Proposed Seed Collection Zones for the Central States

by

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Seed collection zones have been established in several regions and countries to insure that the sources of seed used in tree planting are properly selected. Use of such zones has undoubtedly improved the survival and growth,of trees in plantations and has also facilitated the establishment of specifications for seed procurement and seed certification.

One of the first formal systems of seed collection zones was instituted in Sweden for Scots pine (*Pinus sylvestris* L.) (Lindquist, 1948). Because of the rugged topography of the country and the long north-south range of the species there, zones were based mainly on differences in elevation and latitude. Seed collection zones for a number of conifers in California were set up on the same basis (Fowells, 1962). In the Lake States, where topography is relatively unimportant, seed collection zones now used for native conifers are based largely on latitudinal and temperature differences (Rudolf, 1957). In a broad sense, seed collection zones have been used in all regions of the United States for many years. Zones may not have been delineated on maps nor based on research findings, but local seed was assumed to perform better unless distant sources had proven superior. This, in a sense, is zoning for seed collection.

The use of seed collection zones is, however, the initial and not the last or only step towards improved selection of seed sources. It is equally and often more important that the individual stands and trees that make the best parents be selected as sources of seed. These trees may influence growth rate, form, branchiness, wood quality, and resistance to pests. Seed collection zones, on the other hand, are more likely to influence adaptability of trees to climate and locality and their resistance to drought, but like the parent stands or trees, may also influence wood quality and resistance to insects and diseases.

The many species of trees, both native and introduced, that are planted in the Central States make the use of seed collection zones highly desirable. The location of the region between the Lake States and the Gulf States puts it outside or only on the periphery of the natural northern or southern range of many American species used in planting. Some species of European and Asiatic origins are also planted. Selecting sources that will provide seed best adapted to the different localities in the region is therefore an important phase of the planting program.

IMPORTANT PHOTOCLIMATIC FACTORS TO CONSIDER

Differences in environment that can be mapped and that significantly influence survival, vigor, and growth of trees should be used to delineate boundaries of seed collection zones (Jackson, 1962). It is not practical to use soil and cover in setting zone boundaries because they often differ from acre to acre; their adequacy is ordinarily determined by detailed evaluation of the soil and the site of each projected planting, by trial plantings, or by observation of existing plantations. The most useful considerations in zoning, then, are climate and day-length, or "photoclimatic" factors. Of these, latitude and altitude, temperature, precipitation, and relative humidity are most significant.

It is impossible to describe photoclimatic factors in detail here; that has been quite adequately, however, by Vaartaja (1954, 1959, 1960, 1961), Kozlowski (1962), Kramer and Kozlowski (1960), Kriebel (1957), Wright (1954), Santamour (1960), Pauley and Perry (1954), and many others.

Geographic source of seed may profoundly influence the survival and growth of plantations. Individual trees, as well as other plants and many animals, become adapted to a definite combination of such climatic factors as the amount and distribution of rainfall, length of growing season, frosts, day-length, minimum temperatures, growing-season temperature, and other conditions affecting growth processes. Individuals of some species are more versatile in adapting to changes in one or more of these factors than individuals of other species; the range in all or some of these climatic factors that some species tolerate is very restricted.

The climates at different locations in the Central States mainly differ because of latitude, winds, and storms with their associated air masses (Page, 1949). Because of its mid-continental location, the region as a whole is cold in winter and hot in summer. Prevailing winds are southwesterly in summer, northwesterly in winter. The tempering effects of Lake Michigan and Lake Erie do not extend inland for more than a few miles. Due mainly to differences in latitude, temperatures differ strikingly from one part of the region to another. This is true both in summer and winter. Changes in wind velocity and direction throughout the region alter the temperature and moisture of the air; cyclonic storms with their moving air masses and fronts dominate weather changes.

Altitude and topography also influence regional and local climates. The Ozark highlands in Missouri, for example, are generally cooler than the adjacent areas. But frosts in the lowlands occur later in the spring and earlier in the fall than in the uplands of hilly areas (including the Ozarks).

In general, the most significant changes in temperature and amount of precipitation are along a north-south gradient (Table 1). Thus the average annual rainfall and temperature are lower in the northern parts of the region than in the southern parts. But the most significant changes in the distribution of precipitation, in evaporation rate, and in humidity lie in an east-west gradient. The average summer humidity is lower and evaporation rate higher in the western part of the region than in the eastern part. Rainfall, however, is more evenly distributed throughout the year in the eastern part of the region than in the western part.

BASIS FOR ESTABLISHING PROPOSED SEED COLLECTION ZONES

Because of the large number of native and introduced species planted in the Central States, we cannot fix definite seed collection zone boundaries that could be used for all species. Seed from any part of the natural range of some species may be suitable for planting in a particular locality, while seed from only a small part of the natural range of other species may be suitable. Seed from some sources of a species may be less adapted to a particular locality than seed from other sources. The seed may be particularly susceptible to drought there, while seed from certain sources of another species may not be adapted because of susceptibility to late spring frosts. For both species one or more sources may be found adapted to the locality.

The seed collection zones set up for the Central States (Figure 1) are based on what climatic and geographic factors are considered the most critical in limiting the distribution and planting range of trees commonly used in our planting program(Table 1). The boundaries of zones and their designations (4, 5, 6, and 7, and subzones 4a, 5a, 6a, etc.) are those used on the "Plant Hardiness Zone Map" for the United States and Canada prepared by the U.S. National Arboretum (1960). The relatively small area designated as 6a on the "Plant Hardiness Zone Map" that fringes Lakes Erie and Michigan has been placed in group 5b. Because of critical frost conditions in the Ozarks, a special subzone, 6c, has been established for that locality. Subzones can be further divided if necessary for some species by using state designations, such as 5b-Mo, 5b-ll, etc., and even for parts of states with different distributional patterns of precipitation, e.g., 5b-Oh-E. Although the zone boundaries are based primarily on minimum temperature isotherms, they also reflect differences in annual precipitation, temperature, frost occurrence in spring and fall, number of frost-free days, latitude, and summer day-length. Significant variations within zones and sub-zones are mostly east-west in direction, and result from the differences in precipitation, relative humidity, and evaporation rate.

SUGGESTED USES

By the use of the zone, subzone, and state designations, we can prescribe rather small geographic units for collection of seed, if this be desired for some species. On the other hand, for other species with no important racial variations over extensive areas, we can prescribe large areas such as Zone 6, Zone 6a, or Zones 6 and 7.

The climatic zones (Table 2) can also help in selecting the source when the procurement of seed from out of the state and region is necessary. Seed from collection zones similar in climate to the regions in which planting is planned should be considered the most desirable--unless seed from unlike collection zones has been found to be more satisfactory. Watch especially for differences in latitude, minimum temperature, and length of the growing season. Differences may be critical for one species and unimportant in others. Yellow-poplar (Liriodendron tulipifera L.) and sweet gum (Liquidambar styraciflua L.), if exposed to a longer day-length regime, will break dormancy earlier and then be more susceptible to late spring frosts (Kramer and Kozlowski, 1960). These and many other species (Kienholz, 1941; Cook, 1941) will continue growing later than most others, and may therefore also be susceptible to early killing frosts in the fall. White pine (Pinus strobus L.), on the other hand, stops growing in midsummer or earlier; this species, particularly when it is grown from southern seed sources, is therefore more likely to escape early frosts in the fall than species that continue growing.

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Table 1.-- Factors influencing boundaries of seed collection zones in the Central States

Possible Limiting Factors	General Direction of Change	Critical Attributes
Precipitation:		
Average annual	South (most) to north (least)	Drought
Distribution	East (most uniform) to west	Drought
Temperature:		
Average in July	South (highest) to north (lowest)	Heat, drought.
Average annual minimum	North (lowest) to south (highest)	Freezing, dessication
Killing frosts, spring	North (latest) to south (earliest)	Injury to new growth
Growing season	South (longest) to north (shortest)	Annual Growth
Evaporation	West (highest) to east (lowest)	Drought
Relative Humidity	East (highest) to west (lowest)	Drought
Photoperiod	South (shortest in summer) to north (longest)	Growth (dates and duration)
Topography	Lowland (later spring frosts) to upland (later fall frsots)	Injury to current growth

Table 2.-- Significant features of seed collection zones in the Central States

State and zone	Latitude	Total cumulative daylight[1]	Precipitation: Av. annual[2]	Precipitation: Dist.[3] (days/yr.)	Temperature: July av.	Temperature: Minimum[4]	Temperature: Frost[5]	Temperature: Frost-free days	Evaporation[6]	Relative humidity[7]
	(Degrees north)	(Hours)	(Inches)	(Number)	(Degrees F.)	(Degrees F.)	(Date)	(Number)	(Inches)	(Percent)
Iowa										
4	42-44	312	29	80-100	72	-25	May 10	145	28	50
5	40-43	292	33	80-100	74	-15	Apr. 30	160	34	45
Missouri										
5	39-41	282	36	80-100	77	-15	Apr. 25	175	35	47
6ab	36-40	261	43	80-100	78	- 5	Apr. 20	190	36	51
6c	37-38	251	43	80-100	76	- 5	May 5	175	37	52
7	35-37	246	47	80-100	80	5	Apr. 5	210	35	53
Illinois										
5	40-43	292	34	100-120	74	-15	Apr. 30	165	30	53
6	37-40	271	42	100-120	77	- 5	Apr. 25	185	33	50
Indiana										
5	40-42	292	36	100-120	74	-15	May 10	160	28	53
6	38-40	271	42	100-120	77	- 5	Apr. 30	180	32	50
Ohio										
5	40-42	292	35	100-140	73	-15	May 10	160	27	53
6	38-40	266	40	100-140	75	- 5	Apr. 30	170	28	53
Kentucky										
6	36-39	261	44	100-120	77	- 5	Apr. 20	185	32	55
7	36-39	251	49	100-140	78	5	Apr. 20	190	30	55

1/ Total cumulative daylight in excess of 12 hrs. per day from sunrise to sunset, March 21 to September 22.
2/ Data from Climate and Man (13).
3/ Average number of days in year with .01 inch or more precipitation; from Climate and Man (13).
4/ Average annual minimum temperature; from Plant Hardiness Zone Map (14).
5/ Average date of last killing frost in spring; from Climate and Man (13).
6/ Normal April to October evaporation from reservoirs and shallow lakes, inches; from Climatic Atlas (19).
7/ Average relative humidity, local at noon, July, from Climate and Man (13).

Figure 1.-- SEED COLLECTION ZONES OF THE CENTRAL STATES

Zone number	Mean temperatures		Distribution of precipitation[2]		
	Minimum annual[1] (°F.)	July mean (°F.)	80-100 days	100-120 days	120- days
			Average annual precipitation, inches		
4	-20 to -30	72	29		
5	-10 to -20	74	36	36	38
6	0 to -10	77	43	42	41
7	5 to 0	80		49	49

[1]Approximate range of average annual minimum temperatures.
[2]Average number of days in year with 0.01 inch or more.

Seed Collection Zone boundaries ————————
Seed Collection Subzone boundaries - - - - - - - -


36°
38°
40°
42°
95°
90°
85°
80°
4b
5a
5b
5b
5b
5b
5b
6a
6a
6a
6a
6b
6b
6c
7a
7a
7a
7b