Preliminary Report of the Root Systems of Grape Varieties

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It has been shown by the extensive experiments of Weaver, Jean and Crist, in "Development and Activities of Crop Plants," that an exact knowledge of root development of plants, their position, extent, and activity as absorbers of water and solutes at various stages of growth, is of paramount importance to a scientific understanding of plant production. Again, it is held that a knowledge of modifications produced by variations in subterranean environment, whether due to natural conditions, as excessive water content or drought, or to tillage or fertilizers is no less important. In fact, many processes and practices will cease to be empirical and come to be exact when the relation of roots to soil is recognized as having fundamental value.

In an effort to gain a more complete knowledge of the root development of some of our common small fruits on which to base a more intelligent system of soil practices, preliminary work has been undertaken at the Illinois Station with special reference to root systems of representative grape varieties. It is proposed to extend the investigation to include all the common small fruits as soon as possible. Some interesting data have already been obtained and are briefly presented at this time, with tentative conclusions.

The grape vines whose roots were exposed are growing in the variety vineyard at the Urbana Station. The soil type is the morainal brown silt loan commonly found on an eastern exposure in that locality. Representative soil strata encountered as excavating proceeded follow in order, with their approximate depths; silt loam two feet; yellow silty clay two and one-half; clay two feet with sandy, gravelly drift below. The water table is within approximately two feet of the surface. An average annual rainfall of 36.89 inches is reported by the Experiment Station records for this section.

The vines, two year old, were all planted in the spring of 1917 so have finished their sixth growing season. The four arm Kniffen system of training has been followed. Soil treatment has included clean cultivation, followed the last three seasons with cover crops of rye, wheat, and vetch, respectively.

In the process of uncovering the roots, after the first few inches of soil was removed with a spade, it was found necessary to use a fork and a hand trowel since the feeding roots were encountered quite generally from a depth of six inches. From a depth of four feet down it was often necessary to use a pick to loosen the soil.

The Concord vine examined illustrated the two story root system, the first two laterals of the upper story being found two

inches from the surface, and the third, one inch deeper. These radiated out two feet six inches, three feet ten inches, and four feet three inches, respectively, in a horizontal manner. One branch 2 feet and 7 inches long was found arising from the third lateral. A few fibrous roots were present. There was evidence of injury to these roots by tillage tools. The lower portion of lateral roots, 12 in number, arose at a depth of from 7 to 10 inches below the soil surface and varied in length from 12 feet 3 inches to 17 feet 10 inches. These laterals were fairly uniform in depth, about 8 inches, throughout their length, with one exception. In this instance the root grew out horizontally a distance of four inches from the trunk, then plunged downward to a depth of 5 feet 1 inch, extending horizontally thereafter 18 feet. Eleven branches arose from this lateral and grew up toward the more fertile soil stratum. Extensive branching occurred on the laterals at a depth of 8 inches. Fibrous roots were abundant so the space between laterals was quite well filled. The roots have a feeding radius of 16 feet. The greatest depth at which roots were found was 5 feet 9 inches.

The Worden grape vine examined showed 10 vigorous laterals originating on the trunk at a depth of from 5 to 8 inches. These grew out horizontally in different directions for distances varying from 7 feet to 10 feet 7 inches, before striking downward to an average depth of 5 inches, with one exception. This root grew horizontally 2 feet 7 inches then vertically to a depth of 5 feet. The Worden was characterized by an extensive branching development from the main laterals, ending in masses of fibrous roots. There were no branches found on the laterals in the first 8 inches of soil, but they were found in increasing numbers as the lower soil strata were reached.

A vine of Delaware again illustrated the two story rooting system, the upper story being composed of 5 lateral roots originating at a point 4 to 6 inches below the surface and radiating out horizontally at an average depth of 7 inches to a maximum of 10 feet in length. The lower group of roots, 3 in number, originated at about 11 inches below the surface and after a period of horizontal growth varying from 2 feet 2 inches to 12 feet struck deeply downward, the greatest depth measuring 7 feet 8 inches. The root system had a feeding radius of 11 feet 6 inches. The feeding area was about one-half filled with absorbing roots, and although a considerable number of fibrous roots was found along the top group of laterals, very few branches arose from them. At a depth of three to five feet in the silty clay, laterals branched quite generally the branches turning downward.

The Clinton revealed a vigorous root system with a feeding radius of 21 feet 9 inches and a total depth of one root of 6 feet. The laterals arose from the trunk at an average depth of 10 inches. There seemed to be no uniformity in direction of growth—some radiating out to an average distance of 1½ feet then abruptly turning downward to a depth of 5 feet, while others grew out to a maximum distance of 21 feet 9 inches, then worked down only 18 inches. While there were many fibrous rootlets found on the laterals, branching did not occur till the yellow silty clay was reached.

The vine of Norton was the most vigorous examined, the roots being thick and tough with a feeding radius of 20 feet. Ten laterals arose from the trunk at a depth of from 5 to 10 inches. Those on the north side of the vine radiated out to a distance varying from 16 inches to 7 feet, then struck abruptly downward to from 3 feet 10 inches to 5 feet 3 inches. Numerous laterals branched from these vertical roots from a depth of 3 feet down in the silty clay. The remaining 4 roots with south and southwest exposure behaved very differently than those mentioned above in that they grew horizontally for distances varying from 9 to 14½ feet, then struck downward to from 5 to 9 inches. The greater number of branching roots on all the laterals arose at right angles, seemingly an individual peculiarity. The greatest root depth was 6 feet, 1 inch.

It was noted that the size and distribution of the root systems of different varieties was to a certain extent characteristic. Concord and Worden, representing the labruscas, have a more extensive root growth in the upper soil strata than the Clinton of vulpina parentage, or the Norton of æstivalis parentage. These two latter varieties tend to feed extensively at a greater depth. The Delaware of labrusca-borquiniana-vinifera parentage, with a comparatively small horizontal feeding area, reached the greatest depth of any variety examined, 7 feet and 8 inches. It is of course understood that the root systems of the varieties studied will increase year by year and it appears that the increase will be considerable.

Husmann in his "American Grape Growing and Wine Making," has noted the comparatively shallow rooting system of labruscas, while Hedrick, in "Manual of American Grape-Growing," states that the roots of vulpina feed close to the surface and do not seem able to force their way through heavy clays. These statements are not borne out by the facts in this locality.

It is very probable that the root development described was greaty dependent upon many environmental factors according to Gardner, Bradford and Hooker, in "Fundamentals of Fruit Production." "Within certain limits the size and general character of top growth are influenced by the root system that supports it. Similarly the size and distribution of the root system depends to an important degree on the moistened content of the soil." It is also probable according to Weaver that the root system, as far as it regards the number and length of roots, is connected with the development of the shoot.

Naturally an extensive root system with a deeply rooting portion, is very desirable, if the plants are to successfully endure conditions of drought and produce high yields—grapes of all varieties examined fulfill that requirement for this locality. There was an entire absence of tap root noted on any variety examined. It also appears that while the roots are primarily absorbing agents they serve as a means of support for the vine with the aid of the trellis.

It is concluded with the preliminary evidence at hand that a number of present cultural practices in the vineyard need modification. Deep cultivation, especially near the trunk inevitably breaks off or injures lateral anchor roots. Cultivation, however, is needed nearer the trunk than with most large fruit plants because of the numerous feeding roots close in. Grapes should be set no nearer than 10 feet, preferably 12 or more feet square under conditions similar to those at the Station. The deep and extensive rooting system found explains in some measure the conflicting results secured in earlier fertilizer experiments. It will be possible to more intelligently work out control measures for certain grape insects, as root worm and phylloxera, as root systems are better known. The fact that extensive root activity was noted at extreme depths in the yellow clay indicates that we will need to include lower strata than usual in taking root samples for moisture and plant food.

We must, therefore, conclude with Weaver et al. that deeper soils are not only suited to plant life, but that they play an exceedingly important part in the life of plants and deserve careful consideration in a study of crop production.