XVIII. THE EFFECT OF LIME AND ORGANIC MATTER ON THE DEVELOPMENT OF ALFALFA ROOTS

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Numerous investigations have been conducted relating to the growth of plants above ground, but relatively few in regard to production of that portion of the plant below the surface of the ground, which gathers the mineral food.

Sir John Dawes, 1847, stated that superphosphate caused a much enhanced development of the root system of plants. Sachs, 1865, showed that the more concentrated the nutrient solution was, the shorter were the roots. Muller and Turgau, 1897, found that nitrogen in a nutrient solution caused a vigorous growth of the secondary roots, but that a concentrated solution of mixed salts retarded root growth. Watt in 1913 from some field experiments found that superphosphate on wheat under semi-arid conditions caused the young plant to send its roots into the subsoil.

Root development may be affected by two principal factors: first, stimulating agents, such as fertilizer and moisture on the root itself, and second, the physical characteristics of the soil. It is a well-known fact that lime and organic matter tend to better the physical condition of the soils, but their effect on soils when studied in connection with root penetration on tight land has not been so extensively studied, especially when the subsoil is taken into consideration.

Throughout the United States there are many soils which have a rather impervious sub-soil of a clay hardpan nature. In Oklahoma we have quite an area running from the Northeast to Southwest through the central portion of the state. This structure has been known to be the cause of many crop failures because it does not allow for the proper movement of water and aeration which are necessary for plant growth. Nor does it permit the roots of common plants to develop and have a sufficient range of soil to

get the necessary plant food. This soil is characterized by its tough, plastic hardpan subsoil about three feet thick below which there is a more, open lower subsoil.

In 1916 the Oklahoma Experiment Station started some experiments on this type of soil with the main object to studying methods of breaking up the sub-soil so that plant roots could penetrate it and to bring about better moisture and air circulation. The plots selected had been seeded to alfalfa in 1913 and at that time manure was applied at the rate of 12 tons per acre to one-half of the plot, the other half of the plot having no treatment. In 1916 the plots were further divided and lime applied to half of the manured plot and half of the plot that had no treatment, at the rate of 2 1-2 tons of ground limestone per acre. Since that time the plots have received no further treatment. Careful data have been recorded regarding root development, likelihood of the alfalfa plant, and the crop yield. In studying the root development two plants were extracted from each of the four plots in 1920, for at this time is was observed that the alfalfa was gradually dying out on the check plot. It was noted that the roots from the plants on plot one failed to penetrate the plastic, clay-hardpan. On plot 2 which received lime in 1916 the roots extended about 6 inches deeper than in the check plot. On plot 3 where barnyard manure was applied in 1913 the tap root penetrated the clay hardpan and established a root system in the open, porous lower subsoil. On plot 4 which received manure in 1913 and lime in 1916 the roots extended farther into the open, porous sub-soil and had the greatest root development.

In order to determine whether the root development was caused by the stimulating effect of the manure and lime on the plant or the improvement of the physical condition of the soil by the lime and organic matter, chemical and physical study of the soil was made, and the following are some of the observations:

Table Showing Maximum Moisture Holding Capacity 1920.

Treatment	Check	Lime	Manure	Man. & Lime
Depth	Plot 1	Plot 2	Plot 3	Plot 4
First Foot	40.93%	41.88%	43.93%	47.75%
Second Foot	39.92	42.27	39.64	43.89
Third Foot	40.18	41.91	35.80	38.91

Table Showing Penetration Tests on These Plots.

	Plot 1	Plot 2	Plot 3	Plot 4
	Check	Lime	Manure	Man. & Lime
First Foot	242	226	154	150
Second Foot	390	304	384	329
Third Foot	205	259	329	366

The results of this experiment show that it is possible for farmers to grow alfalfa profitably on the Kirkland clay hardpan type of soil in this state. In the central portion of the state at least 50% of the well-lying cultivable land is of this type of soil. Alfalfa is considered one of the most profitable crops in the state and this should make it possible for many farmers to increase their profits in the farm and grow more livestock.