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VEGETATION IN RELATION TO SOME EDAPHIC FACTORS IN OLIVER'S WILD-LIFE PRESERVE FLOODPLAIN FOREST, OKLAHOMA, U.S.A.

BY

AHMED S. ABDUL-WAHAB*

ABSTRACT

The vegetation in relation to some edaphic factors in Oliver's wild-life preserve flood-plain forest community was studied in two plots of one acre each. Edaphic factors studied and analyzed were pH, organic carbon, total nitrogen, total phosphorus, base exchange capacity, exchangeable potassium, soil compaction, and soil texture at the 0 to 6 and 18 to 24 inch levels. On the basis of frequency, density, basal area, and importance percentage, the type community in the south plot was *Quercus macrocarpa* Michx. and the dominant tree is the north plot was *Fraxinus pennsylvanica*, Marsh. The pH was generally above 8.0 at 0 to 6 and 18 to 24 inch levels in both plots. There was no correlation between the type of vegetation and the soil analyzed. The best correlation was between water-logging and vegetation type.

INTRODUCTION

Very few studies have been done on the flood-plain forest of Oklahoma, U.S.A. "The bottomland (flood-plain) forests of Oklahoma have been virtually neglected." Rice (1965), Duck and Fletcher (1945) reported about 3,400 square miles of bottomland type in Oklahoma. Varying from flat bottomland to steep canyon-like valleys, they described the tree species in bottomlands in a general way. Penfound (1948) reported that the elm-ash flood plain community occurs in nearly all the larger stream valleys of Oklahoma and is widely distributed throughout the deciduous forest formation. Rice (1965) reported that pecan, green ash, sugarberry, hackberry, and black walnut occurred as dominants only in the central counties in Oklahoma. American elm is well distributed throughout the area of study. Green ash is very important along the South Canadian River in Cleveland County. Rice and Penfound (1956) made a complete census of Oliver's wild-life preserve bottomland forest near Norman. They found that green ash was the only dominant, and the secondary important species were American elm, cottonwood, and persimmon. Penfound (1952)

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reported that hackberry-elm-ash associes occurs on low flats and sloughs in the Mississippi alluvial plain. Putnam (1951) reported that occassional small stands of pure ash may occur almost anywhere within the hackberry-elm-ash associes but most notably on moist flats or in shallow sloughs.

The paucity of information on edaphic factors and soil moisture in relation to vegetation composition in flood-plains forests in Oklahoma caused the initiation of the present investigation in Oliver's wild-life preserve flood-plain forest.

METHODS OF SAMPLING AND TESTING

The two stands to be investigated in Oliver's wild-life preserve were marked out previously in one acre plot by Dr. E.L. Rice (Fig. 1). In the analysis the trees were sampled by a complete census and the seedlings by means of the arms-length rectangle method (Penfound and Rice, 1957). The DBH of all species over 4 inches diameter and the seedlings were recorded, care being taken to blaze each tree when sampled. From these data the frequency, density, and basal area and importance percentage of all species were calculated.

For soil analysis eight samples were collected from each plot at both the 0-6″ level and the 18-24″ level. Care was taken to insure that the samples were evenly placed over the entire area of each of the two plots. Soil from each of the eight locations and from each level, respectively, were composited so that one sample was secured to represent the 0-6″ level and one to represent the 18-24″ level for each plot. In the laboratory the samples were air-dried and the lumps were reduced by rubbing the soil in a porcelain mortar. The samples were thoroughly mixed and roots or other extraneous matter were removed. Samples were sifted through a 2 mm seive and stored in stoppered containers. Air-dry samples of known weight for each level and each plot were then oven-dried for 24 hours in a convection oven at 105°C. Oven dry weight of each soil was determined in this manner and per cent of moisture in air-dry soil was established . All subsequent calculations of chemical composition were based on oven dry weight of soil. Following the pH tests and mechanical analysis, the remaining composite soil samples were ground in a soil mill and thoroughly mixed to achieve homogeneity for the remaining analysis.

The Beckman pH meter was used for determining soil pH on all samples. Texture analysis of soil followed the method outlined by

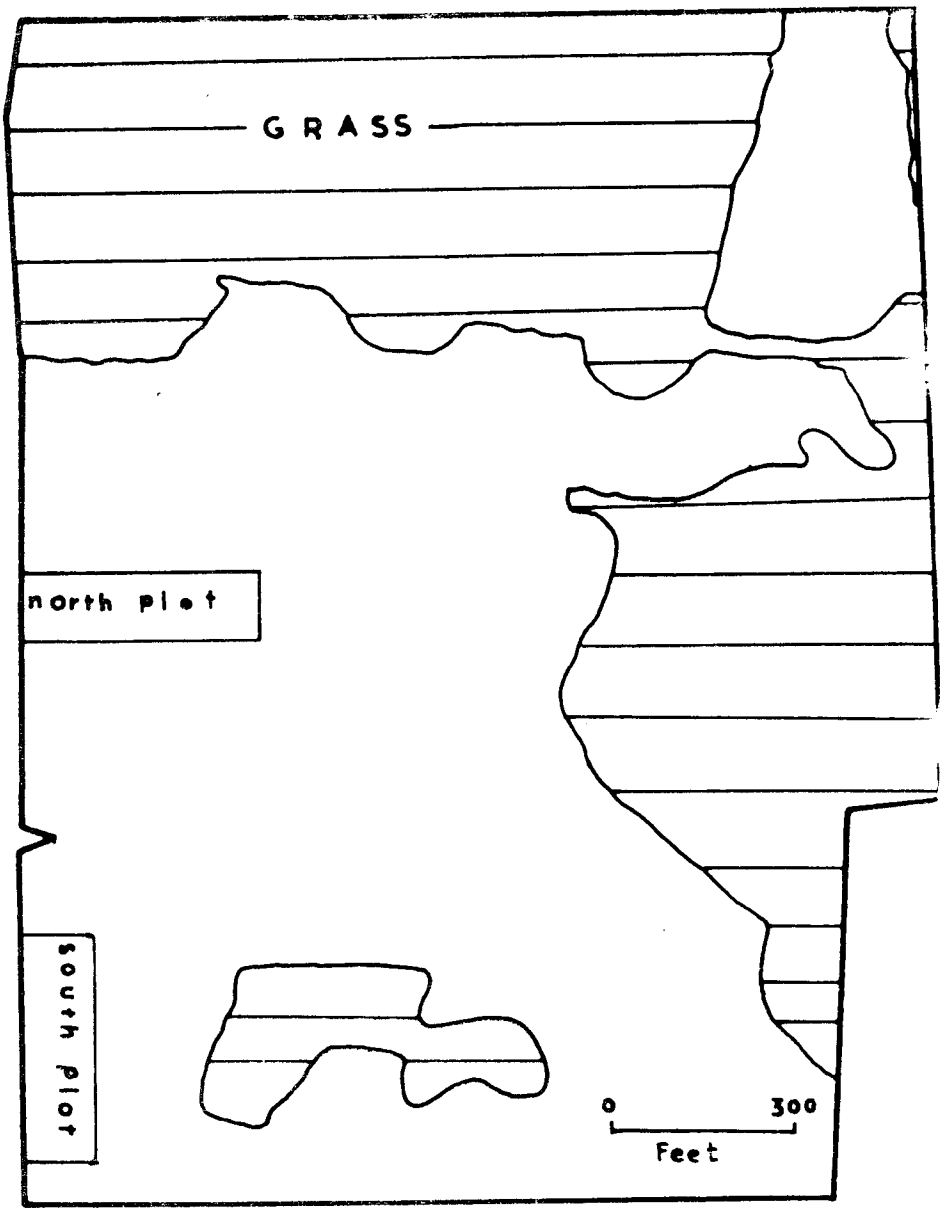
Bouyoucos (1936). Determination of sand complement was based on a five minute hydrometer reading Piper (1942). The clay complement was based on a hydrometer reading of two hours. Organic carbon was determined using the method of Piper (1942), total phosporus by that of Shelton and Harper (1941) using a Spectronic 20 at a wavelength of 675 mμ. The modified method of Peech and English (1944) was used for the extraction of exchangeable potassium and quantitative measurements were made by using a Perkin-Elmer flame photometer, Model 146. The total nitrogen determination of soil was achieved by the modified method from Methods of Soil Analysis (1965). The boric acid was used to react with the ammonium-N to form ammonium borate which was titrated with standardized 0.01N HCl.

A method modified from Noggle and Wynd (1941) was used to determine the total base exchange capacity using boric acid to receive the ammonium-nitrogen. Compaction of the soil in the field based on calculation of volume weight ratio of ten sites spaced evenly over each of the two areas was accomplished by digging a hole of two inches diameter and three inches deep, putting the excavate into soil jars, and hole was filled with known volume of quartz sand. The oven dry weight of the soil was divided by the volume of the sand used to fill the hole to give the volume weight of the soil in gm. per ml.

RESULTS AND DISCUSSION

Based on frequency, density, basal area and importance percentage (Table I), the dominant tree in the south plot is (*Quercus macrocarpa*) Michx. (nomenclature follows Waterfall, 1962), although it is not reproducing. The presence of a large number of seedlings of both *Fraxinus pennsylvanica* Marsh. and *Ulmus americana* L. suggests that these two species will be the dominant in the future. The presence of *Juniperus virginiana* L. as sub-dominant indicates the absence of grazing in the area. Important secondary species listed in order of decreasing apparent importance are: *Fraxinus pennsylvanica* Marsh. *Celtis laevigata* Willd. *Diospyros virginiana* L., *Ulmus americana* L. *Bumelia lanuginosa* (Michx.) Pers. *Salix nigra* Marsh.

In the north plot *Fraxinus pennsylvanica* Marsh. is the dominant tree. Ash seedlings were present in a large number. Few trees of other species are present in the area. The secondary species are: *Populus deltoides* Marsh., *Diospyros virginiana*, L. *Ulmus ameri-*



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cana L. and *Salix nigra* Marsh. The presence of very few large cottonwoods and willows suggests that the cottonwood-willow forest was the immediate predecessor of the oak-ash-elm community in the area.

The water table in the north plot was 5-12″ deep and more than 24″ in the south plot. This may explain the presence of large numbers of green ash and American elm seedlings in the north plot as compared with that in the south plot. Ash is known to form new roots in poorly aerated media, in addition to the adventituous roots. Willow and cottonwood produce adventituous roots, and American elm can withstand inundation for a short time. Hosner (1962) stated that poor aeration due to prolonged saturation of soil with water during the growing season is characteristic of many bottomland areas, and the growth of certain bottomland trees is better under saturated soil conditions compared with better drained conditions. Kramer (1960) stated that root injury occurs in soils having poor aeration, or soils which do not allow free diffusion of gases. de Gruchy (1956) stated that green ash trees can withstand water inundation of 30 inches for 17 month, a mass of adventituous roots developing from the cambium layer just below the water line. American elm can withstand inundation for only 3 to 5 months. Hosner (1958) reported that willow seedlings survive 32 days in flooded areas. Most ash and cottonwood survive 16 days in complete submergence. Hosner (1959) reported that growth and survival of cottonwood is directly related to the formation of adventituous roots; whereas ash, in addition to the formation of adventituous roots, produces new roots in poorly aerated media. This suggests that the oxygen or oxidized substances may be translocated through the shoot to the roots.

EDAPHIC FACTORS

The pH of the soil was generally above 8.0 at both 0-6 and 18-24 inch levels in both plots increasing down the profile. Sabrahmanyan (1927) reported that waterlogging for short periods may decrease the acidity of the soil and increase the availability of certain minerals. Hosner (1962) reported that manganese and iron may become more available over longer periods of water-logging. Kramer (1951) reported that the mineral absorption was reduced when the roots of loblolly pine were immersed in a CO_2 saturated solution. Plants producing adventituous roots received less injury and showed a greater degree of recovery.

The organic carbon, phosporus, potassium, nitrogen and base exchange capacity decreases down the profile. The C/N ratio was approximately the same for both levels in each plot, but was higher in the south plot (Table II). Hosner (1962) reported that the dry weight of the American elm was depressed by soil saturation. However, saturation increases the dry matter of willow by over 100%, but cottonwood and ash increased in dry weight to a lesser degree. Seedlings of ash, willow, and cottonwood grown in saturated soil showed a higher content of nitrogen, phosporus, potassium, calcium and manganese than similar seedlings grown in non saturated soils.

There is some correlation between percentage of sand and organic carbon, phosporus, potassium, nitrogen and base exchange capacity between the two levels of each plot; the more the sand, the less the percentage of the factors listed above. The higher the percentage of clay loam, the more organic carbon, phosporus, potassium, nitrogen, and base exchange capacity, but there was no correlation between the two plots. Soil compaction was approximately the same in both plots and the level of significance was above 0.1 and below 0.2.

There was no correlation between the type of vegetation and the soil factors analyzed. The best correlation was between waterlogging and the vegetation type.

TABLE I

VEGETATION ANALYSIS

South Plot

	B.A./Acre	≠/Acre	Re.B.A.	Re.D.	I.P.
Quercus macrocarpa Michx.	8419.02	37	46.77%	30.33%	38.55%
Fraxinus pennsylvanica Marsh.	2940.44	28	16.34%	22.95%	19.64%
Celtis laevigata Willd.	3014.57	27	16.74%	22.13%	19.43%
Diospyros virginiana L.	1628.68	21	9.05%	17.21%	13.13%
Ulmus americana L.	1762.54	5	9.79%	4.10%	6.97%
Bumelia lanuginosa (Michx.) Pers.	195.96	3	1.09%	2.46%	1.77%
Salix nigra Marsh.	38.48	1	0.24%	0.82%	0.53%
Total B.A./Acre	17999.99	122			

	≠/Acre	Re.D.
Fraxinus pennsylvanica Marsh.	4459	62.74%
Ulmus americana L.	2371	33.29%
Juniperus virginiana L.	234	3.1%
Crataegus viridis L.	50	0.68%
Carya illinoensis (Wang.) K. Koch	17	0.23%
Total ≠/Acre	7341	

North Plot

	B.A./Acre	≠/Acre	Re.B.A.	Re.D.	I.P.
Fraxinus pennsylvanica Marsh.	13191.84	101	88.84%	92.66%	90.76%
Populus deltoides Marsh.	1513.63	1	10.17%	0.91%	5.54%
Diospyros virginiana L.	108.11	6	0.73%	5.50%	3.11%
Ulmus americana L.	36.32	1	0.24%	0.91%	0.57%
Total B.A./Acre	14849.90	109			

Seedlings and saplings per acre	≠/Acre	Re.D.
Fraxinus pennsylvanica Marsh.	21042	88.30%
Ulmus americana L.	2756	11.65%
Populus deltoides Marsh.	33	0.14%
Total ≠/Acre	23831	

*B.A. = basal area
Re.D. = relative density
I.P. = importance percentage
Seedlings and saplings per acre (D.B.H. less than 1 inch).

TABLE II

EDAPHIC FACTORS OF FLOOD-PLAIN FOREST IN OLIVER'S WILD-LIFE PRESERVE

	% sand	% silt	% clay	pH	% organic carbon	% Total phosporus	% Total potassium	% Total nitrogen	mg/100 gm. soil total base exchange capacity	C/N. ratio	vol./wt. ratio (comp.)
North 0-6	29.80	24.2	46.0	8.1	1.956	0.0715	0.1525	0.23	34.9	8.5	0.94
North 18-24	36.88	18.92	44.2	8.4	0.666	0.08475	0.0072	0.081	27.81	8.2	
South 0-6	38.32	22.16	39.52	8.35	1.443	0.05975	0.0168	0.16	26.12	9.0	1.04
South 18-24	54.00	20.4	25.6	9.5	0.41	0.0434	0.00825	0.044	15.23	9.3	

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خلاصـــة

لقد درست علاقة توزيع المجاميع النباتية في غابة اونيفر في اوكلاهـوما بعوامل التربة التالية : تركيز ايون الهايدروجين ، الكاربون العضوي ، مجموع النايتروجين الكلي ، الفسفور الكلي ، البوتاسيوم الممكن احلاله ، قابلية تبادل الايونات القاعدية وصلابة وقوام التربة لاعماق تتراوح بين صفر الى ٦ ثم ١٨ ـ ٢٤ انجا . ونتيجة لدراسة التردد ودليل التردد والكثافة والنسبة المئويـة لاحتمال انتشار النباتات وجد أن نوع الاشجار المسيطرة للمجموعة النباتية في المساحة الجنوبية هي اشجار البلوط . اما الاشجار المسيطرة في المســـاحة الشمالية فهي اشجار لسان الطير . هذا وقد وجد بان التربة تميل الى القاعدية بصورة عامة ولا علاقة بين نوع المجاميع النباتية في هذه الغابة وعوامل التربة المدروسة ولكن العلاقة واضحة بين طول فترة غمور سطح التربة بالماء ونوعية النباتات .

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