The Influence of Soil Structure on the Yield of Sugar Beets

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In the 1950 meeting of the American Society of Sugar Beet Technologists at Detroit the relation of soil structure to beet growth was discussed from a breeder's point of view. There are, however, many aspects of the soil structure problem connected with beet yield and, therefore, of economic importance to the farmer.

Although the major facts about soil structure have been known for a long time, our attention has been turned more particularly to this aspect of beet growing as a result of our work on the possibilities of mechanizing the beet crop in our country. We found soil structure problems closely connected both with spring and fall mechanization. Therefore, one of my collaborators, Mr. Jorritsma, in latter years has studied specifically the influence of soil structure in the various stages of beet growth and development.

In the Netherlands, more than 80 percent of the sugar beet crop is growing on silt and clay soils reclaimed from the sea. These soils can give good beet yields but they are difficult to handle in the spring. Here we met our first problem in spring mechanization. Especially when there is a period of dry weather in March or April, these soils dry very rapidly and form hard clods, so that much work has to be done to build a good seed bed. Enormous variations in emergence are the result. We, therefore, tried to study the relation between seed bed and emergence. For this purpose, we collected blocks cut out of seedbeds both of good and poor structure as they were prepared by farmers.

These blocks were cut out and transported in such a way that they remained in their original state and were all brought to Bergen op Zoom in our experimental garden. Here we planted them all with a certain number of seeds, both natural and rubbed, and studied the emergence without being hampered by differences in climatic conditions as would have been the case if we had collected these data in the original fields spread all over the country.

In these experiments in various years it has been found that the structure of the seed bed under our conditions has a very striking influence on seed emergence and first growth. The seedbed has to act as a "buffer medium" to regulate the influence of weather. If this "buffer medium" works satisfactorily the germination will be regular and reach a high final level, but when due to bad structure the seedbed suffers more from the variations in weather conditions, germination often is very irregular and comes to an end at a much lower level.

For our production this is very important. In the first place poor emergence will give a low plant population and under our conditions 400 plants per acre less means 1 percent less yield. Secondly, our work during

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20 years has shown the first eight-10 weeks of growth to be decisive for the final root yield. Therefore, it is very important that growth after emergence is continuous and not delayed or interrupted due to bad soil structure.

On our silt and clay soil, the ideal seedbed should have a top layer of about one inch of small crumbs and underneath a homogenous layer capable of holding sufficient moisture and quickly draining superfluous moisture. The farmer can do a lot to improve his seedbed by plowing carefully before winter and by superficial preparation in spring. However, when the season is late and the work is done in a hurry, these principles are very often forgotten.

The structure of the soil also has great influence on the shape and development of the root. The root of the beet is an ideal instrument for measuring soil structure as was proven by Dr. van den Berg, working on soils flooded with sea water during the war. Two years ago, I discussed this subject from the breeder's point of view, but from a farmer's point of view this problem is also important, at least with us, as our work has shown now a distinct negative correlation between early development of fangy roots and final yield. Therefore, on a soil of poor structure not only spring and autumn work are more difficult, plant population often too low and tare too high, but even with high dressings of fertilizers these fields will not give an optimum yield.

In addition to soil structure, the composition of the soil profile and soil pH influence root shape. Accumulation of unsatisfactorily decomposed manure and fresh green manure stimulates the development of fangy roots. Parasites like wireworm and fungi (blackroot) on the other hand cause forking of roots.

We also found in our experiments that as a general rule the sugar content of fangy roots is lower than in normal roots of good shape. Mechanical topping in these fields is more difficult, as with the development of sprangled roots there is a tendency to develop a larger crown growing out of the soil more irregularly.

The general picture is somewhat complicated since the reaction of all varieties is not the same. From an agricultural point of view, this problem is of such importance for us that in the description of sugar beet varieties given in the "Official List of Approved Varieties" we have entered also an estimate of the tendency of each variety to develop fangy roots.

Several pests and diseases influence the growth and development of sugar beets through soil structure. Often these reactions are very complicated and it is often not clear whether they are due to a stronger development of the parasite or weakening of the beet.

In our country, the incidence of blackroot is much stronger on soils of very labile structure, collapsing under heavy spring rains.

Wireworm attacks with us are very often connected with unfavorable soil structure and before H.C.H. products came on the market, farmers tried to combat wireworm by bringing air and warmth in the soil, i.e., by hoeing.

In fields with a low plant population or an open stand with many gaps, the development of virus yellows is stronger than in fields with a good population. Aphids have a preference for open stands and their rate of multiplication is much greater. Also, there is a possibility that in plants with a good continuous growth the development of the virus is slower, but for this we have no definite proof.

Sugar beets give their best yields on fields free of weeds. The tendency of some of our soils to develop compact layers at a certain depth is a great nuisance, for some very unpleasant weeds such as Equisetum, Agropyron and Xussilago thrive well on that type of soil. Some weed grasses germinate more easily in compact top layers while Cirsium maintains itself especially well in soils with a bricklike structure with horizontal and vertical cracks. Unfortunately, the relation between weeds and soil structure is not very well known.

In the factory the excessive tare on forked beets from soils of poor structure under wet conditions is a great problem. In the wet harvest season of 1950 in one of our factory areas, a dirt tare of 30-40 percent was considered as quite normal and the mudpumps were the bottleneck for factory capacity. Our factories claim that beets with sprangled roots give shorter cossettes and cause trouble in the diffusion batteries.

"When growth has been slow on soils of poor structure, autumn rainfall can give a start to new top development combined with loss of sugar and increase of noxious nitrogen.

There are many other relations between soil structure and beets, but only a few have been mentioned. In the Netherlands, farmers are very interested in methods and means to improve soil structure. For the beet crop only a very conservative estimation has shown that, by improved soil structure, 15-18 dollars per acre per year, as an average, could be added to the farm income.