Proceedings of the Iowa Academy of Science

Volume 48 | Annual Issue Article 13

1941

Adaption Studies of Plants for Soil Conservation Purposes in Southern Iowa

J. M. Aikman
Iowa State College

Ivan L. Boyd
U.S. Department of Agriculture

ADAPTATION STUDIES OF PLANTS FOR SOIL CONSERVATION PURPOSES IN SOUTHERN IOWA

J. M. Aikman and Ivan L. Boyd

Regional adaptation data of woody plants are usually compiled from the results of test plantings conducted by sections of experiment stations, from growth and survival results in arboreta, from observational notes and collections of botanists, horticulturists, landscape architects and others, and from deductions based on their behavior in similar regions under native and cultural conditions.

At best, recommendations as to whether a species or variety is adapted to a given region are extremely general. One of the most comprehensive attempts to classify woody plants on an adaptation basis has been made by Rehder (6). Included in the descriptions of most of the woody plants in the book is the number of the plant zone of North America in which the plant may be expected to thrive under ordinary conditions. For this purpose, his map of North America is divided into seven climatic zones running nearly parallel to the southern boundary of the area. His cultural directions as to the zone of adaptation for each plant are very conservative as evidenced by the fact that many of the plants are found growing well in zones farther north than is indicated in the description.

It has long been recognized that within a given climatic zone or phytogeographic region, plant growth conditions vary greatly. Edaphic conditions are so variable that within a very small area both success and failure of establishment may result from adaptation experiments with the same plant species or variety, because of soil heterogeneity.

Quantitative studies of microclimate have shown that the difference in the climatic complex surrounding two or more plants may be of sufficient magnitude to induce definite plant response effects even though the plants are separated very little in space (1), (3), (5).

In April 1938, replicated adaptation plantings of 32 introductions of potential hillculture trees and shrubs were made at the field station near Floris, Iowa. Planting sites were selected on east and west facing slopes in order to determine to what extent the response of the plants would be affected by difference in aspect of slope.

Although it was realized that the soil of the two sites, separated 400 yards, would not be entirely comparable, the special soil survey of the farm showed both sites to be on Lindley soil type with 4 to 6 inches of remaining top soil. Both fields had been abandoned and had been allowed to recover for approximately the same length of time. Canadian bluegrass had made slightly better growth on the east slope than on the west slope. The degree of slope was the same; 20 percent.

The plantings were made at 6.6-foot spacing on the exact contour on plowed strips two furrows wide. The furrows were 8 to 18 feet apart. Herbaceous vegetation was allowed to develop on the furrows with the exception of a 1½ foot radius around each tree which was hoed twice each season.

The planting stock was collected from a wide range of sources and averaged only about C grade. Since this was an adaptation test on eroded soil under conditions of minimum culture on the contour, no special attempt was made to save the plants.

In table I are shown the results of the planting experiment. It would seem that *Daphne mezereum, Diospyros virginiana, Lespedeza fruticosa, Lespedeza procumbeus, Prunus angustifolia,* and *Sambucus pubescens* are quite definitely not adapted to eroded soils in southern Iowa under minimum culture conditions. However, later experiments have shown that better stock of *Diospyros virginiana,* if given a medium degree of cultivation for the first two years, will survive on somewhat protected sites.

It may be noted that several varieties of the American plum which have been developed in Kansas and South Dakota and two of the Bessey cherries developed in South Dakota became established almost as well on the west slope as on the east slope. Of the other plants which became established, all seemed to give a higher rate of survival and a more satisfactory growth response on the east slope than on the west slope.

The magnitude of the variation in the response of the plants as shown in the table is greater than was expected and gives emphasis to the importance of careful selection of planting site within a given phytogeographic region. No attempt was made in this experiment to separate the effect on the plants of edaphic factors from that of climatic factors. However, a later experiment with black locust seedlings in climatic phytometer trenches was set up at these two and one other of the factor data stations. The soil from the three trenches was mixed and divided so the plants at the three sites were growing in the same mixture of

Table I. Percentage survival of potential hillculture plants in replicated plantings on contour furrows; comparison of east and west slopes for two years after planting. 1938-1939.

Plants tested for adaptation	Percentage survival			
	1938		1939	
	East slope	West slope	East slope	West slope
Daphne mezereum	8	0	0	0
Diospyros virginiana	50	20	0	0
Lespedeza bicolor	67	16	33	0
L. fruticosa	8	0	0	0
L. juncea	58	70	25	10
L. procumbens	0	0	0	0
Liriodendron tulipifera	58	17	50	0
Malus anoka	66	66	66	33
Malus, Dolga crab	75	100	50	0
Prunus americana	75	42	33	0
P. americana De Sota	100	66	58	66
P. americana Feibing	100	50	83	0
P. americana Forest Garden	50	75	58	50
P. americana Sapa	100	100	100	0
P. americana Surprise	100	66	100	66
P. americana Weyland 3835	100	100	100	50
P. americana Weyland 3950	100	100	100	60
P. americana World Beater	86	75	50	8
P. americana Wright	58	92	75	20
P. angustifolia	33	100	0	0
P. Besseyi	50	83	50	50
P. Besseyi, Hanson's improved	83	33	83	0
P. Besseyi, Hanson's bush	50	83	50	50
P. Compass	100	100	100	83
P. Kaga	100	83	100	17
P. maritima	80	100	33	33
P. Oka	100	50	100	0
P. Opata	100	83	100	0
P. Superior	100	20	83	0
Rubus thrysanthus	75	75	58	0
Sambucus pubescens	17	8	8	8

soil for the first year. Establishment and rate of growth of the locust seedlings was better in the trench on the east slope than in that on the west slope. The rate of growth ratio in the two trenches was 6 to 5.

In an attempt to determine the magnitude of the difference in plant growth conditions of different planting sites on the farm, climatic factor data stations were established on north, east, south, and west slopes of approximately the same degree and protection. Data from these stations covering a two-year period, have been summarized and evaluated in terms of individual climatic factors and of the integration of climatic factors which seem to have the greatest effect on the establishment and growth of plants. (2.)

Table II. Comparison of the east and west slopes as to dryness of site as influenced by wind velocity, average daytime air temperature and rate of evaporation during the critical establishment period. 1938-1939.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Wind, miles per hour												
East slope	2.8	2.6	1.9	2.5	1.7	2.5	3.9	3.4	3.1	3.8	4.1	4.4
West slope	3.3	3.4	2.2	2.8	2.2	3.2	4.5	4.2	4.1	5.0	5.2	4.8
Daytime air temperature												
East slope			85.2	83.4	73.6	65.5	44.9	35.2	35.8	30.4	43.2	51.9
West slope			86.2	84.2	75.7	66.6	45.7	36.7	35.6	30.6	45.9	55.6
Evaporation in C. C. per day												
East slope	8.9	14.2	30.1	26.3	18.8							
West slope	10.0	17.7	37.3	32.5	20.9							

The data in this paper (2) show that average air temperature for July, 1939, was 3 degrees higher on the west slope than on the east slope. This difference equals the average July temperature difference between the position of the farm in southern Iowa and a location south of the Missouri river in Central Missouri (4). Maximum soil temperature on July 7, 1939, at the 2-inch depth reached 118 degrees Fahrenheit on the west slope and 98 degrees on the east slope. Average relative humidity for the two sites for the period July 25 to August 24, 1938, were 78 and 74 per cent for the east and west slopes respectively. The average wind velocity for this period was more than 60 per cent greater on the west slope than on the east slope (2).

A summary of additional data is presented in table II to show differences in factors contributing to the dryness of the atmosphere, throughout the period following planting to resumption of growth at the beginning of the second growing season. Wind velocity differences on the two slopes as well as total miles per hour are seen to be greater in the late fall and winter than during the growing season. During this first season of establishment, high wind velocity on the west slope doubtless contributed materially to the failure of many of the unprotected seedlings. The evaporation data in table II shows that the relationship between the rates on the two slopes is about the same for the growing season as for July and August of the same year (2).

The data in table II and the above summary of the data, from the same stations presented previously (2), show that differences in climatic factors of such magnitude may well account for much of the variation in the response of the plants on the two sites.

The results reported here would seem to indicate that more care should be taken in the evaluation of sites for adaptation studies if the results of such studies are to be interpreted in terms of adaptation of the given plants to an entire area on the basis of tests in a few selected sites within the area.

LITERATURE CITED

1. Aikman, J. M. The microclimate of *Zea mays* in central Iowa. Proc. Iowa Acad. Sci. 38:73-83. 1931.
2. Aikman, J. M. The effect of aspect of slope on climatic factors. Iowa State Coll. Jour. Sci. 15:161-167. 1941.
3. Geiger, Rudolf. Microklima and pflanzenklima. Verlag Gebruder Borntrager, Berlin. 1930.
4. Kincer, Joseph B. Atlas of American agriculture. Section of temperature, sunshine and wind. U. S. Govt. Print. Office. 1938.
5. Potzger, J. E. Microclimate and a notable case of its influence on a ridge in central Indiana. Ecol. 20:29-37. 1939.
6. Rehder, Alfred. Manual of cultivated trees and shrubs. The Macmillan Co., New York. 1940.

DEPARTMENT OF BOTANY, IOWA STATE COLLEGE, AMES, IOWA, AND
SOIL CONSERVATION SERVICE, U. S. DEPARTMENT OF AGRICULTURE.