SOIL STRUCTURE EFFECTS IN THE GROWTH OF SUGAR BEETS

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The soils in the sugar beet area of northwestern Ohio are nearly all heavy in nature; most of them are either silty clay loams or clays. Crop yields throughout this entire area, especially corn and sugar beets, have been declining gradually since the soils were first cultivated. These lower yields have occurred even though most of the soils contain a fairly good supply of the nutrient elements necessary for plant growth. Moreover, in many instances, little response has been obtained from the application of fertilizers.

When one considers the soil requirements of the sugar beet in the light of the properties of the soils in this area, it is not difficult to visualize the causes for the poor growth of beets. The sugar beet, like many root crops, requires aeration of the soil to an adequate depth in order to produce good root growth. A high tonnage of sugar beets is obtained only when the beets are long and tapering. Short, stubby beets rarely are associated with good yields. In order to produce long tapering beets the soil must be friable and well aerated to depths beyond the plowed layer.

The heavy texture of the soils in northwestern Ohio, the level topography and the slow under-drainage tend to provide a soil environment which is not conducive to good growth of beets. The subsoil is usually compact, impervious, saturated with water and poorly aerated. This state of compaction and inadequate aeration often extends to within a few inches of the surface. Sometimes the immediate surface becomes puddled. Since adequate aeration is one of the essential factors in plant growth, especially for root development, it is easy to understand why fertilizer additions may not give responses on these heavy soils.

Bradfield has shown that 40 years of cultivation has resulted in a large decrease in the total porosity of the Paulding clay, one of the important sugar beet soils of the area. The first foot, for example, showed a decrease from 60.3% to 50.5%. This decrease in total porosity, however, only tells part of the story. There has been a much greater decrease in the content of the large pores which are responsible for adequate aeration. When compaction occurs, the major decrease in porosity results in the elimination of the larger pores. This fact is illustrated in Table 1. Note that total porosity of the 0-3 inch and 3-6 inch layers of these various plots do not show such wide differences as do the values for the "non-capillary porosity". This is particularly true of plots D 2 and E 14.

Different farmers have observed that they usually obtain much better beets when sod land is used than when beets are preceded by corn or small grain. A striking example of the effect of a good sod on soil structure and sugar beet growth was studied rather thoroughly during the growing season of 1939. A farmer had planted beets in a field, part of which had been in an old pasture prior to 1938 and part of which had been cropped to corn, beets and small grain for a number of years. The same fertilizer application was given to the entire field. Large differences in the growth of beets appeared early in the season. The beets on the cultivated area were shallow rooted and protruded from the surface of the soil. The sod land outyielded the cultivated land by about 5 tons of beets per acre. Soil structure differences were obvious to the eye. Soil monoliths were taken from the two areas and studied in the laboratory. Cores of soil in their natural structural conditions were analyzed for total porosity and aeration. These investigations showed that the grass sod had a loosening effect upon the soil to a depth of about 24 inches. The cultivated area was decidedly compacted below about 2 inches; less than 2% of large pores per unit volume were found on this area.

The field observations from the aforementioned farm were confirmed by plot data from the sugar beet experiment farm in northwestern Ohio. Definite attempts were made to improve the structure of the soil on this farm by plowing under legumes and manure, by disking manure into the surface and by ridging the soil. The 1939 season was an extremely bad one for sugar beets because of the large amount of rain that fell during June and July. There were 15.8 inches of rainfall during these two months as compared with a normal precipitation of 8.3 inches. The yields of beets from several of the

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