SOME NOTES ON THE USE OF MODERN CLIMATIC DATA IN NURSERY AND PLANTING OPERATIONS

by

R. J. Boyd

Associate Silviculturist
Intermountain Forest & Range Experiment Station, Ogden, Utah 84401
Stationed at Forestry Sciences Laboratory, Moscow, Idaho

A good poker player is a combination mathematician and psychologist. He knows the mathematical probabilities (the odds in the gambling trade) of a particular maneuver and he knows how to "psych" (bluff) his opposition. A good nurseryman or tree planter, in his never-ending game with the weather, must also be able to figure the odds with a great deal of mathematical precision. Until fairly recently the nurseryman or tree planter had no such recourse to published or computable probability data for weather and climatic information. But as the years roll by, a wealth of climatic data is being accumulated at weather stations throughout the country. This information, when properly compiled and analyzed, can provide the nurseryman and planter with a great deal of information which will help keep him in the "win" column. Numerous examples dot the landscape which attest to the fact that "bluffing" the opposition is not one of the forester's tricks in the serious game of reforestation.

My intent, in this paper, is to bring to your attention some of the various types of climatological summaries that are available and to show how we have used these summaries to help make decisions concerning nursery and planting operations and to aid in the interpretation of study results. In a modest way we have, I believe, improved our chances of winning the game of reforestation through the judicious use of these data which have been collected by observers for many years. You nurserymen and planters, having done battle with the adversary for many years, can undoubtedly find many other ways to use this information.

Listed below are some sources of summarized weather data which we have used in our work. You are probably all familiar with the first of these, the Monthly and Annual Summaries issued by the Environmental Science Services Administration. The others are recent publications with which you may not be familiar. I make no claim that this is a complete list, even for our own area. There are summaries which have come to my attention, and which I have found useful. There may be others. One should check with his own State Climatologist for sources of local information.

1. Climatological Data - Monthly and Annual Summaries by States; U.S. Department of Commerce, Environmental Science Services Administration. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. $2.50/year.

2. 1969. Climatological Handbook, Columbia Basin States, Meteorology Committee, Pacific Northwest River Basin Committee.

   Volume 1 A&B - Temperature
   Volume 2 — Precipitation
   Volume 3 A&B - Hourly data

   Pacific Northwest River Basins Commission, Box 908, Vancouver, Washington 98660. $25.00.

3. 1967. Probability of Selected Precipitation Amounts in the Western Region of the United States. T-8, Agriculture Experiment Station, University of Nevada, Reno, Nevada 89109, or your State Agriculture Experiment Station.

4. 1968. Climatic Atlas of the United States, U. S. Department of Commerce, Environmental Science Services Administration. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. $4.25.

Distance from existing weather stations to the nursery or planting site is a problem that will be encountered frequently when using the published information for predicting probabilities. Nurseries should maintain their own weather stations so that they can eventually build their own experience data that will be adequate for figuring probabilities. Until the years of data necessary for this type of prediction can be accumulated, the nursery records can be used to make adjustments in predictions based on the long-term records of nearby stations. If possible, field planting studies should incorporate weather station data to provide comparative year-to-year information to aid in the interpretation of results.

1. Spring Frost Hazard

Ever since it began operations, the Coeur d'Alene Nursery has been plagued with damaging frosts during the month of May. New shoots on Douglas-fir and Engelmann spruce are frequently injured. The frost generally is of the radiation type. On clear still nights, the reradiation from the ground surface is so strong that a subfreezing temperature zone develops just above the ground line.

After experiencing a year of two of this type of damage at the Coeur d'Alene Nursery, it was obvious that we needed: (1) some appraisal of frequency of occurrence of such damage; and (2) a method of preventing damage. Using the Monthly Summaries it was a simple matter to scan back through the May minimum temperature data for the previous years and see that May frosts were common occurrences to be guarded against. A more recent publication, however, has given us an even better idea of the hazards involved. Table 1, which is an excerpt from the "Climatological Handbook, Columbia Basin States," shows that based on 35 years of records, the average date of the last occurrence of freezing temperature at the Coeur d'Alene Nursery is Nay 15. The standard deviation for this occurrence is 15 days, which means that during approximately 2/3 of the years the last freezing temperature of the spring will occur within 15 days of May 15. There is also a small chance that it will freeze in June, sometime before the 18th. Knowing that the new shoot growth on Douglas-fir and Engelmann spruce seedlings begins in late April and thereafter is susceptible to frost damage, it is obvious that the probability of injury to beds of these species at Coeur d'Alene is very high. One solution: an alert nurseryman with his hand on the valve to the sprinkling system any time after the buds start to swell. Also, a frost warning system tied to a temperature sensor located near the ground in one of the lower portions of the nursery would be a useful supplement,

Table 1.[1/] --Low temperatures: Date of last occurrence in spring... for temperatures of 36°, 32°, 28°, 24°, 20°, and 16° F-- mean, standard deviation, median, probability of occurrence, latest or earliest of record, 1931-1965

Station name	Statistic	Spring (minimum temperatures of) 36°	32°	28°	24°	20°	16°
Coeur d'Alene Ranger Station (35 years of data)	Mean	6/1	5/15	4/26	4/5	3/17	3/7
	Standard deviation	16.8	15.0	17.3	16.1	15.9	20.1
	Median	5/29	5/16	4/27	4/5	3/14	3/8
	Probability of occurrence	1.0	1.0	1.0	1.0	1.0	0.94
	Latest recorded	7/8	6/18	6/11	5/30	4/21	4/3

[1/] Excerpted from Climatological Handbook, Columbia Basin States, Meteorology Committee, Pacific Northwest River Basin Committee, 1969. Vol. 1, Part B, page 411.

2. Damaging Weather Sequences at the Nursery

It often happens that a sequence of climatic events, rather than a single event, causes the damage to plants. Such was the case in the late winter and early spring of 1965 at the Coeur d'Alene Nursery. Warm weather triggered germination of fall-sown seeds and subsequent freezing temperatures killed the new germinants. Small plot studies the previous 2 years during which good seedling establishment was obtained had led us to believe that fall sowing might be to our advantage. However, after the failure of 1965 it was obvious that we needed to know the probable frequency of this failure in order to weight important advantages of fall sowing against the risk of unacceptable seedling losses the following spring.

Again, using the Monthly Summaries, maximum and minimum daily temperatures from the available 20-year local weather records were plotted for February, March, and April. Standards for a "damaging sequence" of temperatures were set by (1) studying the sequence of temperatures in those years when damage was obvious and (2) knowledge of temperatures needed to start germination and temperatures which would cause damage to germinants. A "damaging sequence" was thus defined as "several days with maximum temperatures above 50 F. followed by temperatures below 25 F.--a sequence which would be - lethal to a large percentage of the potential crop, regardless of species."

It was estimated that germinants from fall-sown seed would be subjected to hazards similar to those of 1965 in one year out of every five (a 20-percent probability). A similar analysis for the Lucky Peak Nursery near Boise, Idaho, indicated a hazard probability of nearly 50 percent. Since the risk seems to outweigh the advantages, I believe both of these nurseries have abandoned fall sowing.

3. Evaluation of Planting Performances

When one gets involved in field planting trials he really lays himself wide open to the perversities of the weather. Even in a well designed experiment such as the planting season study described by Sam Sinclair, one should still look at the weather records for the study period and compare them to a longer term average. First, this should be done to see if unusual weather factors might account for some of the differences in results; and secondly, it should be done to see just how far the results from the study might be extended to other years.

Unfortunately, the "normal" or average weather factors published by the Environmental Science Services Administration can be very misleading to the layman. When we see, for instance, a normal, or average, precipitation of 1.50 inches for September we could be misled into thinking that, in the long run, half of the years will have September precipitation below and half above 1.50 inches. But, due to an asymmetrical distribution of precipitation over a series of years, the average, or mean, precipitation can be considerably above the point where half the observations are above and half below the average (Figure 1). A statistic which is less misleading than the average or mean is now being published in some of the latest climatological summaries. This statistic is the "median," which is defined as that value for which 50 percent of the observations lie on each side.

Let me illustrate how this discrepancy between the mean and the median could lead one astray. In our season of planting study, we assumed that fall precipitation would have a strong influence on the success of fall planting, so I plotted the cumulative late summer and fall precipitation for the 3 years of the study (Figure 2). Two years, 1966 and 1967, were much the same, but one, 1968 was, by comparison, very wet. But what could we expect, on the average? The mean cumulative precipitation--available from the Environmental Science Services Administration's Annual Summary of Climatological Data--shows average cumulative precipitation somewhat above the 1966 and 1967 curves. This, of course, indicates that during the 3 study years we had two relatively dry falls in our sample of weather conditions and one very wet one.

Since I was aware that the published normals can be misleading, I went to the data compiled by the Columbia River Basin group where they have published not only the mean precipitation, but also the medians. The curve of median cumulative precipitation plots right on or slightly below the 1966 and 1967 curves. When compared to the median, our three sample years don't look nearly as representative as they did when the mean was used as a standard.

4. Introduction of Techniques from Other Climatic Regions

The nurseryman or planter is often faced with the problem of adapting to his own particular operation a technique that has been developed elsewhere. For instance, planting of container-grown and through-the-growing-season planting of container-grown and bare-rooted nursery stock, is conducted on an operating basis in certain. areas of North America. The applicability of these techniques may depend, to a great extent, upon the climatic similarities between our western conditions and those in Ontario and Alberta where these practices were developed and seem to have met with greatest success.

Let's look for a moment at a precipitation map from the "Climatic Atlas of the United States" (Figure 3). Starting in the Pacific Northwest, notice the precipitation pattern which shows a substantial dip for the summer months. This same pattern persists as we move inland to Spokane, but by the time we cross the Bitterroot Mountains to Missoula a considerably different pattern becomes evident. Crossing the Continental Divide to Havre, Montana, brings about a complete reversal of the Seattle-Spokane pattern, with the greatest amount of precipitation now occurring in the summer months rather than the winter. This pattern persists across the northern Great Plains and through much of the Great Lakes area. By the time we reach Buffalo, we're equally wet any month of the year. A similar trend of precipitation distribution extends across southern parts of Canada, as we might expect.

To the extent that the success of planting depends upon growing-season precipitation, it's clear that the precipitation pattern east of the Continental Divide is much more conducive to planting success, especially summer planting successes, than any of the typical patterns west of the Divide. I'm not implying that the climate of our area would necessarily preclude success with small container-grown trees --but it's certainly a factor to consider in planning any studies or changes in programs. Essential to sound planning are: familiarity with climatic patterns in a region where a practice has been developed and consideration of differences in these patterns in the area to which the technique may be introduced. Publications such as the Climatic Atlas can be a great help in making these decisions.

The long-range weather data accumulated over many years and the various types of summary information that are being published provide the nurseryman and tree planter with powerful tools. Weather-dependent operations can be evaluated more accurately than ever before and a great deal of risk can be minimized without the expensive trial-and-error procedures of the past.

Many single-event probabilities are available and their evaluation involves little more than looking at a suitable table in one of the existing publications. More complex situations that involve sequences of weather events may require a special, but usually straightforward, analysis. Very complex analyses will probably require the greater sophistication and rigor of computer analysis.

To be most effective, supplemental observations should be made at the nursery, and where possible, at study-planting sites. In addition to the standard weather station observations, the nurseryman and planter should consider additional observations which are important to his specific operation. These might include temperature close to the ground, soil temperatures, and soil moisture.

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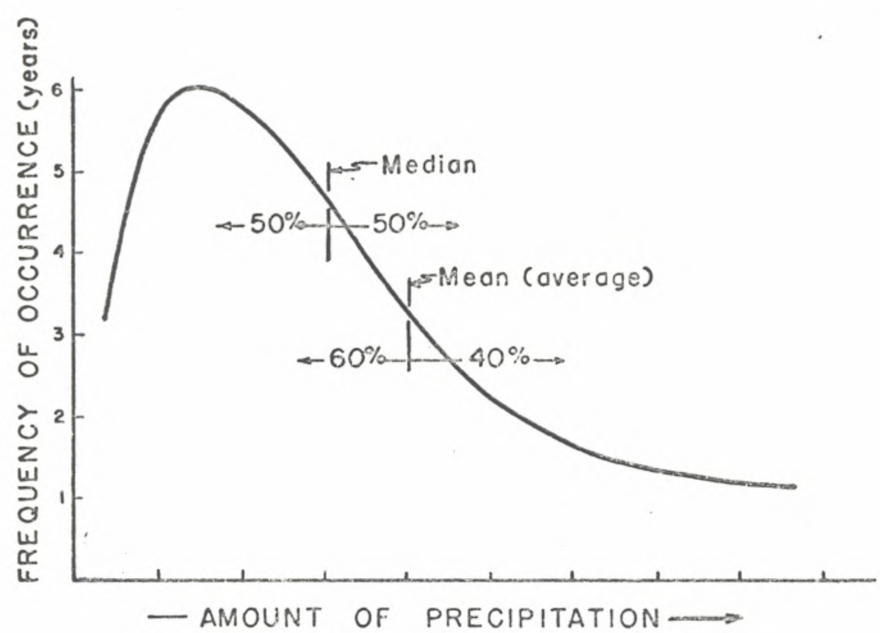
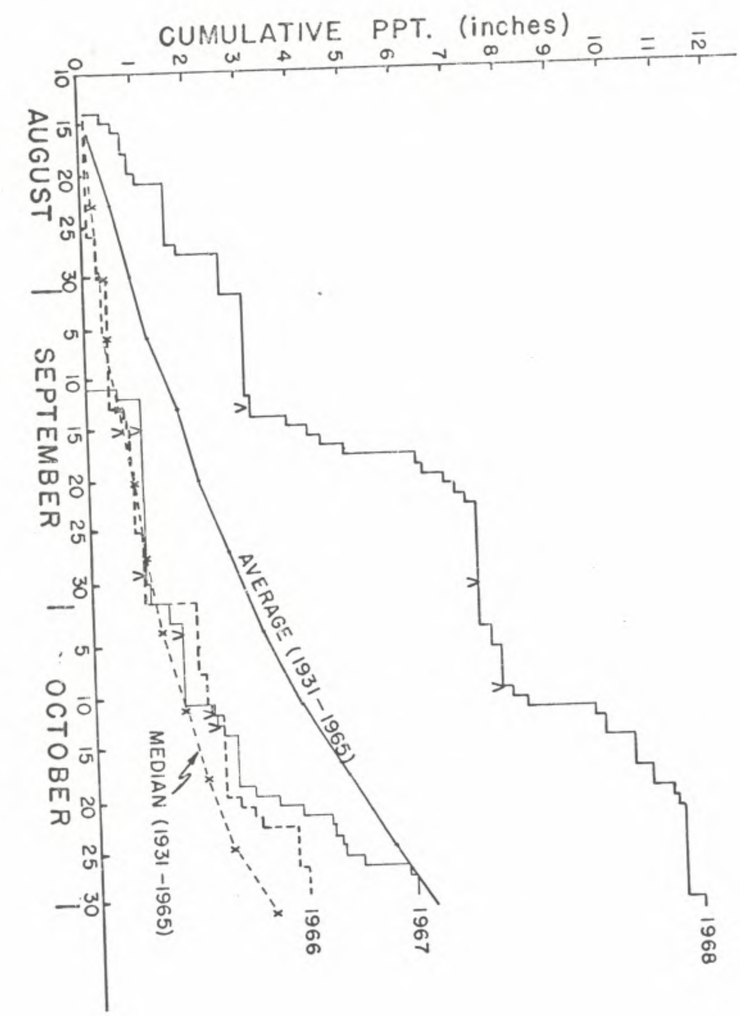
FIGURE CAPTIONS

Figure 1.--Distribution of precipitation amounts over a series of years showing the difference between mean and median values.

Figure 2.--Cumulative precipitation during the fall planting season, Avery Ranger Station, 1966, 1967, 1968, average and median. (A indicates planting dates.)

Figure 3.--Yearly average precipitation patterns at various points across the northern United States (based on data from Climatic Atlas of the United States, U.S. Department of Commerce, Environmental Sciences Services Administration, p. 44).


FREQUENCY OF OCCURRENCE (years)
6
5
4
3
2
1
Median
50%
50%
Mean (average)
60%
40%
AMOUNT OF PRECIPITATION


CUMULATIVE PPT. (inches)
AUGUST
SEPTEMBER
OCTOBER
AVERAGE (1931-1965)
MEDIAN (1931-1965)
1966
1967
1968


PRECIPITATION (inches)
MONTHS
Seattle
Spokane
Missoula
Havre
International Falls
Buffalo