseries, and other interested persons.

Use of "representative" staked rows may have some statistical shortcomings. However, they provide an index of seedling performance by seed lot, planting crew, weather conditions, and other variables which, if adequately documented, can help identify factors that depress seedling performance.

Plantations should be checked several times during the first growing season to identify problems and probable causes. Trees that turn brown a few days or weeks after planting were probably dead, or nearly so, when planted. This would indicate preplanting handling problems. Failure to acclimatize the trees properly may cause the needles and buds to droop or become flaccid a few hours after planting. Trees responding in this manner will probably develop short leaders and needles on the initial growth and suffer depressed growth for some time. Other stressful situations, such as broken dormancy, root damage, and fluctuating storage temperatures and humidities may cause similar symptoms.

Plantations must be visited often enough that damage by gophers and other rodents, livestock, big game animals, and other agents is detected before serious losses occur. Gophers and livestock are generally considered the most serious cause of plantation damage in the Intermountain Region. They are often the leading cause of seedling mortality. It is important that such damage be detected before it becomes widespread and while the causative agent may still be identified so that appropriate and timely protective or corrective action can be taken.

Trees that are well grown and handled, properly planted on site, and protected, will make good growth from the start. Bud burst and top growth will be near normal, as will needle development. Root growth will be vigorous. Such trees will increase in height (from root collar) by 30 to 100 percent or more the first year, depending on initial height. Growth will accelerate annually until it reaches the site potential.

A means of evaluating plantation growth is badly needed. Efforts are underway in the Intermountain Region to develop meaningful *ways* of doing this.

One approach, which can be applied as soon as the new growth hardens off the first season is to classify leader/needle development of a sample of trees. Four classes are used: a) normal, b) near normal, c) abnormal, and d) aborted. Experience shows that few of the "a" and "b" trees will subsequently die; while more of the "c" trees and many of those classified as "d" will succumb.

Initial growth can also be used to evaluate performance the summer or fall after planting. However, such measurements must be correlated with seedling size. We have found that the smaller seedlings usually grow less in actual elongation, but more in percentage of initial height, than do the larger trees. Table 1 shows this relationship for 2-0 lodgepole pine planted in 1977 on the Twin Falls District of the Sawtooth National Forest. Seedling performance in terms of leader development class has been included.

*About 14 percent of the trees fell in the "abnormal" and "aborted" leader classification. This resulted in substantial depression of average growth for the project and provides a clue as to the amount of mortality that can be expected in years 2 and 3.

Table 1.--Relationship between seedling height when planted (initial height) and leader elongation during the first growing season

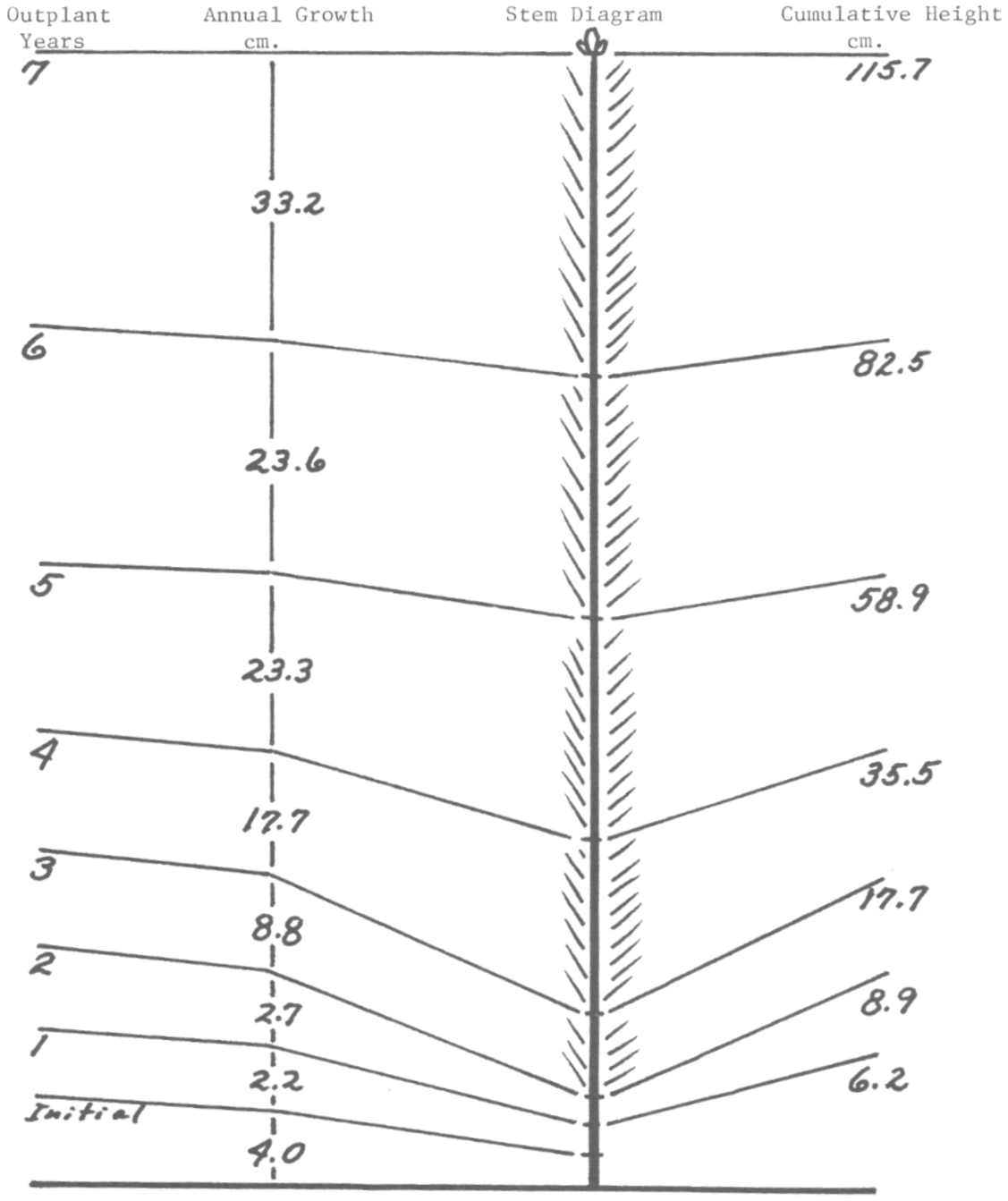
Initial Height	No. Trees in Sample	1st Yr. Growth	Increase in Height	Trees in each leader development class			
				a	b	c	d
cm		cm	%				
3	21	2.8	94	11	1	7	2
4	49	3.5	87	36	2	9	2
5	70	4.0	80	55	3	9	3
6	81	4.3	72	67	2	5	7
7	80	4.9	71	72	2	5	1
8	70	4.9	61	65	1	1	3
9	43	5.0	56	36	2	3	2
10	30	5.8	58	26	1	1	2
11	21	5.2	48	19	-	-	2
12	19	6.6	55	18	-	-	1
13	4	6.3	48	4	-	-	-
14	5	4.8	34	4	-	-	1
15	2	4.5	30	1	-	-	1
16	1	7.0	44	1	-	-	-
Avg. 7.1	496	4.6	65	415	14	40*	27*

A third potential means of evaluating growth performance would be through collecting annual growth data on selected plantations for different species and sites. These data could be used to develop "plantation expectation charts" against which the growth of any plantation of the same species on similar sites could be compared at any point in time. This comparison capability would also make it possible to make some predictions as to future plantation performance. Figure 1 is an example of such a chart of the performance of 1-0 ponderosa pine seedlings planted in the Cold Springs area of the Idaho City Ranger District, Boise National Forest in 1974.

Figure 1

Plantation Expectation Chart (Height)

Species - PP; Stock - 1-0; Seed Source - Idaho City; Planted - 1974; H.T. - Not Avail; Site Index - Not Avail; Planting Method - Auger; Planting Quality - Good (90+); No. of Sample Trees - 35; Other - Annual Gopher Control; Location - Cold Springs Creek, Idaho City R.D., Boise N.F.



CONCLUSION

Our experience has shown that we can get excellent survival and growth from planted forest trees throughout the Intermountain Region. I am sure that similar success is attainable over a-much wider area. However, it is essential that the basic principles, to which new techniques have been or may be adapted, be closely followed. We have been accused by some of being too "zero defect" oriented. Unfortunately, if you compromise planting quality, allowing a small percentage to die for the sake of economy, a disproportionately larger percentage gets sick, and doesn't perform.

Attention to detail is what counts, and the people who use your trees often don't know the details. Dialogue between nursery people, research people, and those who use the trees will benefit all. Invite those who use your trees to visit your nursery, examine the stock, and discuss details. Provide basic instruction and reference material on provenance, seedling care, planting procedures, and plantation protection to those who may not be aware of these needs. A visit to the "home ground" of some of your "customers" can pay big dividends. Sharing ideas, skills, and concerns helps build the good relationships required for successful plantations. Remember, the order for a few hundred or thousand trees from a small user may have little significance to your operation, but it is extremely important to that person.

Extend your vision and effort beyond the nursery gate--there is a big world out there and a lot of people who need your help.

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