UNIVERSITY OF THE STATE OF MISSOURI.

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

Agricultural Experiment Station

BULLETIN NO. 38.

Winter Protection of the Peach.
Peach Growing in Missouri.

COLUMBIA, MISSOURI.

April, 1897.

E. W. STEPHENS, Printer, Columbia, Missouri.

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Winter Protection of the Peach.

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SUMMARY OF RESULTS.

I. IN THIS LATITUDE, WINTER KILLING OF THE FRUIT BUDS OF THE PEACH IS USUALLY DUE TO THE UNFAVORABLE EFFECTS OF FREEZING AFTER THEY HAVE BEEN STIMULATED INTO GROWTH BY WARM WEATHER, DURING WINTER OR EARLY SPRING.

II. THIS EARLY SWELLING AND GROWTH OF THE BUDS IS DUE TO THE WARMTH THEY RECEIVE, IS PRACTICALLY INDEPENDENT OF ROOT ACTION, AND MAY TAKE PLACE ON WARM SUNNY DAYS IN WINTER, WHILE THE ROOTS ARE FROZEN AND DORMANT.

III. PEACH FRUIT BUDS MAY SAFELY ENDURE A TEMPERATURE OF TEN OR TWENTY DEGREES BELOW ZERO, PROVIDED THEY MATURE WELL IN AUTUMN, ARE ENTIRELY DORMANT, AND THE COLD COMES ON GRADUALLY.

IV. ZERO WEATHER MAY KILL FRUIT BUDS THAT HAVE SWOLLEN DURING PREVIOUS WARM DAYS, OR THAT WERE NOT PROPERLY RIPENED IN AUTUMN.

V. SHADING OR WHITENING PEACH TREES TO PREVENT THEIR ABSORBING HEAT ON SUNNY DAYS, OPPOSES GROWTH OF THE BUDS AND IS, CONSEQUENTLY, A PROTECTIVE MEASURE.

VI. SHADING THE TREES WITH BOARD SHEDS ENABLED PEACH BUDS TO SURVIVE THE WINTER UNINJURED, WHEN EIGHTY PER CENT OF UNPROTECTED BUDS WERE KILLED.

TREES PROTECTED IN THIS WAY BLOSSOMED LATER, REMAINED IN BLOOM LONGER, SET MORE FRUIT IN PROPORTION TO THE NUMBER OF APPARENTLY PERFECT FLOWERS, AND HELD THEIR FRUIT BETTER THAN ANY OTHER TREES ON THE STATION GROUNDS. THIS IS THE MOST EFFECTIVE MEANS OF WINTER PROTECTION TRIED AT THE STATION, BUT IT IS PROBABLY TOO EXPENSIVE FOR COMMERCIAL ORCHARDS.

VII. WHITENING THE TWIGS AND BUDS BY SPRAYING THEM WITH WHITEWASH IS, ON ACCOUNT OF ITS CHEAPNESS AND BENEFICIAL EFFECTS, THE MOST PROMISING METHOD OF WINTER PROTECTION TRIED AT THIS STATION.

VIII. WHITENED BUDS REMAINED PRACTICALLY DORMANT UNTIL APRIL, WHEN UNPROTECTED BUDS SWELLED PERCEPTIBLY DURING WARM DAYS LATE IN FEBRUARY AND EARLY IN MARCH. (See Fig. II, p. 149.)

WHITENED BUDS BLOSSOMED THREE TO SIX DAYS LATER THAN UNPROTECTED BUDS. (See table, page 150, also Fig. III.)

EIGHTY PER CENT OF WHITENED BUDS PASSED THE WINTER SAFELY, WHEN ONLY TWENTY PER CENT OF UNWHITENED BUDS PASSED THE WINTER UNHARMED.

IX. THERMOMETERS COVERED WITH PURPLE MATERIAL REGISTERED, DURING BRIGHT SUNNY WEATHER, FROM TEN TO OVER TWENTY DEGREES HIGHER THAN THERMOMETERS COVERED WITH WHITE MATERIAL OF SIMILAR TEXTURE, THUS INDICATING THAT WHITENED PEACH TWIGS MIGHT BE EXPECTED TO ABSORB MUCH LESS HEAT THAN THOSE THAT WERE NOT WHITENED.

Winter Killing of Peach Buds.

One of the most serious drawbacks to successful peach growing, in some parts of Missouri, is the winter killing of the fruit buds. In many parts of the state serious winter killing is not frequent, and magnificent crops of peaches, particularly of certain varieties, are reasonably sure. In other portions, however, killing of the buds is sufficiently common to cause frequent loss of the peach crop. Probably in every portion of the state the peach is in enough danger from unfavorable winter conditions to make the question of winter protection one of considerable economic importance. Even where a good crop is reasonably certain, the fruit buds are often weakened during the winter.

CAUSES OF WINTER KILLING.

Low temperature and consequent severe freezing is often the direct cause of winter killing of the fruit buds of the peach. Peach buds, however, have often withstood a temperature of ten degrees, or even twenty degrees below zero, and subsequently produced flowers and fruit. On the other hand, five degrees below zero has sometimes entirely killed the peach buds throughout considerable areas. This shows that other conditions besides mere cold weather must be studied in attempting to ascertain the causes of winter killing of buds or plants.

Imperfect ripening of the wood and buds, in autumn, renders them more susceptible to injury from cold weather. This imperfect maturity may be caused by late cultivation or by warm autumn rains which prolong the season of growth. Often the dry weather and cool nights of August induce partial ripening of the wood and buds. Subsequent rains and warm weather induce an autumn growth that is somewhat akin to a spring awakening; so much so that occasionally some of the flower buds burst into bloom in autumn.

Sudden change of temperature is always more dangerous than gradual change. A sudden drop from our ordinary winter temperature to five degrees below zero, particularly if accompanied by strong wind, is more severe on peach buds than a gradual fall to ten or fifteen degrees below zero. Sudden thawing is sometimes more damaging than sudden freezing. Buds and twigs are also unfavorably affected by bright sunlight during times of low temperature.

Growth of buds during warm weather in winter renders them very susceptible to injury from subsequent freezing. This is the most common cause of winter killing of peach buds in this state. It very often happens that a warm spell as early as February causes the peach buds to make considerable growth. If growth starts to any great extent the subsequent cold weather is almost sure to kill the buds. The peach is quite easily stimulated into growth by warm days, even in winter. The purple color of the twigs favors the absorption of heat during sunny days. Purple twigged varieties are more easily stimulated into growth, and they bloom slightly earlier than the green twigged varieties like Snow. Peach buds sometimes remain dormant throughout the winter and suffer from late spring frosts after they have begun to blossom.

METHODS OF WINTER PROTECTION EMPLOYED.

Numerous methods of protecting peach buds during winter have been tried with more or less success.*

Layering, or bending down in autumn, and covering with soil, mats, pine branches or other protecting material, has been resorted to. To facilitate bending down, the trees are usually headed low, the roots are cut on one side of the tree, the tree is then bent over in the direction opposite the cut side, and may be quite readily laid on the ground. This should only be practiced on trees that have been bent down each year after setting. If an old tree is treated in this manner for the first time it may seriously impair its vigor. The Iowa Station advises shaping trees, to be thus protected, by training the trunks horizontally along the ground and allowing the upright head to form several feet to one side of the stump. Grown in this position the prostrate trunk may be twisted sufficiently to allow the head to be laid over on the ground. Some growers are reported to have successfully laid down the peach by planting the young tree so its roots are guided laterally, in two opposite directions, by a trough-shaped piece of sheet iron, embedded in the ground. The roots in this position may be twisted sufficiently to permit the layering of the tree.

Coating the buds, by spraying with glue, and other sticky substances, has been tried, with the hope of affording winter protection.

"*Baling*," or drawing together the branches, as closely as possible, in a vertical bundle, and wrapping them with coarse grass or cornstalks, has been tried with some success.

Experiments in Winter Protection at This Station.

Whitening the twigs and buds by spraying with whitewash has been given more attention at this station than any other means of protection. Careful observation has shown

*See Bulletin No. 16, Missouri Experiment Station; Bulletin No. 19, Iowa Exp. Sta.; Bulletins Nos. 1, 10 and 17, Mass. Hatch Exp. Sta.; Bulletin No. 21, Illinois Exp. Sta.; Bulletin No. 14, Kan. Exp. Sta.

that warm, sunny days in winter, or very early spring, are indirectly more dangerous to the peach buds, in this state, than is the very cold weather. Peach buds are able to endure fifteen or twenty degrees (possibly more) below zero, without injury, provided the wood ripens properly in autumn, the cold weather comes on gradually and the buds remain dormant. On the other hand, the buds of peaches on a southern slope may swell and grow perceptibly when the atmospheric temperature reaches fifty or sixty degrees above zero, if there is bright sunlight. After a few days of such weather, a sudden drop to near the zero mark is almost certain to destroy the fruit buds that have been stimulated even into slight growth during the previous warm days. Reference to the reports of the U. S. Weather Bureau and the State Board of Agriculture shows that the temperature seldom goes low enough, in any part of the state, to kill dormant peach buds. The same reports, however, record frequent winter temperatures sufficiently high to cause peach buds to swell perceptibly, and also show that a fall of sixty degrees within less than a week is not uncommon. Last winter a fall from 69° above to 4° below zero, during January, killed a portion of the fruit buds of the peach, in the vicinity of the Station, and weakened many buds that were not killed.

It should be constantly borne in mind *that peach buds may swell and grow when the ground is frozen*, and the roots of the tree are inactive. There is an erroneous opinion in regard to this among fruit growers, some of whom believe that growth of the buds cannot take place unless the roots are thawed and active. In conformity with this theory, they advise heavy mulching, under the trees, after the ground freezes, to keep the roots frozen and dormant. This is supposed to retard swelling and growth of the buds until danger of frosts is over.

The error of the above theory has been amply proved. Many years ago it was shown that when the branch of a grape vine, which stood near a building, was drawn through the wall into a warm room, it could be forced into considerable growth, while the parent plant to which it was attached remained frozen solid outside. Circumstances are frequently met with

which tend to disprove the necessity of root action in promoting the growth of winter buds, on warm days. Trees of certain varieties, if cut down while frozen in winter, will often leaf out in spring, when their trunks are entirely severed from the stumps. Inside of lumber camps built in winter, of certain kinds of logs, sprouts of considerable length are stimulated into growth by the warmth of the camp fire, while the outer sides of the logs are still frozen. Florists force lilacs into growth in winter, by drawing branches of dormant lilacs into the forcing house, through the wall. All parts of the twigs that receive warmth begin growth, while the rest of the plant is frozen. Twigs of early flowering plants, like the peach, may be forced into bloom, in winter, by cutting them and putting them in a vase of water in a warm sunny room. These facts corroborated by other investigations indicate *that the starting of dormant buds into growth is due to the warmth they receive, and is practically independent of root action.* The twigs contain sufficient stored up food material to promote considerable growth, before the roots and developing leaves are called into use.

Some plants require much more heat than others to begin growth. The peach is quite easily stimulated into growth. Its buds will swell during quite low temperatures, especially if the sunlight is intense. Whitened buds are less liable to injury, as they absorb less heat and are therefore less likely to be stimulated into growth during warm weather. The effect of different colors on the absorption of heat is too well known to need extensive comment. Everyone knows that a black garment is warmer on a hot day than a white one of similar texture. A black hat is said to "draw the sun" and is warmer than a white one. A black cloth spread on the snow will absorb enough heat from the sun to melt its way down into the snow much faster than a white one of similar texture will do.

In contrast with the fact that whitened buds *reflect*, rather than *absorb* heat, it is of interest to note that the purple coloring matter of peach twigs is admirably adapted to absorbing heat. For this reason purple twigged varieties are more easily stimu-

lated into growth, and bloom slightly earlier than green twigged varieties, originated in the same climate. Vegetable physiologists have shown that the blue and purple coloring matters of plants have the power of absorbing more heat than other colors, thus especially fitting purple plants for growing at low temperatures. As an indication of this fact, many plants, growing in cold regions, have abundant purple coloring matter. Many species that are green during summer take on a deep purple as winter approaches. We may readily recall many instances of this kind, aside from the peach. It is particularly marked in the alternanthera of our flower borders, in the dark leaved cannas and even in the purslane or "pursley" so common, as a weed, in our gardens. The Clothilde Soupert and other roses produce much darker flowers, as well as foliage, upon the approach of winter. Certain species that are green when grown in warm localities, become purple if removed to a colder region. Careful observation and experiment have led to the generally accepted conclusion, that this purple coloring matter favors the absorption of heat, by the plant, and enables it to grow at low temperatures.

Experiments at this station, during the past two winters, have shown that whitening peach buds, to keep them in a dormant condition, has had a very marked effect.

During the winter of 1895–6, a row of peach trees, running diagonally across the orchard, so as to embrace several varieties, was whitened by spraying with a lime whitewash. These trees had been set only two years and had but few fruit buds. Four older trees, in various parts of the grounds, were also whitened.

The winter was marked by changeable temperatures. During warm days the unwhitened peach buds swelled considerably, and during subsequent cold spells most of these fruit buds were killed. The unwhitened buds swelled and grew perceptibly before any swelling could be detected in the whitened buds.

Figure I, b, represents the longitudinal section of a whitened bud, taken March 20. Figure I, a, represents a

FIGURE I. Sections of unwhitened (a) and whitened (b) buds of Heath Cling Peach, taken March 20, 1896, showing that the unwhitened bud had swollen and grown considerably and had an imperfect pistil, while the whitened bud was nearly dormant, and had a perfect pistil.—Original.

similar section of an unwhitened bud, taken on the same date. These sections are magnified about twenty diameters. They show that considerably more growth has been made by the unwhitened bud. It is longer and broader; its scales are more open at the apex, the point of attachment of the stamens has pushed out farther by the lengthening of the bud, and the stalk of the bud shows greater lengthening by the greater distance between the scales. In the unwhitened bud the pistil was shriveled and dead, while in the whitened one it was still uninjured. Microscopic study of a great many buds showed, in all cases, that the unwhitened buds had made more growth and that their pistils were usually injured.

Whitened trees came into bloom about one day later than unwhitened trees of the same variety. Undoubtedly there would have been more difference in an average year, but during the blossoming season of 1896 the weather became suddenly hot, with a dry wind, and all varieties came into bloom at nearly the same time. On the unwhitened trees, only twenty per cent of the flowers that opened had perfect essential organs, most of the pistils and often the stamens being shriveled and dead. Of the flowers that seemingly had perfect organs only a few set fruit. The hot, dry, windy weather prevented their remaining in bloom more than one day. On the whitened trees eighty per cent of the flowers had perfect essential organs. They remained in bloom longer, and set fruit better, than those that were not whitened.

During the winter of 1896–7 the same trees were whitened. The same marked effect was noted in retarding the growth of the buds. Figure II shows the comparative amount of swelling of whitened and unwhitened buds, at different times during late winter. Number 1, in each case, is from an unwhitened tree, and number 2, beside it, is from a whitened tree of the same variety. The two twigs, taken March 4, show that the buds of the unwhitened twig (number 1) have swollen perceptibly, while the whitened one (number 2) is still dormant. The twigs taken on March 15 and 26 show that the unwhitened buds

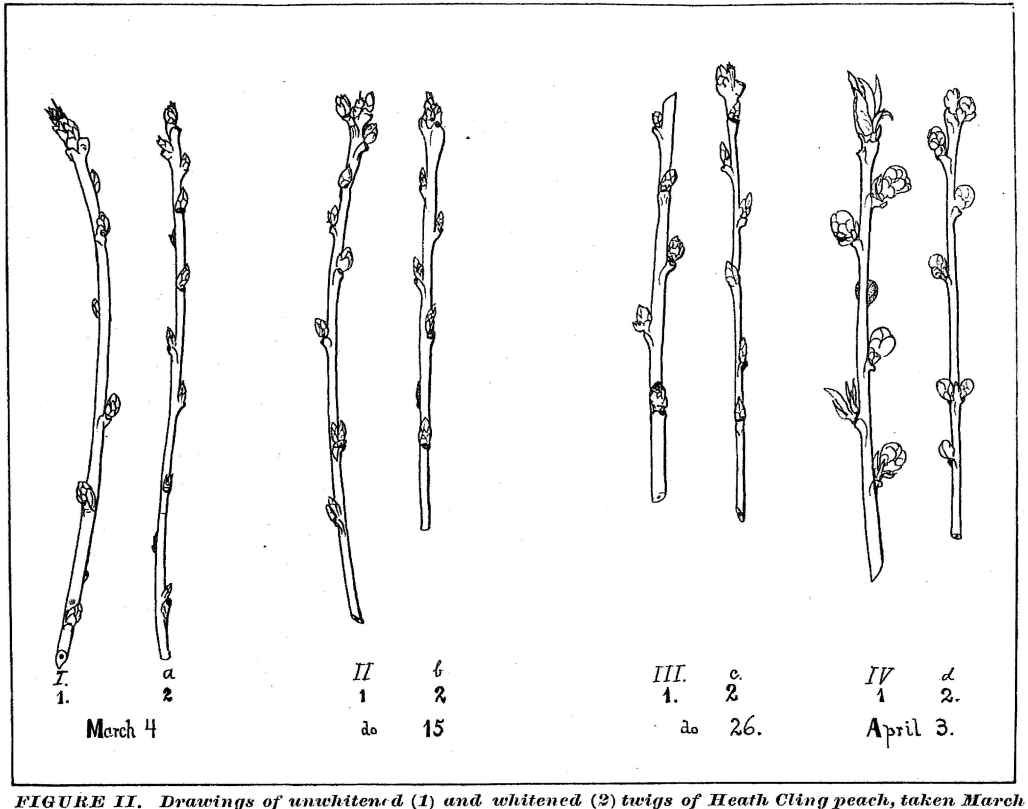

FIGURE II. Drawings of unwhitened (1) and whitened (2) twigs of Heath Cling peach, taken March 4, March 15, March 26 and April 3, 1897. No. 1 shows that there was considerable swelling of the unwhitened buds on March 4, and that they continued to swell from time to time until on April 3 they were nearly ready to blossom. No perceptible swelling is noticed on whitened buds (No. 2) until after March 26.—Original.

FIGURE III. Whitened and unwhitened River's Early trees, showing difference in the date of flowering.

are swelling much more rapidly than the whitened ones, as the season advances. Those taken on April 3 show that the unwhitened buds are almost ready to bloom, while the whitened ones have swollen much less.

Table showing comparative time of blossoming of whitened and unwhitened peaches, 1897:

Variety.	Color.	First flower.	Full bloom.†	Last flower.
Heath Cling...	Whitened	April 13. ...	April 21....	April 29*...
	Not "	" 11. ..	" 18....	" 27....
Wonderful	Whitened	" 14.....	" 22...	" 29*...
	Not "	" 11.....	" 18....	" 25....
River's Early..	Whitened	" 13.....		" 29*...
	Not "	" 9.....	" 21....	" 27....
Silver Medal..	Whitened	" 13.....	" 18....	" 28....
	Not "	" 7.....	" 13...	" 21....

It will be noticed that the whitened buds of each variety opened from two to six days later than those that were not whitened.

Figure III is from photographs, taken April 13, of a whitened and an unwhitened River's Early, showing that when the first flower opened on the former, the latter had put out considerable bloom. Figure IV shows the average difference in time of blossoming of whitened and unwhitened buds.

The hailstorm of April 29, which took the remaining petals off the whitened trees, makes it uncertain as to whether or not the whitened trees would have remained in bloom longer than those that were not whitened. The difference in the actual dates of flowering of the whitened and unwhitened trees does not accurately express the difference in the time of swelling and developing of the buds. As shown on the drawings, Fig. II, the whitened buds do not begin to swell so early as do the unwhitened ones.

* On April 29 the remaining petals were taken off by a hailstorm, which also took off some of the setting fruit.

† The trees were considered in full bloom when all the buds had opened sufficiently to expose the essential organ.

The whitened buds may remain entirely dormant during weather that is sufficiently warm to produce considerable swelling in unwhitened buds.

In each of the four varieties except River's Early, the whitened trees set more fruit. River's Early set fruit very abundantly and equally well on whitened and unwhitened trees.

In order to approximate the difference in the amount of heat absorbed by different colors, the following experiment was tried with thermometers.

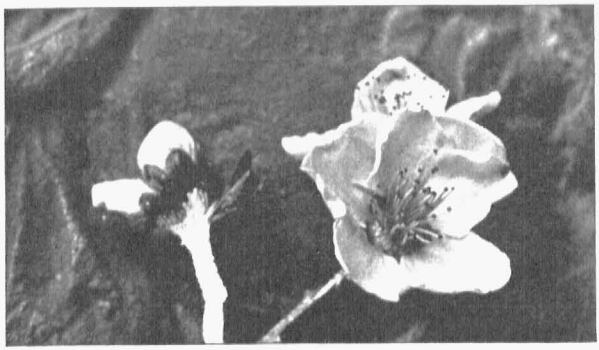

FIGURE IV. Showing difference in time of blossoming of whitened and unwhitened buds.

At first five dairy thermometers were selected, after comparing them, at different temperatures, to see that they were approximately uniform in their readings. One was exposed naked and the other four were wrapped about the bulbs with four thicknesses of muslin of like texture, but of different colors —one green, one purple, another black, and the fourth of the natural white of the cotton. These five thermometers were then hung, side by side, about ten inches apart, and five feet from the ground, in the orchard.

In times of bright sunlight these thermometers registered very different temperatures. During hazy weather and at night they stood nearly alike. The readings were not recorded at any given hour of the day, but the times of the brightest sun-

light were selected, as being most favorable to the swelling of peach buds.

The following table records some of the readings that show the greatest extremes between white and dark covers.

TABLE SHOWING INFLUENCE OF COLOR IN ABSORPTION OF HEAT.

DATE.	Temperature in degrees Fahrenheit.					WEATHER.
	Exposed Naked.	White.	Green.	Purple.	Black.	
February 20, 1 P. M.	70°	71°	77°	79	80	Clear.
" 22, 2 P. M	36	33	38	39	40	"
" 22, 3 P. M.	38	37	42	42	42	Slightly cloudy.
" 22, 4 P. M	30	28	30	30	30	" "
" 25, 11 A. M.	59	64	66	67	69	Clear.
" 25, 2 P. M.	59	61	64	67	70	"
" 25, 4 P. M	48	47	49	49	50	"
" 26, 11 A. M.	27	27	27	28	29	Haze.
" 28, 1 P. M.	42	43	47	48	50	Clear.
March 3, 12 M.	37	38	40	41	42	Haze.

Four of these thermometers were then hung on the south side of a building, where they would be less affected by wind. The muslin wrappings were removed, and spread over them, so that each thermometer was behind a screen of cloth one foot square. The following readings were then taken:

DATE.	Temperature in degrees Fahrenheit.				WEATHER.
	White.	Green.	Purple.	Black.	
March 25, 2 P. M	72	83	93	99	Bright sunlight.
" 26, 12:30 P. M	86	90	100	100	" "
" 26, 2 P. M.	86	90	98	93	" "

Whenever dew or rain occurred the cloths were taken from the thermometers and dried, to avoid the effect of unequal evaporation. It will be seen that the thermometer covered by a white cloth was frequently lower than the naked thermometer. It will also be seen that the darker the color, the higher the temperature reached. It is perhaps remarkable that the proportion of difference varied so much at different readings. By watching the thermometers for some time, it was noticed that the readings fluctuated very frequently, as the sunlight became intense or partially obscured by clouds. It was also noted that the proportional difference between the temperatures behind the different colors also fluctuated. For instance, if the sunlight began to be more intense, and the thermometers began to rise, the exposed thermometer might, at first, rise faster than the white; on the other hand, where clouds caused a sudden fall in temperature the exposed fell more rapidly than the white.

On April 2, standard thermometers were brought into use. Their bulbs and such portions of their tubes were coated with whitewash as could be covered without obscuring the readings.

The wash on one was left white, while that on the others was stained green, purple, and black, respectively, with aniline dyes. These thermometers were hung in the open air, and the following readings noted:

TIME	Temperatures in degrees Fahrenheit				WEATHER.
	White	Green	Purple	Black	
April 2, 2.00 P. M.	57½	61	66½	66½	Bright sunlight.
" 2, 3.30 P. M.	61	77	79	80½	Very br't sunl't.
" 3, 2.00 P. M.	63	70	71	71	Some haze.
" 8, 2.00 P. M.	57	70	72	72	Bright sunlight.
" 17, 12.30 P. M.	52	67½	68	68	" "

The readings of these thermometers were afterward compared with the standard in the office of the Missouri Weather

Bureau and the records may be depended upon as being accurate. Even though the proportional difference between the temperatures recorded under the different colors is not uniform, it is evident that the darker colors absorb much more heat than the lighter ones. When the sun was not shining the various thermometers registered alike. At one time, during bright sunshine, a difference of 21 degrees was recorded between the white covered and the purple covered thermometers. A difference of 10 to 15 degrees was frequently noted between these two. This is sufficient to indicate that we might expect considerable difference in the growth and time of flowering of whitened and unwhitened peach trees.

EXPENSE OF WHITENING.

The expense of whitening is not great. A common lime whitewash was at first used, but it washed off badly during rainy weather. Finally a whitewash of lime with one fifth skimmilk added to the water, was tried with much more satisfactory results. About one pound of salt was also dissolved in each bucketful of the whitewash. Four applications of this wash, applied during the winter and spring, are sufficient to keep the peach trees thoroughly whitened. The first whitening should be done early in winter, shortly before Christmas. The wash may be sprayed on with almost any kind of a spray pump. We found the Bordeaux nozzle to be satisfactory, as a solid stream could readily be turned on if the lime clogged the nozzle. The whitening should be repeated as often as the lime is washed off by rains. A good wash, however, will adhere well for weeks. The trees need two sprayings to begin with, just as wood needs two coats of paint in order to cover it well. Two subsequent sprayings are sufficient. The whitewash should be made as thick as can be sprayed through a Bordeaux nozzle. We used a small bucket spray pump and applied about one half a bucketful, to a tree, at each spraying. The time required to apply the whitewash will vary from five to ten minutes, according to the kind of pump and to the size of the trees. The more trees that are sprayed, the cheaper it can be

done per tree. Altogether, the cost need not exceed ten cents per tree for the winter.

As fungicides are more safely applied to peaches when they are dormant than when they are in leaf, we tried adding copper sulphate to the whitewash. The copper sulphate was dissolved in the liquid used to thin the lime, at the rate of one pound to ten gallons. This discolored the whitewash somewhat, and another spraying of the wash without copper sulphate was given to cover it. We are not yet ready to report on the efficacy of the winter application of fungicides for the diseases of the peach.

It should not be believed that the winter whitening of the peach will be found a reliable prevention of all classes of injuries caused by cold weather; yet, from the results already given, it is clear that it tends to check swelling of the buds on warm days of winter, and to retard blossoming in spring. We have not been able to detect any injury to the trees by this practice. Wherever peach buds are subject to winter killing by fluctuating temperatures and where their flowers are frequently killed by the late spring frosts, we suggest that whitening be tried on a small scale at least.

Baling, or drawing the branches into a bundle, tying them in the line of the central trunk of the tree and covering them with coarse grass or cornstalks, has been put to practical test in this state. Hon. N. F. Murray, vice-president of the State Horticultural Society, Oregon, Missouri, suggested this method and reported that he had fruited peaches, protected in this manner, when all unprotected trees in his orchard had their fruit buds killed.

During the winter of 1895–6 a few trees were protected in this manner at this station. The branches were drawn together by passing a rope around the head of the tree, passing the two ends through a small ring, to prevent slipping, and drawing on the two ends of the rope. Figure V shows a tree with its branches drawn together and covered. About eighty per cent of the fruit buds protected in this way were saved from injury, while only twenty per cent of unprotected buds survived the

winter. Trees covered in this way blossomed two days later than unprotected trees, and remained in bloom several days longer. The protective feature of this method is probably the shade afforded the buds.

Some of the trees were uncovered as soon as they were in full bloom. The flowers seemed to suffer somewhat from being suddenly exposed, but many of them set fruit. One tree was left covered for nearly three weeks after it came into bloom. It was found that the shaded flowers had set fruit except near the top, where the twigs were tied very tightly together, and where the covering was very dense.

With young trees this method is about as expensive as whitening, and has about the same merits as a protective measure. Old trees, with stiff branches, are not easily managed in this manner.

Shading with canvas was tried on four trees and has about the same protective value as the two methods mentioned above. Figure VI shows the trees, pruned, and covered with canvas hay cock caps, staked down at the corners.

FIGURE V. "Baled" peach tree

With young trees, headed low, hay cock covers answer this purpose very well. Old trees with high heads would require so much canvas as to render this method too expensive. Suitable canvas covers for young trees cost about fifty cents each, and will last several years.

Covering with board sheds was tried during the past two winters. Posts, seven feet long, were set between the rows of trees, just at the outer spread of the branches, after pruning.

FIGURE VI. Showing row of peach trees protected with canvas.

Rafters extended from these posts, so that they met over the center of each tree. This formed a framework over which a roof of fence boards was nailed, the boards being placed one inch apart. The walls were also boarded down three boards lower than the eaves of the roof, thus inclosing the trees in a shed.

This shedding was by far the most effective method of winter protection thus far tried. In the spring of 1896 the trees under the shed set fruit better than those protected by any other method; in fact, they seemed to suffer none whatever, from unfavorable winter conditions. The hot, dry, windy weather at the time of flowering, so severe on unprotected trees, had almost no bad effect on trees under the shed.

In the spring of 1897 the beneficial effects of the shed was even greater than in 1896. The buds did not start into growth until the normal period in spring. The flowers opened on an average four or five days later than on unprotected trees, and one day later than whitened trees. They remained in bloom

longer and set fruit far more abundantly than any other trees of the same varieties on the grounds. The growth of the young fruit was marked by greater vigor. While a fair proportion of fruit dropped or withered on unprotected trees, almost none dropped or withered on trees protected by the shed.

The expense of shedding peaches is too great for commercial purposes. The cost of the lumber for peaches four years old was two dollars per tree, and the labor of making the shed and taking it down, is eighty cents per tree. Reckoning the lumber to last ten years, which seems to be a fair estimate, the annual cost of shedding would be one dollar per tree. This renders the expense too great to be recommended except in private grounds, where one is willing to meet that expense for the sake of having fine, home grown peaches for the table, when the general peach crop fails.

If this method is to be practiced, the shed should be built after the leaves fall in autumn, and before the cold weather of winter, which may be expected about the last of December. The shed should be left in spring until the fruit has reached considerable size, and danger of frosts is over. At the Station the shed was allowed to remain over the trees until the middle of May. The trees grew better, and seemed to be benefited by its presence up to that time.

II. CULTIVATION AND MANAGEMENT OF THE PEACH.

The peach interests are so rapidly developing in this state, and the industry is proving so lucrative, that many are engaging in it, who have had but little previous experience in fruit growing. A large number of such growers, together with many amateurs, who wish to grow a few peaches for home use, write to the Station for information concerning peach culture.

To all such, it is hoped the following pages may be useful. The instructions given are based upon the results of experiments with a large number of varieties of peaches at this Station, as well as upon observations in some of the largest peach orchards in the state, and correspondence with representative peach growers.

SOIL AND LOCATION.

Generally speaking, the peach is successfully grown throughout Missouri. The Ozark Mountain region to the south, and the "loess" formation in the western and northwestern portions of the state, are perhaps the most extensive peach regions of the state, but the peach succeeds in some localities in nearly every county.

High, dry land, affording drainage of both soil and atmosphere is best. Red soil or friable loam, with loose or even gravelly subsoil, is to be preferred. Peaches are not likely to succeed well in heavy, black, clayey soil, or where there is an impervious, clayey hardpan near the surface. Avoid land that holds water.

A northern exposure is to be preferred.

Peaches often fruit on the north side of a building when those having no such protection on the south winter-kill.

Planting.—Plant in the spring just before growth begins, using one year old trees. Each peach tree needs one square rod of space. The beginner is more likely to plant too deep than too shallow. Planting so that the union where the bud was inserted shall be just below the ground, so that the variety will be thrown on its own roots, seems to have the preference. In extensive planting, hand digging may be almost wholly done away with by opening up double furrows, both ways across the field, and planting the trees in the cross-marks formed. Plant firmly.

The best varieties, named in order of their ripening, are: Southern Early, Mountain Rose, St. John, Reeves' Favorite, Champion, Family Favorite, Foster, Elberta, Mrs. Brett, Wheatland, Old Mixon Free, Old Mixon Cling, Gaylord, Crawford's Late, Stump the World, Smock, Piquette's Late, and Salway.

Of these the most profitable commercial varieties are Elberta, Salway, Mrs. Brett, Piquette's Late, and Mountain Rose, in about the order named.

There are several varieties that are much earlier than either

of these, but they rot so badly that it is best not to plant them. They are not only almost a total loss themselves, but they breed the spores of rot and may infect the later varieties.

Cultivation should be clean throughout the spring and early summer. The ground should be stirred deep enough in spring to loosen up a deep, spongy layer of earth, capable of holding a large quantity of moisture. Then the moisture that comes up into this layer, later on, should be retained there by stirring the surface often enough to keep a loose dust mulch on top. Cultivation should cease early enough to permit the new wood to thoroughly ripen for winter. To neglect cultivating, for a time, in summer, and then to resume it late the same summer may injure the trees by producing a late spongy growth. If any crop is to be planted between the rows, it should be something that admits of thorough cultivation. A peach orchard should not be seeded to grain or grass.

Pruning should be done mainly in winter. The trees should be headed about one foot from the ground. The new wood should be cut back one third to one half each winter. This induces a stronger wood growth and lessens the amount of the necessary thinning of the fruit. In winters when the fruit buds are killed, or, for any cause, a crop of fruit is not going to be produced, the trees may be cut back to two year old or even three year old wood, provided this wood is in healthy, bright, vigorous condition. Judiciously done, this brings the future bearing wood nearer the ground and induces the formation of more vigorous branches. Judgment should be used, however, in this severe cutting back. If the branches are cut back too severely, particularly into old, bare branches with thick shelly bark, the tree may fail to make good growth. Where possible, spurs of comparatively new wood should be left, as buds do not readily start from old wood, below where any new shoots are formed.

Thinning the fruit is of importance, where heavy crops set. This should be done in late spring or early summer, before the fruit has attained much size. The young peaches should be thinned to six inches apart. This increases the size,

appearance and quality of the fruit, conserves the vigor of the tree, and does not materially lessen the actual measure of fruit produced.

Picking should be done when the fruit is well colored but before it becomes soft. Padded baskets should be used and every care should be taken not to bruise the fruit. Bruised or softened fruit will not stand shipping and will not keep.

Protection against borers is afforded by placing thin wooden wrappers around the trunks, at the time of planting, and filling the hole at the top of the wrappers with cotton or some such material. Young trees, treated in this way, make better growth than unprotected trees. These wrappers prevent excessive evaporation from the wood while the young tree is getting established. These wrappers should be removed every autumn, any borers that may have gotten in should be removed with a sharp knife or wire, and the wrappers replaced.

Protection against rot is best secured by not planting the very early varieties which rot badly. Many growers say the Mountain Rose is the earliest peach that is sufficiently free from rot to be profitable. At this Station Southern Early (a few days earlier than Mountain Rose) has fruited heavily, is of good quality, and does not rot badly.

Spraying with dilute Bordeaux mixture has reduced the rot one half in Hale's Early at the Station, without injuring the foliage. The strength used, except for the first spraying, was two pounds of copper sulphate, three pounds lime and fifty gallons of water. The first spraying was done just before the buds started in spring, using double the above strength. The subsequent sprayings were of the two pound solution mentioned. The second spraying was done just before the flower buds opened, but while they showed a pink color; the third, shortly after the flowers fell, and the fourth just after the fruit was gathered, to kill any spores that formed during the ripening of the fruit.

In some parts of the state this spray has injured peach foliage badly, hence, if used at all, it should be used with caution, and only after thorough trial on a few trees. The injury

may not show for three weeks after the application of the fungicide.

The first application, *while the buds are entirely dormant*, has never been known to injure the peach. If whitening the buds is practiced for winter protection, the addition of copper sulphate to the whitewash, at the rate of one pound to ten gallons, undoubtedly has a fungicidal value. The Station will be able to report more fully upon this, later. In adding copper sulphate to the whitewash, the slaked lime should become cool before the dissolved copper sulphate is added.

Fertilizers.—Unleached wood ashes applied at the rate of 800 or 1,000 pounds per acre, or 100 pounds of muriate of potash or 400 pounds of kainit, per acre, will prove beneficial in most cases to peaches. An application of 200 to 300 pounds of finely ground raw bone or bone meal, per acre, is also good, although it will prove more beneficial if applied with one of the forms of potash mentioned above.

These fertilizers should be applied in spring, at the time of the first cultivation, so they may be worked into the soil at that time. The fertilizer should be sown broadcast in a circle under each tree, so that it reaches just beyond the outer spread of the branches, and not nearer the trunk of the tree than two feet. Cowpeas grown between the rows and plowed under, the next spring, have given good returns at comparatively small cost.

Purchasing trees for planting.—Peach yellows, prevalent in many of the eastern states, is gradually spreading westward. The Rosette has a foothold in several states. Missouri is, at present, practically free from these two fatal diseases of the peach. During the past year, however, a few isolated cases of these diseases have been found in this state, and the owners of the infected trees have taken immediate steps to destroy them, and thus stamp out the disease. In each case, these diseased trees had been purchased outside the state of Missouri.

In order to guard against the introduction of these diseases, as well as against fraud by irresponsible agents, nursery stock

should be purchased from home nurserymen. The attention of the Station is frequently called to fraudulent practices of irresponsible agents. Such men, who have no regular place of business, and who represent no responsible firm, sometimes offer for sale, at exorbitant prices, young trees, for which they claim superior merit. "Grafted trees instead of budded" or "budded instead of grafted," and trees "worked on hardy almond" or "plum" are some of the phrases used to deceive the planter who is unacquainted with the methods used in propagating the peach.

Your home nurseryman, who has a regular place of business and a reputation to sustain, is more likely to sell reliable trees, than is the agent, who has no such place of business.