A PRELIMINARY SURVEY OF IMPORTANT FACTORS WHICH AFFECT TREE DEVELOPMENT IN WESTERN OKLAHOMA*

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There are three important factors which are essential for the successful development of trees. These three factors are as follows: (1) Soil conditions must be favorable for root development; (2) An adequate moisture supply is necessary for satisfactory growth; and (3) Species must be planted which are adapted to soil and climatic conditions.

Although there are many soils in western Oklahoma in which the root systems of trees can develop satisfactorily some soils may contain too much clay and will not absorb much of the total rainfall. Other soils may be coarse in texture and under such conditions the rainfall passes quickly into the subsoil or is lost by evaporation. In some cases soils may be very low in plant food and the growth of many kinds of trees may be stunted and, consequently, the trees will be more susceptible to the attack of diseases and insects.

Adequate moisture for the growth of trees may be affected by total rainfall, favorable distribution of rainfall, favorable conditions for absorption and retention of rainfall by the soil or the concentration of water on limited areas of land as a result of runoff. In western Oklahoma the most favorable conditions for the growth of trees occurs where the water concentrates as a result of runoff from torrential rainfall. On many of these areas trees are making a satisfactory growth at the present time.

Certain kinds of trees are more suitable than others for western Oklahoma due to the effect of soil reaction, high temperatures, and restricted use of water in their development. Although more than field observations are needed to arrive at definite conclusions on this subject it is very evident that only a few species are adapted to the climatic and soil conditions which prevail in the western part of the state and it is quite possible that different kinds of trees should be planted in different kinds of soil. A more extensive discussion of these factors will appear in another portion of this report.

SOIL CONDITIONS IN WESTERN OKLAHOMA

SOIL REACTION

Preliminary studies on the soils in eight western Oklahoma counties indicate that 65 per cent of these soils still contain considerable amounts of calcium carbonate which is a good indication that rainfall does not penetrate into the soil to any considerable depth. If rainfall has not penetrated into the soil deep enough to remove soluble substances like calcium carbonate it is very doubtful if enough moisture will be absorbed by the subsurface layers to furnish trees with water during prolonged periods of drought. The results of these tests are given in Table I.

Similar soil conditions are found in Texas and in Beaver counties. Only 28 samples of soil have been secured from these counties but all of them are neutral or basic in reaction. Ten of the sixteen soil samples from Texas county were above pH 8.0 which is not a favorable condition for the growth of most trees and shrubs.

* Contribution from Oklahoma A. and M. College, Stillwater, Oklahoma.

TABLE I.

A Study of the Reaction of Soil Samples Secured from Eight Counties in Western Oklahoma

Soil Reaction

County	Basic	Neutral	Slightly Acid	Medium Acid	Strongly Acid	Total No. of Samples Analyzed
Beckham	60	18	7	2	4	91
Ellis	32	5	1			38
Greer	70	41	6	4	2	123
Harmon	8	11	1			20
Harper	43	7	2			52
Jackson	47	21				68
Roger Mills	16	10	1			27
Woodward	36	17	6	1		60
Total	312	130	24	7	6	479
Per Cent of Total	65.1	27.1	5.0	1.4	1.3	

ORIGIN OF SOIL MATERIAL

A marked variation occurs in the origin of the soil material in western Oklahoma and because of these differences, conditions are not as favorable in some places as in others for the growth of trees. The source of the different soil materials are given in Table II.

TABLE II.

A Preliminary Study of the Relative Areas of Recent Alluvial Soil, Old Outwash Sandy Land, and Fine Textured Upland Soil in Counties Along the One Hundredth Meridian in Oklahoma

Soil Condition	County and Percentage of Soil in Each Group							
	Beckham	Ellis	Greer	Harmon	Harper	Jackson	Roger Mills	Woodward
Recent alluvium	6.1	11.4	16.6	5.6	5.2	20.8	13.4	6.1
Old outwash (sandy)	28.4	42.2	11.9	20.8	24.8	5.2	33.6	47.9
Residual soils*	65.5	46.4	71.5	73.5	70.0	74.0	53.0	46.0
Total area of each soil in each county (data in square miles)								
Recent alluvium	56.0	139.	107.0	33.0	53.0	162.0	152.0	75.0
Old outwash (sandy)	260.	514.	76.	113.0	256.0	40.0	381.0	590.0
Residual soils*	600.	565.	461.0	402.0	724.0	576.0	602.0	568.0

* From sandstone and shale.

The counties studied represent a total of 7,505 square miles. Sixty per cent of this area (4,498 square miles) is covered with residual soil

and where the soils have been derived from the weathering of shale compact subsoils occur which are not favorable for root development and moisture movement. On many areas the topography is rolling and rough and this condition is not favorable for the growth of trees except on areas of land where a concentration of water occurs naturally or where water can be concentrated by artificial means.

Thirty per cent of the land in these eight counties (2,330 square miles) has been covered with old outwash sand from the Rocky Mountain region. In many places the sand is deep and varies in texture from very coarse to fine sand. Coarse sand will not hold water and is unfavorable for plant development under the climatic conditions which prevail in this part of the country. Surface water cannot be concentrated on these areas because the rain penetrates into the soil where it falls. Fine sand holds more moisture than coarse sand and provides more favorable environment for the development of trees and shrubs. In some instances where the sand rests on an impervious subsoil gravitational water percolates into the subsoil and seepage areas develop. Trees make a satisfactory growth when planted on soils where the root system of the tree penetrates into the subsurface layers which contain a good supply of moisture which is derived from sub-irrigation or by absorption of runoff water.

About 10 per cent of the soils in this region have been formed from recent alluvial deposits. The total area of bottom land and terrace soils is about 777 square miles. Most of this land will grow trees but it has a high agricultural value and the average farmer would prefer to continue to use his best soil for the production of cultivated crops and plant the trees on poorer soil.

STUDIES ON SOIL TEXTURE AND TREE DEVELOPMENT

A preliminary study on the effect of soil texture and alkalinity on the growth of trees was made using thirty-three samples of soil obtained from eleven different areas. These soils were analyzed to determine the degree of alkalinity and the quantity of coarse, medium, and fine sand, and the amount of silt and clay which was present in each sample. These data are reported in Table III.

A careful study of the data will show that many of the soil samples, because of their origin from outwash material, contain very little silt and clay but a marked variation in the distribution of size of the sand particles occurs in the different samples. Where trees were making a good growth the percentage of fine and very fine sand was high, and an excellent correlation was secured between the percentage of fine and very fine sand and the growth of Black Locust trees. Where the content of fine and very fine sand was less than 30 per cent in the second and third foot, the growth was poor. Where the content of fine and very fine sand was above 30 per cent the growth of Black Locust trees was fair to excellent, the best growth occurring as the percentage content of fine sand increased. On soils which contained a large amount of medium and coarse sand a large percentage of the trees were either dead or growth was very poor. The honey locust made a better growth on the coarse sandy soil than the black locust or catalpa. Cottonwood made a fair growth on soil similar to samples 22 to 26. An excellent growth of cottonwood occurred when the quantity of fine sand in the soil was higher than 50 per cent and the clay content was low. The effect of alkalinity is not as important as soil texture on the growth of such trees as black locust, honey locust, cottonwood and bois d'arc since these trees will grow on alkaline soils if moisture conditions are favorable.

CONCLUSIONS

The conclusions to be drawn from this investigation are that an accurate knowledge of the mechanical composition of the soil profile will

TABLE III.

Studies on the Relation Between Tree Development and the Mechanical Analysis and pH Value of Soils

No.	Location	Depth of Sample in Ft.	Trees Present	Condition	pH Value of Soil	Percent of Sand			Percent of Silt	Percent of Clay
						Coarse	Medium	Fine		
1	W. of Dairy Barn	1	Cedars	Good	8.5			61.4*	24.0	14.6
2	Woodward, Okla.	2			8.2			54.4*	30.6	15.0
3		3			8.2					
4	8 mi. N Woodward	1	Catalpa & Black	Poor	7.4	2.40	58.95	36.65	2.00**	
5	8 mi. N Woodward	2	Locust		7.2	2.40	58.62	35.21	3.77**	
6	8 mi. N Woodward	3			7.7	2.65	68.55	26.65	4.15**	
7	12 mi. N 3 mi. W	1	Black Locust	Fair	8.3	1.40	42.55	53.37	2.68**	
8	12 mi. N 3 mi. W	2	Black Locust		8.4	1.75	44.83	51.53	1.89**	
9	12 mi. N 3 mi. W	3	Black Locust		8.3	1.85	40.86	54.57	2.72**	
10	2½ mi. S Laverne	1	Black Locust	Poor	8.2	14.45	62.58	21.12	3.85**	
11	2½ mi. S Laverne	2	Black Locust		8.2	11.80	68.20	18.50	1.50**	
12	2½ mi. S Laverne	3	Black Locust		8.3	21.20	65.60	11.40	1.80**	
13	4 mi. S Laverne	1	Black Locust	Fair	8.6	22.30	49.25	26.35	2.10**	
14	4 mi. S Laverne	2	Black Locust	Fair	8.6	28.10	42.27	26.65	3.00**	
15	4 mi. S Laverne	3	Black Locust	Fair	8.5	16.50	27.65	44.80	1.05**	
16	8 mi. S Shattuck	1	Osage Orange	Good	8.1			62.4*	25.4	12.2
17	8 mi. S Shattuck	2	Black Locust	Poor	7.7			61.4*	22.0	16.6
18	8 mi. S Shattuck	3			7.6			63.7*	18.7	17.6
19	8 mi. S Arnett	1	Black Locust	Poor	7.4	3.45	71.46	23.70	1.39**	
20	8 mi. S Arnett	2	Black Locust		6.7	8.00	63.70	25.45	2.85**	
21	8 mi. S Arnett	3	Black Locust		6.9	3.55	67.85	26.00	2.60**	
22	12 mi. SE Arnett	0-3"	Shin Oak	Good	6.9	4.25	54.10	38.85	2.80**	
23	12 mi. SE Arnett	3-14"			6.7	3.45	55.20	39.95	1.40**	
24	12 mi. SE Arnett	14-20"			7.1	3.35	56.20	39.10	1.35**	
25	12 mi. SE Arnett	20-36"			6.3	3.75	33.35	47.80	5.10**	
26	12 mi. SE Arnett	36-48"			6.6	1.65	24.80	70.85	2.70**	
27	1 mi. W. Berlin	1	Black Locust	Excellent	8.5	1.00	21.45	75.50	2.05**	
28	1 mi. W. Berlin	2			8.6	2.90	21.25	73.65	2.20**	
29	1 mi. W. Berlin	3			8.5	1.95	21.90	73.40	2.75**	
30	2 mi. E. Erick	1	Black Locust	Good	7.7	3.30	58.15	37.20	1.35**	
31	2 mi. E Erick	2			7.3	2.65	55.60	39.45	4.95**	
32	2 mi. E. Erick	3			7.2	2.20	43.90	49.75	6.35**	
33	3 mi. S. Cheyenne	1	Poor Grass,	No trees	8.4			28.4*	45.6	26.0

* Separation of sand into three groups not made. (Beaker method used).

** Silt and clay not separated. (Bouyoucos method used).

help materially in determining where trees are more apt to grow if planted in regions of low rainfall. Further correlations between soil texture and the natural adaptation of different species of trees to different soils will assist in the successful development of any tree planting project.