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R. P. Speer
Iowa State College

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CHARACTERISTICS OF

HARDY AND TENDER FRUIT TREES.

R. P. SPEER.

The winter of 1884 and 5 and the remarkable drouth of 1887, destroyed all of the apple orchards in Iowa, except in a few localities, where natural drainage and a very porous condition of soils, favored constant growth during the summer seasons. All of our American apples, as well as all of the apples from western Europe, have proved much too tender on ordinary prairie soils. But the Duchess of Oldenburg, Te-tosky and a few other varieties of the apple from Russia, have endured the most trying tests in all parts of the state without being harmed. As Iowa farmers are anxious to plant new orchards again, as soon as they shall be assured that their late losses will not be repeated, I will give the results of my observations and experiments in Northern Iowa since 1866; which may be of much value to many who have given but little attention to the nature and wants of different kinds of trees. If apples had not been disseminated over many degrees of latitude and longitude in Europe, Asia and America; it is probable that there would have been but few varieties, now. But they were scattered widely over the face of the earth, and as they were taken farther and farther north, they acquired new characteristics which enabled them to endure more degrees of cold. And when they were moved to places where the climate was much dryer and hotter, or moister than the one to which they were adapted, changes were effected in them after several generations, which adapted them to the unfavorable conditions which surrounded them. That I may be clearly understood, while describing the effects of unfavorable climatic conditions upon trees, I will explain the structure of trees and the principles of plant growth very briefly. All of the different parts of trees and herbaceous plants are composed of cells. A living cell is a very small, porous and elastic sack like a bladder; which contains a
semi-fluid substance called protoplasm and assimilated cell sap. After growing for a short time, each cell is divided into two parts or two new cells, each of which again divides and thus growth proceeds, forming webs of cells, which are spread one upon another during the growing season. As the webs of cells become covered with webs of newer cells, their walls grow thicker; they lose their protoplasm, their ends become perforated and unite, and they are converted into tubes. Of indefinite numbers of such tubes bundles are formed, causing ducts or air passages between them. Through such ducts in the sap wood of trees, the crude sap is taken from the roots to the leaves. The pith and medulary rays are used as store rooms for reserve food materials, from which new leaves will be formed during the following spring; or they may be used to support growth when the regular supplies of assimilated sap are cut off by drought or other causes. The wood cells of a tree which have been formed in a single season, constitute the sap-wood. The protoplasm not only constructs sap-wood during the growing season, but it forms a new inner bark, by a process similar to that which was used in the formation of sap-wood. At the same time, the old inner bark is converted into new green bark and the old green bark is changed into corky bark. The lives of cells are of very short duration. In fact, the only living cells in the limbs, body or roots of a tree, are those which contain protoplasm. Except at the tender terminal points of growth, they are formed only on the outside of the sap wood and on the inside of the inner bark, and constitute what is called the cambium layer. Therefore, all the cells of a former season’s growth are dead and worthless, for all purposes, except conducting fluids, and supporting more elevated parts of the tree. Then it is not difficult to understand, that the seat of life is in the very thin cambium layer, between the sapwood and bark of trees; that life is really in the semi-fluid protoplasm of the billions of working cells in this layer, and that all growth takes place here. When the atmosphere becomes sufficiently warm in the spring, the protoplasm becomes active at all points between the sap wood and the inner bark of trees, and new leaves are formed from reserve food materials, which were stored up in the medulary rays and pith, near the close of the previous seasons’ growth. As soon as the leaves become sufficiently developed, a green substance called chlorophyll is formed in
them by rays of light, which is always combined with particles of protoplasm.

The leaves have myriads of breathing pores, (called Stomata) which are situated principally on their undersides. They open when light, heat and moisture are favorable to growth, and close during the night or unfavorable weather. Through them respiration and exhalation take place. When they are open, carbonic acid gas is absorbed through them from the atmosphere, which with other crude food materials furnished through the roots, are decomposed by the chlorophyll in the leaves. As decomposition proceeds, oxygen and other waste materials which are not needed by the plant or tree, are exhaled or thrown off through the stomata. During the night and cloudy or wet weather, the leaves are inactive and do not digest crude sap; but the living cells in the cambium layer, work at night as well as during the day, building wood tissue from the reserve materials stored up previously in the pith and medulary rays. The products of assimilation are carbon, the albuminous matter which is necessary to form chlorophyll, starch, etc. The direction in which the assimilated substances move, is downwards through the inner bark, from which it is distributed to the growing cells in all parts of the tree; but when there is a surplus, it is stored in the pith and medulary rays for future use. All of the food materials which enter trees from the ground, are absorbed through the soft and delicate cells near the points of their young fibrous roots. No mineral or other crude food materials can be absorbed by the rootlets of trees or herbaceous plants, unless they are in a state of solution. Three forces are used for propelling the crude sap from the roots to the leaves, and the assimilated sap from the leaves to the new and forming cells in the cambium layer, to-wit, capillary attraction; suction by the leaves, and osmose, (the tendency of fluids to mix.) If trees or herbaceous plants should be surrounded by very favorable conditions, they would complete a season's growth in a definite length of time each year, but the time of their ripening would be hastened or retarded by surrounding them with unfavorable conditions: Thus, when the lives of my young apple trees were threatened by the remarkable drouth of 1887, many of them formed terminal buds, and shed their leaves much earlier than in favorable years; and in other instances, I have noticed that the growth and ripening of corn and other plants was delayed many days.
on account of cold rains and cloudy weather. When a tree is ripe and ready for winter, its pith and the medulary rays will be well supplied with starch; its leaves will have performed their task and ceased to work; all of its cells will have completed their growth, lost their protoplasm and died; then there will be no life in any part of the tree, except in the cambium layer, where a new growth will start during the following spring. No crude sap is absorbed by the fibrous roots of trees during the winter season, but all of their roots are continually absorbing moisture from the ground, to replace that which is lost from their limbs and bodies by evaporation.

There are periods of time during the winter seasons, when it is almost impossible to excite growth in trees and herbaceous perennial plants by the most favorable conditions of heat, moisture and light; but from the analogy between them and hibernating animals, it is very evident that they use considerable quantities of starch while taking their winter rest. During the hibernating periods of the bear, the chip munk, and other animals; their breathing is indistinct; the action of their hearts is weak, and they have the appearance of being dead. Such characteristics have been wisely provided, to prevent unnecessary consumption of the reserve food materials on hand. Bears go into winter quarters fat and always come out poor. During the hibernating periods, they live upon their fat and trees live upon their starch. The foregoing explanations of the structure of trees and plant growth, will enable us to explain more satisfactorily, the effects of unfavorable surrounding conditions upon fruit trees in Iowa. The wide-spread losses of apple orchards in the Northwestern states within a few years, were caused by severe winters; very changeable spring seasons; excessive summer heat, and continued drouths. Is it possible to breed, or to import varieties of the apple from foreign countries, which would prove well adapted to a climate, which has so many characteristics that are unfavorable to plant life? I would answer no promptly, if it was not for the fact, that the Duchess of Oldenburg, Tetofsky and a few other Russian apples, have been grown in all parts of Iowa for many years, without suffering from climatic injuries. A careful examination of the trees which I have named and others which have proved tender, would disclose the fact; that the former are very different from the latter in many respects. I will now point out such differen-
ces; beginning at blossoming time in the spring, and will follow them through the different seasons until blossoming time again. The petals of the flowers of varieties which have endured the climate of Iowa best, are larger and much thicker, than the petals of the flowers of tender trees. The former differ from the latter also, in having shorter and more stocky pistils and stamens and larger stigmas, anthers and pollen grains. In very moist climates like that of England, where there is much cloudy weather, trees have proved best which have thin leaves; that are calculated to expose the chlorophyll which they contain as much as possible to the rays of the sun. But where the summers are as hot, and the air is as dry as in Iowa or Central Russia, thick leaves have proved best. Their unusual thickness prevents injuries by heat or drouth. For the same reason, the leaves of tropical trees are generally thicker, than the leaves of trees which belong to cooler and moister latitudes.

Very frequently, spells of weather which have been favorable to plant growth, have been followed by others which were wet and cloudy for many days. At such times, there can be but little or no growth, as the leaves of trees can not assimilate plant food and their stomata do not open, except when the sun shines. When clear, warm days come after such spells of weather, the leaves of trees would regain their green color, if atmospheric air was not excluded from their roots by stagnant water. After protracted spells of wet weather in June, it is not uncommon for apple trees to drop their fruit. Generally, such losses have occurred, where the roots of trees were excluded from plant food by stagnant water, and after their reserve food materials were exhausted. Although clear days and severe drouths in the fall, have caused trees to ripen prematurely but perfectly; nevertheless it is very evident; that such unfavorable conditions as those which I have refered to above, would retard their growth and might cause serious losses frequently, by preventing them from ripening at the proper time. The ripening of trees, consists in completing the growth of all of the cells in their cambium layers and in supplying their piths, medulary rays and seeds with sufficient supplies of starch and other reserve food materials for future use. As the average length of the growing seasons in Iowa is not more than 120 days, it is not strange that nearly all of our orchards are dead; because we have been trying to grow varieties of the apple which be-
longed to Western Europe, and old eastern favorites, which require from 130 to 140 days of favorable weather for the completion of a season's growth. It is but seldom that tender trees are injured severely by short spells of very cold weather; but when the ground was frozen deeply and there was a very low range of temperature for many days, I have known even moderately hardy trees to be ruined frequently by continued losses of moisture from their bodies and limbs by evaporation. But the Duchess of Oldenburg, the Whitney and other very hardy trees differ from tender trees, in having wood, bark and bud scales of much finer texture than the latter. They require much less water than trees of courser texture, and generally, their main roots are extended perpendicularly into the earth beyond the frost lines, where they have constant access to water; while the roots of trees which are spread out near the surface of the ground, are encased in frozen earth frequently for months during the winter seasons. But cold winters have troubled our orchards much less than unfavorable spring seasons. The Siberian crab apples are hardy in their native country, where there are only about 85 days in each year, which are favorable to plant growth; but they have proved tender in Iowa. The native trees of Siberia begin to grow at a much lower temperature than the trees of milder climates; but there the spring seasons grow warmer steadily and rapidly; while it is not unusual here, to have several spells of summer weather followed by winter weather in April. Frequently the starch in tender American trees is dissolved by warm weather in March, and their cambium layers become gorged with liquid matter, which causes bark-bursting and other serious injuries, when the mercury falls much below the freezing point. The leaning of trees towards the northeast and bark scalding on their southwest sides, are sure indications of unadaptation to climate. This trouble is not caused by cold, summer heat, or southwest winds; but by excessive heat about the time that the buds are beginning to open in the spring.

On the 20th day of April, 1879, I examined the trees in my nursery and orchard carefully, and found all of them in good condition. Eight days afterwards, the mercury ran up and stood at from 80° to 85° in the shade for several hours. On the 5th day of May, I examined the trees in my orchard again, and found all of them severely injured on their south, west sides, except the Duchess of Oldenburg, Tetofsky,
Whitney and Alexander. When such injuries were inflicted, the cambium layers of American apple trees were flooded with liquid matter, and their buds were just beginning to open. As there were no leaves on the trees to cause an upward flow of cold crude sap from the sub-soil their southwest sides became sufficiently heated, to cause fermentation or coagulation of the albuminous matter in their cambium layers, and kill the bark to a greater or less extent. As it has already been settled by carefully conducted experiments, that crude sap rises in healthy trees of ordinary texture, at the rate of two and a half feet per hour; therefore, it is very clear, that such bark-scalding could not be caused by summer heat. On still clear days in June, it is not uncommon to find atmospheric moisture condensed on the bodies of trees by the cold crude sap within them, until their bark is wet to the height of three or four feet from the ground. If it was only necessary that fruit trees should have certain characteristics, which would enable them to endure excessive heat, or drouth, or cold or very unfavorable spring seasons, it would not be difficult to select trees which would prove satisfactory. But it is absolutely necessary that apple trees should have characteristics which will enable them to pass through all of the climatic troubles which I have described unharmed, or it would be useless to plant them. Our long continued experiments with American varieties of the apple, have been expensive, as nearly all of our orchards are dead. Shall we plant new orchards again, or depend upon the fruit-growers of New York and Michigan for apples in the future? I will give my experience with many Russian varieties of the apple and let others answer the question.

In the spring of 1874, I procured cions of 76 varieties of the apple, that had been imported by the Department of Agriculture from St. Petersburg in Russia; which I rootgrafted and planted in my nursery at Cedar Falls. When they were four years old, I did not like the appearance of 62 of the varieties, and I threw them away. The other fourteen varieties were planted in my orchard, and all of them have proved as hardy as the Duchess of Oldenburg, except five, which I have discarded on account of blight or bark-scalding on their southwest sides.

Three of the remaining nine varieties are valuable dessert apples; another is a choice cooking apple, which will keep until the middle of winter, and the other five are summer ap-
pies of medium size and quality. In 1881, I procured cions of fourteen varieties of Russian apples from Mr. A. G. Tuttle of Baraboo, Wisconsin, which he considered hardy. Eight of them have proved hardy and valuable, while the other six varieties have not proved sufficiently hardy. In the fall of 1882, I procured cions of sixty Russian apples from Prof. Budd, which he had imported from central Russia.

During the winter of 1883-4, Prof. Budd imported cions for me from central Russia, of forty carefully selected varieties of the apple. I also procured from him fifteen promising Silesian apples. The winter of 1884-5 was the coldest winter in Iowa since 1885-6, and the spring of 1885 was very changeable. In April of the latter year, I found that nearly all of the varieties of the apple which had been imported from central Russia were hardy; while many varieties from western Russia proved tender. I found also that the severe winter and unfavorable spring, had killed more than 40,000 of my three year old trees of such varieties as Wallbridge, Fameuse, Phumb’s Cider, Tallman’s Sweet, St. Lawrence, Pewaukee and Wolf River. Further investigations showed that my bearing orchard of 1500 trees, which consisted mainly of the varieties which I have named above, was ruined—in fact it contained no sound trees, except the Whitney, Wealthy and varieties of trees which had been imported from Russia.

I have never known fruit trees to suffer as much from blight in Iowa as they did last summer. I examined my three and four year old Russian apple trees on the 5th and 6th days of last month very carefully, and the results of my observations are as follows, to-wit:

The varieties included in list No. 1 (below) have never shown any signs of blight on my grounds, and they appear to be as hardy as the Duchess of Oldenburg.

Nos. 56, 38, 50, 44, 26, 131, 40, 109 and 51. Also from Moscow, Nos. 30, 12, 80, 21, 28 and 18. Also from Orel 4, 7 and 202.

The following list (No. 2) are very liable to suffer from blight in Iowa and should be discarded.

List No. 2, to-wit: Glass, Titus, Kardinal Celine, Peter the Great, Czars' Thorn, Stripe, Round Borsdorf, Juicy Transparent, Sweet Pipka, Charlamoff, Green Streaked, Moscow Pear, Kremers' Glass, Garden, Aport, Koursk, Reinette, Royal Table, Kruder, Titovka (Dept.), Possarts and White Astracan.

The following list (No. 3) were blighted some, (here and there,) but it was very evident that they had been infected by spores from badly blighted trees around them, List No. 3, to-wit: Antonovka, Bogdanoff, Zolotoreff, Basil, Yellow Transparent, Anis, Saunkernaty, Sweet Miron, Ukrain, Getman, Leipzig Borsdorf, Autumn Aport, Thaler, Champagne Pipka, Hare Pipka, and Voronesh Marmalade.

The following list (No. 4) are tender in Iowa, to-wit: Batullen, Black Wood, Serinka, Hassenkoff, Muscatel, Borsdorf, Citronat, Repka Malenka, Geinse, Eisser Apple, Himber Apple, Rother Eisser, Heren Apple, Alpriston, Red Steine, Boiken, Winter Table, Zwibel Borsdorf and Rhenish Bohn. I have not tested any apples from Northern Germany, which are sufficiently hardy for central and northern Iowa. As Russia is a very large country, where there is almost as great a diversity of climatic conditions as in the United States, it should not be expected that many of the Russian apples will prove hardy in Iowa.

The apples which have proved hardy farthest north in Russia, would suffer from blight in Iowa, and be injured severely by our very changeable spring seasons. Others which are adapted to western Russia, near the Baltic sea, could not endure our dry atmosphere and hot summers. And if we should import apples from the vicinity of the Black sea in southern Russia, they would prove as tender here as Bailey's Sweet and Red June. All of our selections of varieties of the apple should be made from that part of the steppes or prairies east of Moscow, where the climate and soils resemble ours most. We have it from Drs. Regel and Shroeder of Russia, and many other reliable pomologists who have traveled over that country, that good apples and cherries have been grown on the prairies east of Moscow for hundreds of years, in such immense quantities that they are frequently of but little value. It is not probable that any of the
hardy Russian apples will have the longkeeping and fine dessert qualities of the Janeton, when it is grown where the summers are long, warm and not too dry. If I am wrong in this belief; then why is it, that Janeton apples have always been of much poorer quality, when grown in central or northern Iowa, than others that were grown in Missouri? In wet summers, we have grown winter apples that would keep, but they were not fit for table use, and in hot and dry seasons, we have grown winter apples of fair quality for dessert use; but they lacked keeping qualities. No state or country will ever be noted for the production of valuable, long keeping apples, where drouths are common, or where the summers are cool and wet. The experience of the fruit-growers of all countries proves, that favorable surrounding conditions, and growing seasons which are longer than Iowa summers, are absolutely necessary for the production of the best long keeping apples.

As this paper is already too long, I will present here only a few plain facts, which favor the proposition which I have offered above, to-wit: In 1886, the Jonathan ripened on the trees, and rotted in the best cellars in November; while in more favorable years, it has been kept without extra care until March. For several years, the Fameuse has ripened and rotted in October; but it has been kept frequently after moist summers in good condition until February. The differences between the keeping qualities of other apples in different years, has been as great as in the examples just given.

Again, bearing trees have suffered more and oftener in Iowa from climatic injuries than non-bearing or younger trees of the same varieties. In such instances, in unfavorable years the leaves of a tender winter apple tree, would assimilate only enough or too little plant food to supply the wants of the tree; but much of it would be appropriated by the fruit, the seeds, etc.

In such cases, the scarcity of the food materials would delay the ripening of trees, and prevent the full or natural development of their fruits. By heavy manuring and by tile drainage, we could cause our fruit trees to make a more constant growth during the summer seasons, and improve the keeping qualities of their fruits. I am confident, that good winter apples, from central Russia can be grown in Iowa as cheaply as potatoes; which will keep with ordinary care until April; but that very long keeping varities like the Janeton and Winesap, will have to be shipped to us from Missouri or New York.