THE RELATION OF THE WILTING COEFFICIENT AND THE PER CENT OF LOSS ON IGNITION OF THE SOIL TO SOME OF THE FOREST ASSOCIATIONS IN THE VICINITY OF MOSCOW MOUNTAIN

A RESEARCH PROBLEM

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR BOTANY 203 AND 204

PLANT PHYSICS NUTRITION AND GROWTH

IN THE

DEPARTMENT OF BOTANY

OF THE

UNIVERSITY OF IDAHO

BY

FRANCIS GORDON ELLIS

1928

ACKNOWLEDGEMENT

Acknowledgement of appreciation is made to Dr. F. W. Gail for his cooperation and suggestions in the preparation of this work. Also, to G. R. McDole who so kindly assisted in running the Moisture Equivalents.

TABLE OF CONTENTS

THE RELATION OF THE WILTING COEFFICIENT AND THE PER CENT OF LOSS ON IGNITION OF THE SOIL TO SOME OF THE FOREST ASSOCIATIONS IN THE VICINITY OF MOSCOW MOUNTAIN

OBJECT

The object of this study is to determine the relation existing between the wilting coefficient and the per cent of loss on ignition of the soil to the various plant associations found in this region.

Representative soil samples were collected from the following timber associations found on Moscow Mountain.

Pinus contorta (lodge pole pine)

Pinus ponderosa (yellow pine)

Pseudotsuga taxifolia, Abies grandis (red fir, white fir)

Pseudotsuga taxifolia (red fir)

Larix occidentalis (larch)

Thuja plicata (cedar)

Representative soil samples were also collected from Agropyron--Elymus association adjacent to the timbered region.

The centrifugal machine method was used for determining the moisture equivalents of the various soils and from the moisture equivalents, the wilting coefficients were determined by the formula $\frac{\text{moisture equivalent}}{1.84} =$ Wilting Coefficient as given by Briggs and Shantz.

METHOD

Two samples of approximately thirty grams each of the soils were taken. The samples were put in centrifuge cups, a piece of filter paper being placed over the fine wire mesh in the bottom of the cup to keep the soils from washing through the screen. The centrifuge cups containing the samples were placed in water about one half the depth of the cups and allowed to stand twelve hours The soil in the cups was then allowed to drain until the excess water had been largely removed. This left the soil samples saturated with a small excess of water. The cups containing the soil samples were then put in the centrifugal machine and whirled at a rate such that the soil samples were subjected to a force one thousand times that of gravity for a period of forty minutes. The soil samples were now removed and placed in aluminum weighing cans and weighed on an analytical balance to the nearest hundredth of a gram. The soil samples were then put in a Freas Oven and dried at a temperature of 105° C. for twenty-four hourse, then cooled in a dessicator and reweighed. The difference in weight of the soil samples after whirling in the centrifugal machine and the oven dry weights divided by the oven dry weight of the soil, gives the moisture equivalent of the soil, which is the per cent of water the soil can retain in opposition to a centrifugal force one thousand times that of gravity. The wilting coefficient was then computed by the use of the formula previously given. The results

are tabulated in Table II.

The per cent of loss on ignition of the soils, which is approximately the same as the per cent of organic matter in the soils, from the various associations was determined by placing the samples of the various soils in evaporating dishes and drying in a Freas Oven to constant weight at a temperature of 105° C. The soil samples were then cooled in a dessicator and weighed on an analytical balance to the nearest five thousandth of a gram. The soil samples were then put in a Multiple Unit Electric Furnace and subjected to a temperature of approximately seven hundred degrees centigrade for four hours. The dishes containing the soil samples were then removed, cooled in a dessicator, and reweighed. The difference between the two weighings divided by the oven dry weight of the soil and multiplied by one hundred gave the per cent of loss on ignition of the soil samples. The results of the experiment are tabulated in Table I.

RESULTS

The Agropyron--Elymus association is composed of the more xeric type of mesophytic vegetation. The particular location from which the samples were obtained was adjacent to a rather well-established yellow pine association. It is characterized by such plants as (Agropyron spp.) wheat grasses; (Elymus spp.), Rye grass; (Bromus), brome grasses; (Festuca) fescue; Calochortus elegans, and Ephilobium

angustifolium. The average per cent of loss on ignition of the soil of this association (Table I) was 6.78 and the average wilting coefficient (Table II) was 9.38.

The (Pinus contorta) lodge pole pine association composed of a ground layer of Arctostaphylos uva-ursi, Frasera fastigiata, Opulaster pauciflorus, is found on the somewhat protected slopes and adjacent lowlands in this region. It is not found on such exposed places as the yellow pine association. The average per cent of loss on ignition of this association (Table I) was 4.81, the lowest figure of any of the soils examined. The average wilting coefficient (Table II) was 11.94.

The (Pseudotsuga taxifolia, Abies grandis) red fir-white fir association has a ground layer consisting of a few scattered bunches of Pachistima myrsinites and Coptis occidentalis. The average per cent of loss on ignition in this association (Table I) was 5.85 and the average wilting coefficient (Table II) was 13.30. The per cent of loss on ignition of the soil of this association is slightly higher than that of the yellow pine association, but the wilting coefficient is slightly lower.

The (Pinus ponderosa) yellow pine association which has a ground layer of crustacerus lichens, mosses, Symphoricarpos racemosus, Opulaster pauciflorus, and Frasera fastigiata, is found on the drier exposures of Moscow Mountain. It is one of the more xeric of the forest associations in this

region. The average per cent of loss on ignition of the soil of this association (Table I) was 5.53, and the average wilting coefficient was 13.86.

The (Pseudotsuga taxifolia) red fir association has an undergrowth of Pachistina myrsinites, a few rather weak plants of Opulaster pauciflorus and considerable Coptis occidentalis. It is one of the three most mesophytic types of vegetation in this region. The average per cent of loss from ignition (Table I) was 8.93, and the average wilting coefficient (Table II) was 17.51.

The (Larix occidentalis) larch association is characterized by a ground layer of Salix spp., Ceanathus velutinus, Pachistina myrsinites, Rubus parviflorus and Ribes viscosissimum. The average per cent of loss on ignition of this association (Table I) was 8.05. This is slightly lower than the red fir association, but it has an average wilting coefficient (Table II) of 20.30, being surpassed in this respect only by the soil from the cedar association. The low per cent of loss on ignition of the soil is undoubtedly explained by a rather recent fire. The fine texture of the soil may account for the rather high wilting coefficient.

The (Thuja plicata) cedar association characterized by an understory of Athyrium cyclosorum, Disporum majus, Clintonis uniflora and several species of orchids, are all mesophytic types of vegetation. In fact, it is the most mesophytic type of vegetation in this region. The soil of

of this association is rich in humus, having an average per cent of loss on ignition (Table I) of 20.45, and an average wilting coefficient (Table II) of 30.80.

DISCUSSION

The soil from the Agropyron--Elymus association has a higher per cent of loss on ignition than some of the soils from some of the other associations. There was, however, considerable quantities of flakes of partially disintegrated rock. This necessarily made the wilting coefficient low. In fact, it is the lowest wilting coefficient of any of the soils studied. The vegetation Agropyron spp. Elymus spp. are plants whose water requirements are low. On the bottom of this location which is surrounded on two sides by hills, there is much seepage, making it possible for Ephilobium angustifolium to grow on the lower levels.

Lodge pole pine characteristically grows on well-drained sites of shallow rocky rather poor soil. The per cent of loss on ignition of the soil of the lodge pole pine association is lower than any other soil studied, but the wilting coefficient is some higher than that of the Agropyron--Elymus Association. This undoubtedly is due to the rather large quantitites of only partially disintegrated rock in the latter association.

The per cent of loss on ignition and the wilting coefficient of the soil would place the lodge pole pine as a pioneer in the early stages of succession. In this region,

the stands of lodge pole pine are very limited, but where it does occur, the soil conditions are very similar to those in places where lodge pole pine is found growing extensively. The high winds in this region may be a factor in confining the growth of the lodge pole pine to protected places.

The soil from the red fir-white fir association has a wilting coefficient slightly higher than any of the preceding associations. The per cent of loss on ignition is slightly higher than that of the soil from the yellow pine association and the wilting coefficient is lower. The two associations are very close together in respect to both per cent of loss on ignition and wilting coefficient. The red fir-white fir association grows on a slope much less exposed to winds and dry atmospheric conditions than does the yellow pine. Its protected location probably explains why the more mesophytic red fir and white fir can grow on a soil whose wilting coefficient differs so little from that of the yellow pine association.

The soil from the red fir association has a per cent of loss on ignition which is next to the highest of the soils studied. The wilting coefficient of the soil is lower than that of both the larch and cedar soils. The red fir soil has the greater amount of humus, so it would seem that the wilting coefficient would be higher than that of the larch soil; however, the red fir soil contains considerable quantities of partially disintegrated rock flakes. This

difference of texture of soil probably explains why red fir soil with a higher per cent of loss on ignition has a lower wilting coefficient than does the larch soil.

The soil from the larch association has a high wilting coefficient being excelled only by the soil from the cedar association. The per cent of loss on ignition is slightly lower than the red fir soil due to reasons previously stated, but contains a relatively high per cent of loss on ignition, nevertheless.

The cedar association which is the extreme type of mesophytic vegetation in this region has much the higher per cent of loss on ignition, and also much the higher wilting coefficient. The cedar is a shade enduring tree, and comes in on the soils in which the amount of organic matter has been built up to a great extent by humus accumulation from forest trees and other vegetation of earlier stages of succession. This makes it possible for vegetation of high moisture requirements such as cedar to establish itself as the climax association of this particular region.

CONCLUSIONS

1. Using the per cent of loss on ignition and wilting coefficient as the basis, the lodge pole pine should be the first tree association to appear in this region. This does not appear to be true, however. The possible explanation may be due to the strong winds, since it occurs only in protected places.

2. There is a gradual increase in the per cent of loss on ignition and wilting coefficient of the soil as the successions advance from the early stages (more xeric) to the later stages (more mesic) types of vegetation. The red fir-white fir, yellow pine, red fir, and larch associations follow in this respect with the cedar association constituting the climax forest in this particular region.

3. The soil of the first stages in this succession is typically characterized by a semidecomposed rock, having little organic matter and relatively low in available moisture content.

4. Probably the most influential and universal cause of one plant association giving way to a more mesophytic plant association is the addition of humus to the soil, and as a result, more moisture is retained in the soil.

5. The Agropyron--Elymus association constitutes an early

herbaceous cover in this region. This association increases the organic matter in the soil, making the wilting coefficient higher than is found in the moss-lichen stage of successions preceding this, and makes it possible for the seeds of the yellow pine association to germinate and the seedlings to become established.

TABLE I

Average of Three Samples

Association	Per Cent of Loss On Ignition
Lodge Pole Pine	4.81
Western Yellow Pine	5.53
Red Fir-White Fir	5.85
Prairie	6.78
Larch	8.05
Red Fir	8.93
Cedar	20.45

TABLE II

Average of Two Samples

	Wilting Coefficient
Agropyron--Elymus	9.38
Lodge Pole Pine	11.94
Red Fir-White Fir	13.30
Western Yellow Pine	13.86
Red Fir	17.51
Western Larch	20.30
Western Red Cedar	30.80

BIBLIOGRAPHY

Alway, F. J.--Studies On The Relation Of The Nonavailable Water Of The Soil To The Hygroscopic Coefficient; Research Bulletin No. 3, Agr. Exp. Sta. of Nebraska.

Alway, F. J.--Neller, J. R.--A Field Study of the Influence Of Organic Matter Upon the Water Holding Capacity Of a Silt-Loam Soil; Reprint from Journal Agricultural Research; Vol. XVI, No. 10--1919.

Alway, F. J., McDole, G. R., Trumbull, R. S.--Relation of Minimum Moisture Content of Subsoil Of Prairies to Hygroscopic Coefficient; Reprint from "The Botanical Gazette"-Vol. LXVII, No. 3--March, 1919.

Briggs, L. J., Shantz, H. L.--The Wilting Coefficient And Its Indirect Determination: Botanical Gazette, Vol LIII, Page 20, 1912.

Briggs, L. J., Shantz, H. L.--The Wilting Coefficient and Its Indirect Determination; U. S. Dept. Agr. Bur. Plant Indus.; Bulletin 230.

Briggs, L. J., Mclane, J. W.--The Moisture Equivalents Determinations And Their Application; In Proc. Amer. Soc. Agron., Vol. 2, 1910--Page 138-147.

Briggs, L. J., Mclane, J. W.--The Moisture Equivalents of Soils; U. S. Dept. Agr. Bur. Soils; Bulletin 45.

Approved: Floyd W. Gail Date: March 9. 1928.

Major Professor________________________

Dean of School________________________

- -

Location of Complete Research:

Author & Title: Francis Godon Ellis:
THE RELATION OF THE WILTING COEFFICIENT AND THE PER CENT OF LOSS ON IGNITION OF THE SOIL TO SOME OF THE FOREST ASSOCIATIONS IN THE VICINITY OF MOSCOW MOUNTAIN

University of Idaho Library:

Call Number- SPEC COL MG5319
Only Available in the Special Collections Portion of the Library.

College of Natural Resources:

Department-

Other Sources: