THE CORRELATION BETWEEN THE SOIL SALINITY AND FLOWERING DATE IN COTTON

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INTRODUCTION

In an earlier paper (7) evidence has been adduced to show that under certain conditions there is a positive correlation between soil salinity and seedling stand in cotton. On certain experimental plots on the saline soils of the Gila River Valley at the United States Field Station, Sacaton, Ariz., larger numbers of seedlings were produced on the more saline areas of the experimental field.

In the paper cited it was pointed out that such relationships could not be expected over an indefinitely wide range of soil salinity. Notwithstanding these cautions and the suggestions made concerning the explanation of the results for seedling stand, it is possible that these findings may be interpreted by those who are not acquainted with the full complexity of the problem as indicating that under irrigation in the Southwest highly saline soils are actually better than those of low salinity for cotton production.

Such conclusions might seem to be supported by the fact that, as related by Kearney and Means (14) and by Kearney (15), cotton is one of the most salt-resistant of the staple crops. Balls (1, 2) made observations that lead to the same conclusions. Finally, detailed investigations made for the Office of Alkali and Drought Resistant Crops of the Bureau of Plant Industry have shown not only that the chloride (12) and sulphate (9) contents of the leaf-tissue fluids of cotton are high, but also that there is a differential absorption of these anions (4, 6, 10, 11).

Within certain ranges of soil salinity a positive correlation between salinity and seedling stand has been found (7). In view of this fact it is desirable to extend investigations to the consideration of the relationship between the properties of the soil and other characteristics of the plant for the purpose of determining whether, within certain rather narrow and tolerable ranges of soil salinity, higher values of soil salinity have a beneficial or a deleterious influence on the plant.

An elaborate investigation has been made of the relationship between the electrical conductivity of the soil on the one hand and the osmotic concentration (as expressed in terms of freezing-point depression), specific electrical conductivity, and chloride content of...
the plant-tissue fluids on the other (5). For present purposes, however, a series of investigations of the relationship between the salinity of the soil and some functional characteristics of the plants grown, such as time of maturity or crop yield or quality, is needed.

The purpose of this paper is to consider the relationship between soil salinity and the time required for the plants to reach the stage of development indicated by the production of the first flower.

**MATERIALS AND METHODS**

The cultures considered are those of an experiment made in 1922. This set of cultures has furnished data on the chloride content (12) of the tissue fluids of Pima Egyptian and Meade and Acala upland cottons. The arrangement of the cultures has been fully described in papers on the relationship between soil salinity and the physico-chemical properties of the leaf-tissue fluids (5) and between soil salinity and seedling stand (7). These papers, as well as one on the regression of the soil properties of neighboring plots (8), may be consulted for details of arrangement of plantings.

By means of the soil bridge (3), soil-resistance determinations were made on samples from the 72 subplots devoted to each of the three varieties. These subplots were arranged in sequence so that the three varieties were uniformly distributed over the entire experimental area, which was 180 by 79.5 feet in dimension. Each subplot comprised two rows each of 10 hills 1 foot apart. Three soil borings were made at distances separated by about 3.3 feet in each subplot, but the cores were combined in order to give an average sample for the plot as a whole.

The order of magnitudes of the soil resistances have been indicated elsewhere (7).

Since each soil determination serves for a number of plants, the soil-conductivity determinations were weighted with the number of plants produced on each subplot in the determination of the means and standard deviations of soil resistance and in the determination of the correlations between soil resistance and flowering date.

Since soil borings were made in three series, each of 72 subplots containing originally 20 hills of cotton, a total of 1,440 plants of each variety would have been available if every hill had produced one plant. This result can not generally be realized. All available plants were considered. The date of flowering was determined for 870 plants of Pima Egyptian cotton, for 725 plants of Meade upland cotton, and for 999 plants of Acala upland cotton. Since the present paper is concerned primarily with the correlation between the soil properties and the flowering date rather than with the question of differences in earliness of maturity of the different varieties, it seems unnecessary to deal specifically with the means, standard deviations, and other constants for the time of flowering.

**RESULTS**

The correlation coefficients measuring the relationships between the electrical resistance of the soil and the time required by the plant to reach the flowering stage are given in Table 1. Coefficients
for the resistance of each of the four soil layers of 1 foot each, \( R_1 \) to \( R_4 \), are given. The average values are the mean of these four coefficients. The correlation between the average resistance of the four individual layers, \( R_{1-4} \), and the period required for flowering are also included.

Since soil resistance is measured in ohms (high resistance indicating low salinity and vice versa) and the time of flowering is measured in number of days after a given origin date for the determination of flowering records, a negative correlation between the two variables shows that later flowering is associated with lower values of the electrical resistance of the saturated soil mass, or with higher salt content.

**Table 1.—Correlation coefficients measuring the relationship between soil salinity (in terms of electrical resistance) and time of flowering in Egyptian and upland cottons grown at the United States Field Station, Sacaton, Ariz., in 1922**

<table>
<thead>
<tr>
<th>Depth of soil sample</th>
<th>Pima (Egyptian)</th>
<th>Meade (upland)</th>
<th>Acala (upland)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( r \pm E_r )</td>
<td>( r \pm E_r )</td>
<td>( r \pm E_r )</td>
</tr>
<tr>
<td>First foot, ( R_1 )</td>
<td>-0.1097±0.0226</td>
<td>-0.0902±0.0248</td>
<td>-0.0183±0.0213</td>
</tr>
<tr>
<td>Second foot, ( R_2 )</td>
<td>-0.1535±0.0229</td>
<td>-0.1186±0.0247</td>
<td>-0.0841±0.0212</td>
</tr>
<tr>
<td>Third foot, ( R_3 )</td>
<td>-1.075±0.0226</td>
<td>-1.081±0.0248</td>
<td>-0.0486±0.0213</td>
</tr>
<tr>
<td>Fourth foot, ( R_4 )</td>
<td>-0.0723±0.0228</td>
<td>-1.006±0.0248</td>
<td>-0.0678±0.0212</td>
</tr>
<tr>
<td>Average correlation</td>
<td>-0.1108</td>
<td>-0.1034</td>
<td>-0.0547</td>
</tr>
<tr>
<td>First to fourth foot, ( R_{1-4} )</td>
<td>-0.1288±0.0225</td>
<td>-1.111±0.0247</td>
<td>-0.0507±0.0213</td>
</tr>
</tbody>
</table>

The coefficients are all negative. While in general the values are low, a number of the constants may be considered significant in comparison with their individual probable errors. The average correlations for the resistance of the first to the fourth foot are -0.111 for Pima Egyptian, -0.103 for Meade upland, and -0.055 for Acala upland cotton. These may be compared with the correlations between the average resistance of the first to the fourth foot \( R_{1-4} \), which are -0.129 for Pima Egyptian, -0.111 for Meade upland, and -0.051 for Acala upland cotton.

Whether the generally lower correlation for Acala cotton is significant, and possibly related to the earlier flowering of this variety, must be determined by further investigation.

**SUMMARY**

Consideration of the correlations between soil resistance and flowering date in an extensive culture of Pima Egyptian, Meade upland, and Acala upland cottons, made at the United States Field Station in the Gila River Valley at Sacaton, Ariz., indicates that there is a low negative correlation between the soil resistance and the time required for flowering in these three varieties of cotton. Since soil salinity is measured in terms of resistance, while flowering date is measured in terms of days after an arbitrary origin date (June 1), negative correlation coefficients indicate that the flowering date is slightly retarded by soil salinity.
LITERATURE CITED

(1) Balls, W. L.  

(2) ———.  

(3) Davis, R. O. E., and Bryan, H.  

(4) Harris, J. A.  

(5) ———.  

(6) ———.  

(7) ———.  

1927. ON THE REGRESSION OF SOIL PROPERTIES AND CROP CHARACTERS IN ASSOCIATED PLOTS OF AN EXPERIMENTAL FIELD. Minn. Univ. Studies Biol. Sci. 6: [351–371], illus.

(9) Hoffman, C. T., and Hoffman, W. F.  

(10) Hoffman, W. F., and Lawrence, J. V.  


(12) Lawrence, J. V., and Lawrence, Z. W.  

(13) Kearney, T. H.  

(14) ——— and Means, T. H.  