uppermost parts of the root in November are distinctly less injured by artificial freezing than those parts more deeply buried. With a very tender strain, such as Hairy Peruvian, there was but little difference in hardiness found in different parts of the same root.

**Root Development in Hardy and Non-hardy Winter Wheat Varieties.**

**Wallace W. Worrell, Purdue University.**

The root systems of eight varieties of hardy and non-hardy winter wheats were studied at various intervals during two successive seasons, 1929-30 and 1930-31. The purpose was (1) to study differences, if any, in the nature and development of the roots, and (2) to ascertain the relation between the differences that may be found and resistance to winterkilling. The 1929-30 season was cool and wet and the roots grew slower and did not penetrate as deep as did the roots in 1930-31 when it was warmer and drier. There appeared to be no significant differences as to the average length and depth of seminal roots, although the non-hardy varieties showed greater average spread from the base of the plant than the hardy varieties.

Most of the seminal roots of the non-hardy varieties developed almost horizontally in the early stages of growth with most of the spread remaining at comparatively shallow depths then turning downward, whereas in the hardy varieties most of the seminal roots ran obliquely outward or straight downward with very little spread near the surface.

Adventitious roots showed little development in the fall, but grew rapidly in the spring. Roots of mature wheat plants were found to penetrate to a depth of 70 inches.

**The Relation of Weather to Root Reserves and Time of Cutting in Alfalfa.**—**C. J. Willard, Ohio State University.**

It is a matter of common observation that alfalfa is usually more injured by frequent cutting east of the Mississippi than west of the Missouri. In the dry year of 1930, alfalfa at Columbus, Ohio, yielded rather less than half a normal crop of hay during the season, but root reserves increased steadily throughout the year. The increase in weight of roots during the year amounted to from $\frac{1}{4}$ to $\frac{2}{5}$ of the yield of hay produced. Alfalfa went into the winter of 1930-31 with about 1,000 pounds per acre more root reserves than normal. Cutting four times in 1930 did not weaken the stand or prevent root storage as in normal years. The coefficient of correlation of average daily root storage with average daily rainfall was $-0.44 \pm 0.07$ for 61 records during 7 years.

In a dry season or climate alfalfa uses a smaller proportion of the materials produced by photosynthesis in top growth and a larger proportion in root growth than in a wet season or climate. Consequently, the western farmer, in a dry climate, can cut his alfalfa rather carelessly, and the climate will prevent undue exhaustion of the roots, as it did in Ohio in 1930.

The eastern farmer, on the other hand, is in a climate which normally favors the exhaustion of most of the reserve material from