PLATE I.—1. Tree No. 1 just before it was dug. Right side of top dead and left side poorly developed.
2. Roots of Tree No. 1. Long roots on right show development on side of tree which was alive.
3. Stump and some roots of tree No. 2.
NOTES ON A DRY LAND ORCHARD

By J. E. PAYNE

In 1894, a few trees were planted at The Plains Substation at Cheyenne Wells. These consisted of a few each of cherry, plum and apple trees. Some gooseberry plants were set out at the same time. Among the apple trees planted were four Wealthy trees which were headed about five feet high. These were set at the regulation depth—two or three inches deeper than they had been in the nursery row. These Wealthy trees were planted in a row along the east side of the main apple orchard, between the apple orchard and the house yard. It happened that the space west of the trees was kept cultivated up to the time of digging the trees out, while the space east of them had not been cultivated since 1903. By 1910, two of the trees were dead and the two remaining were in bad condition, especially on the east side of each tree.

In 1905, the main orchard was planted in deep-plowed ground. The trees set this year were set in holes dug in dead furrows and about half a barrel of water was put into each hole before planting the trees. It was a very dry time when the trees were planted, but all of them lived. These trees were set only a few inches deeper than they grew in the nursery. All were headed rather low. These trees all grew well. The orchard was kept cultivated so that few weeds grew there. Several trees were killed by rabbits the first winter after they were planted, but only one died from other causes, and it seemed to have been diseased when first set out.

In 1897, the vacancies in the orchard were filled with apple trees which were shipped from an irrigated nursery. All these trees were headed from four to five feet high. As the high-headed trees set in 1894 had grown very little during the three years they had been planted, it was thought best to set these deep enough so that the heads would be the proper height. Deep holes were dug, and they were planted two to two and a half feet deeper than they grew in the nursery. They all grew well and were soon larger than the trees planted in 1894. In the spring of 1910, these deep-set trees were as large as some of the trees set shallow in 1895.

When the orchard was planted, the trees were set so that each tree occupied a space nearly twenty-three and one-half feet square. When the orchard was inspected in the spring of 1910, branches were almost meeting in many places. When the orchard was trimmed, one-third of the trees were marked for cutting out in order to give room for further development. At this time, the trees were from six to twelve inches in diameter at the ground.

This orchard had grown entirely with the water which fell
upon its surface, except such as was brought to it during the first twelve years by a few furrows which carried storm water from about forty acres of prairie. But it had received no water from this source since 1907, when the prairie adjoining was plowed. During three years, it produced quite good crops of apples, and some fruit has been borne every year since 1900.

The Substation orchard is one of the best Dry-Land orchards in eastern Colorado. But, its history shows that the trees have needed extra water at some time during the year every year since they began bearing fruit. If, at this critical time, a barrel of water could have been given to each tree, much more fruit would have been borne and it would have been of better quality.

The foregoing paragraph applies especially to apple trees. The cherry and plum trees produced good crops without extra water nearly every season until they began to suffer from old age. But, it is quite probable that they too would have given larger returns had they received extra water at some time during the year. By 1910, all the plum trees and nearly all the cherry trees were dead. Gooseberries bore well during the years 1896-1900. By that time, they needed thinning and resetting. As this was not done they bore but little fruit during the later years.

Forest trees were planted for windbreaks around the orchard and along the north side of the farm. Honey locust, black locust, Russian mulberry, White elm and Box elder have all done quite well. Russian mulberry bore considerable fruit while left untrimmed. After they were trimmed, they bore sparingly. Some trees bore fruit with fine flavor, while the fruit borne by other trees was insipid, and quite worthless.

ROOT SYSTEMS OF APPLE TREES.

As we were destroying trees, we thought it well to get some facts concerning the development of the root systems. In August, 1910, we dug up four apple trees and examined the root systems, tracing the roots to their ends or until it was impracticable to trace them farther. One tree was a Wealthy which was set shallow in 1894, one was a Wealthy which was set deep in 1897, one was a Mann which was set deep in 1897, and the other was a Ben Davis which was set shallow in 1895.

Tree Number One.—This was one of the Wealthy trees which were set shallow in 1894. It was headed high. It was kept cultivated on all sides until 1903. From 1903 until 1910 the ground on the west side was kept cultivated, while the ground on the east side was not stirred. When dug up, the top of the tree was dead on the east side. Only a few short roots were found on the east side. These grew about five feet horizontally and only one foot deep. But, on the west side four strong roots were traced ten to twelve
feet horizontally where they were still nearly one-half inch in diameter. Judging by other roots which were traced out more completely, these roots were probably fifteen or twenty feet long. None of them grew deeper than fifteen inches. The tree was three inches in diameter. The west side of the tree was alive, but was in bad condition. Plate I, Figure 1 shows the tree as it stood in the ground, and Figure 2 shows a view of the roots.

Tree Number Two.—This was a Wealthy tree which was planted deep in 1897. Its trunk was seven inches in diameter. It was found that the roots grew upward until they came near the surface, and then grew outward or downward according to the soil. Twelve roots of this tree were traced from five to ten feet horizontally from the tree where they were cut off when still one-fourth to one-half inches in diameter. Six of them turned down when three to ten feet from the trunk. These all followed holes which had been made by burrowing animals. Two were traced three feet, one four feet, one five feet, and two five and one-half feet deep. And they were from one-fourth to one-third inches in diameter when cut off. But nearly all the real feeding roots of this tree were in the upper eighteen inches of soil. In few cases during the work of digging out all the trees were roots found going more than three feet deep, excepting those which followed holes. The upper eighteen inches of soil were filled with fibrous roots. Roots from other trees were found interlacing with the outer ends of the roots of all the trees. One view of the roots of this tree is shown in Figures 3 and 4 which shows the tangle of roots starting from the trunk. The subsoil here contained many large lumps in which they were found many white flakes which are supposed to be compounds of lime and magnesia. The roots seemed to have tried to avoid these lumps, going around, over or under them rather than through them. We expected to find many roots above the graft on these deep-planted trees, but none were found on either this tree or the other deep-set tree which was dug out.

Tree Number Three.—Tree number three was a Mann apple tree which was set two and one-fourth feet deep in 1897. It had grown well and its trunk was about seven inches in diameter at the ground. Plate II, Figure 4 shows this tree with roots dug out. The top of this tree spread about eight feet in all directions. The extreme tips of the roots, traced until they were only one-fourth inches in diameter, spread 33 feet. A few of these roots were traced three feet deep. The roots of this tree occupied the upper eighteen inches of soil quite fully in a space 30 feet in diameter. Many of its roots were traced 15 feet from the trunk. The tree had a well-balanced top, and its root system showed a good distribution through the soil on all sides.
PLATE II.—4. Tree No. 3 with part of its roots. The roots spread 33 feet.
5. Stump and large roots of tree No. 4.
6. Roots of tree No. 4 showing roots spread 33 feet.
While digging out this tree, roots of black locust were encountered 30 feet from the nearest black locust tree. In other parts of the orchard, we found roots of black locust 60 feet from the nearest black locust tree.

Tree Number Four.—This was a Ben Davis apple tree which was planted shallow in 1895. It had a well-balanced top, and was eight inches in diameter at the surface of the ground. It had grown well and had borne several crops of fruit. It was healthy when cut down. Some of the roots of this tree were quite large, measuring as much as three inches in diameter where they joined the trunk. This tree stood where it got water from the prairie whenever a heavy dashing rain fell. This made conditions favorable for rooting deeply. One root was traced five feet down, one was traced four feet down and several were traced three feet down. But, the most of the feeding roots remained in the upper eighteen inches of soil. The main roots were found growing most of the distance within one foot of the surface. Fifteen of the large roots were traced distances varying from eight to twenty-six feet. One root was one-half inch thick at 17 feet and was still one-eighth inch thick when broken and lost at 26 feet from the tree. Another was traced 21 feet. The remaining 13 were traced from 8 to 15 feet. These were all cut when one-third to one-half inch thick. The stump with roots attached is shown in Plate II, Figure 2.

In digging out this tree, a Russian mulberry root was found which was traced 50 feet from the nearest mulberry tree. This accounts for the stunted appearance of some apple trees which were planted close to Russian mulberry trees.

CONCLUSIONS.

1. Trees used for windbreaks for orchards under dry farming conditions are expensive unless the trees of the windbreak group are planted far enough from the fruit trees so that the roots of the windbreak group will not compete with the fruit trees for moisture. The root development of the Russian mulberry and black locust found at The Plains Substation indicate that the windbreak group should be planted 100 feet from the fruit trees.

2. Roots of apple trees do not feed deeply here. If the ground about the ones dug up had been plowed twelve inches deep nearly all the large roots would have been broken.

3. The roots of these trees grew deeper when the soil was wet below the normal depth.

4. Deep planting of trees did not decrease the rate of growth. Neither did it alter materially the position of the feeding roots.

5. The Dry-Land orchard is not considered as a commercial proposition, but it will pay every settler to plant a few well-selected trees and take extra care of them. Nearly all settlers plant more trees than they find time to care for, so they lose all.