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SOIL MOISTURE CONTENT AND GENERAL PLANT GROWTH CONDITIONS OF ERODED SOIL AS INFLUENCED BY CONTOUR FURROWING

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A research program of water conservation and of soil rebuilding and maintenance has been initiated in southern Iowa as a phase of the Cooperative Hillculture project of the Iowa Agricultural Experiment station and the Soil Conservation Service. Existing and newly established vegetative covers are being evaluated as interplanting materials between the rows of larger, chiefly woody, plants of economic value which are grown in furrows on the exact contour under varying degrees of cultivation.

Although it is generally agreed that water conservation and soil conservation go hand in hand, there are few quantitative data available on the effectiveness of water conservation practices in increasing the water content of the soil. Contour furrows may be of sufficient depth and frequence to permit little or no water loss from a slope and yet a consistent increase in soil moisture content as compared to that on comparable unfurrowed slopes is difficult to demonstrate by means of soil moisture samples. The purpose of this paper is to present soil moisture data showing the changes induced by furrowing in soil moisture content to a depth of five to six feet and the general effect of furrowing on plant growth conditions.

The furrows in the 1938 experiment were made in November 1937 on three eroded slopes of Clinton soil type on the upper part of the slope and of Lindley soil type on the lower part. The degree of slope in the Clinton type was approximately 20 per cent and in the Lindley type approximately 33 per cent.

The soil moisture samples were taken to a depth of five feet every two or three weeks on adjacent furrowed and unfurrowed areas on each of the three slopes. There were no replications of furrowed and unfurrowed plots on each slope.

The data from the 1938 experiment, in figure 1, show that, at most depths to five feet and for most dates, soil moisture percentages were greater in the furrows and directly below the furrows than in unfurrowed soil. However the results are not very consistent; the unfurrowed soil showing the higher moisture con-

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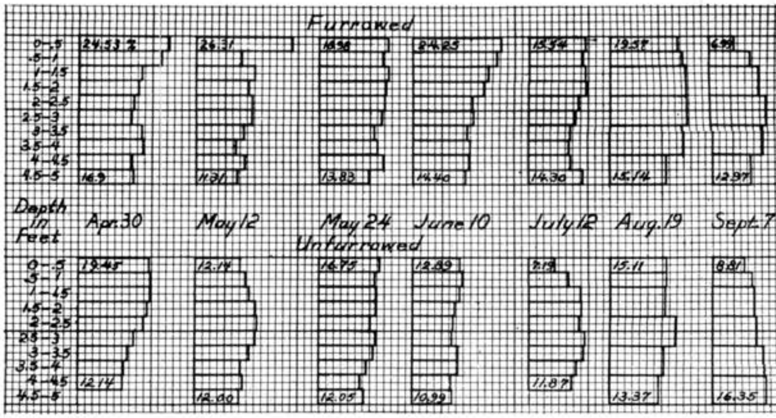

Fig. 1. Percentage of moisture throughout the growing season to the depth of five feet in denuded Lindley soil type with about 2 inches of top soil. The upper charts represent the moisture content and available moisture in cultivated contour furrows, the lower in an unfurrowed area, 1938.

tent for different depths on several dates. The lack of sufficient replications on each slope seemed to prevent the elimination of the error of surface variation and soil heterogeneity. Continuation of the soil moisture results on this experiment during 1939 gave about the same results for the first half of the year but the increase in soil moisture of the furrows over the unfurrowed area was much more consistent after the dry period in late-summer.

This experiment showed that, in both the Clinton and Lindley soil types for both seasons, there was less increase in soil moisture in the upper foot of soil as the apparent result of furrowing than at the other depts. However, ease of planting and of establishment of woody plants was much greater in or on the furrows than in the unfurrowed area.

Determinations of available water in the upper foot of soil showed that a higher percentage of the soil water present in the furrows and on the ridges is available to the plant than of the soil water present in the unfurrowed soil of the same soil type. The apparent leaching of fine clays from the upper soil layer of the furrow and ridge to the lower soil levels seems to be the contributing cause of this difference as well as of the improvement in structure of the furrowed over the unfurrowed soil.

Although there were no replications of the furrowed-unfurrowed treatment on each slope, the growth of the natural plant cover and of the introduced woody plants showed an increase in the furrowed over the unfurrowed area on all three slopes. The growth of natural vegetative cover of bracted plantain, small annual ragweed, aster and sweet clover, over the entire area independent of the contours, was twice as great, as determined by weight-list quadrats, on the furrowed as on the unfurrowed area.

The survival percentage of post trees on the furrowed area, planted in blocks independent of the contour, were: Osage orange 85, Catalpa 97 and Shipmast locust 63 per cent compared to 75, 96 and 10 per cent on the unfurrowed area. On the third slope, the growth of commercial grapes was almost twice as great on the furrowed as on the unfurrowed area.

Because of the difficulty of demonstrating a consistent increase in soil moisture content induced by furrowing as a result of the experiment begun in 1938, in spite of the demonstrable improvement in plant growth conditions on all of the slopes, the 1939 furrowing experiment was initiated.

To correct for variations in soil surface and for soil heterogeneity, the experiment was set up so that each of five planting rows, extending around the hill at right angles to the slope, was made up of six sections, one half chain in length, alternating the furrowed and unfurrowed condition three times. Comparisons of soil moisture content, in the furrow and at a 10-foot distance from the furrow, were also made up and down the strips. The furrows which were, on an average, 20 feet apart, were made in April 1939. Other furrows made the preceding fall showed a higher water content because the furrows helped conserve the fall and winter precipitation.

In figure 2 the results of the new 1939 furrowing experiment are seen to be quite consistently in favor of the furrowed rows over the unfurrowed rows in spite of the fact that the furrows were opened only about six weeks before the first soil moisture data were taken. In contrast to the results of the 1938 experiment there seems to be as great a soil moisture difference in the top foot of soil between the furrowed and unfurrowed as at the other depths.

Between June 5 and June 27 there were 5.67 inches of rainfall. The soil moisture readings for June 27, Figure 2 in the second column from the left, show that penetration into the fifth and sixth-foot depths was greater in the furrows than in the unfurrowed part of the row. The rainfall in the period of June 21 to August 15 reached a total of 8.21 inches. The fourth column from the left shows that the difference in depth of penetration is three feet. Failure of the water to penetrate through impervious clays, which have not been opened up by previous percolation, probably accounts for the greater water content in the second and third-foot levels in the unfurrowed area for August 15. Only twice during

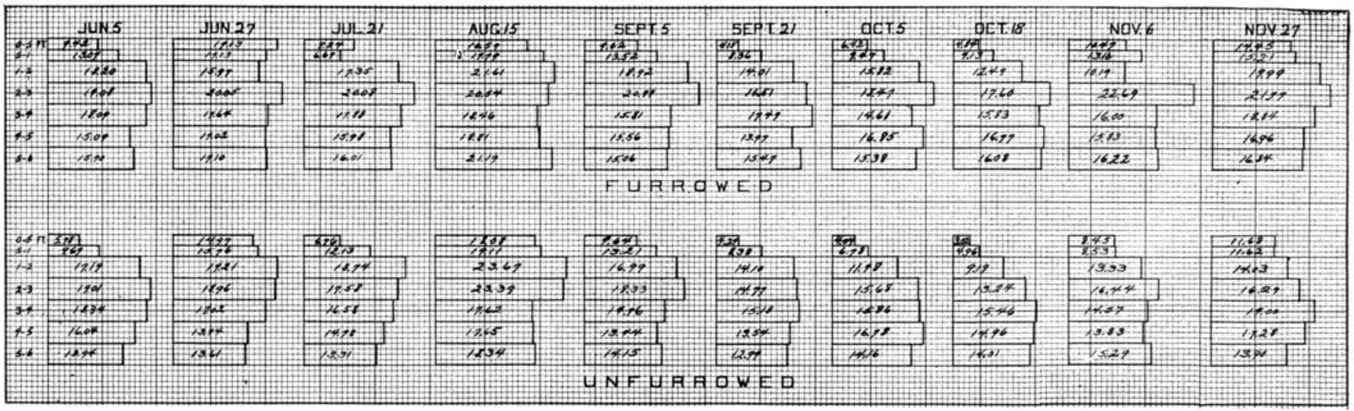

Fig. 2. Average soil moisture readings in per cent, of three replications from furrowed and unfurrowed rows in Lindley soil type on a 20 per cent slope. 1939.

the seven-month period was the soil moisture in the unfurrowed area higher than 15 per cent at the six-foot depth but at no time was it lower than 15 per cent at this depth in the furrows.

In order to evaluate the plant growth conditions of woody hill-culture plants, which are generally planted on the edge of the ridge bordering the furrow, five plants of different habitat requirements and habit of growth were planted: seedling peach, Ponderosa pine, black locust, linden and Concord grape. The plants were set out in units of five, one of each plant, at a spacing of 6.6 feet, each unit covering a half-chain distance. There were approximately 30 plants of each of the species randomized in the 5 rows; 15 of each on the furrowed and 15 on the unfurrowed portion of the rows.

The response of the plants to the conditions of the furrowed and unfurrowed portions of the row is shown in Table I. The plants on the unfurrowed part were cultivated to approximately the same degree as those on the upper side of the ridge bordering the furrows.

Survival seemed to be slightly greater on the furrows than on the unfurrowed area (Table I) although survival of the black locust

Table I — Survival and growth response of five plants to furrowed and unfurrowed conditions on eroded Lindley soil. 1939.

Species	Treatment	Number of plants	Survival per cent	Ave. No. of new branches per plant	Ave. total length of new branches per plant	Average total height per plant
Peach	furrowed	16	25.	3.	25.7″	9.8″
	unfurrowed	17	23.5	2.1	19.5	6.5
Ponderosa pine	furrowed	16	18.75	2.	1.3	1.1
	unfurrowed	16	6.25	1.7	.4	.4
Black louust	furrowed	18	22.2	1.7	14.4	10.7
	unfurrowed	14	28.57	1.1	7.8	11.6
Linden	furrowed	17	52.35	1.4	2.7	8.5
	unfurrowed	14	57.13	.8	1.4	8.3
Concord grape	furrowed	16	81.25	2.4	26.1	11.9
	unfurrowed	19	73.68	1.3	7.2	6.1

was an exception. The fact that the furrows were not made the fall preceding planting but were planted as soon as made, may account for the fact that the plants on the furrows had little advantage in survival.

The plants on the furrows had an advantage, of considerable magnitude in most instances, in growth response as shown by the number of new branches per plant, the average length of new branches and the average total height per plant. The black locust was again an exception in its response in average total height.

In line with the second-year results of a furrowing experiment with commercial plums, the plant growth response to improved moisture conditions, especially at the lower depths, may be expected to be greater during the second year when increased food reserves, built up the first year, will result in increased growth. In fact the five plants of this experiment have shown a greater variation in response to the furrowing treatment during the first year than is usually shown by woody plants to variations in treatment unless the growth conditions are very definitely modified.

In proving the value of contour furrowing in the use of steep land for the culture of plants, the response of the plants to improved conditions seems easier to demonstrate than does any marked increase in available soil moisture. Although a definite increase in soil moisture is demonstrated by the results in figure 2, all of the water held on the slope does not remain in the soil in the upper six feet. The improved rate of percolation at the six foot depth would seem to indicate that much of the water percolates to still greater depths. A definite indication of this is the seepage of water from the base of furrowed hills.

Under hillculture conditions both the woody plants on the contour furrows and the herbaceous plant cover between the furrows show an increase in total quantity of plant material. The increase in the size as well as in the succulence of the above ground parts of the plants induces greater water loss from transpiration which accounts for at least a small per cent of the water retained on the slopes by contour furrows which is not demonstrable by soil moisture determinations.

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