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# WINTER INJURY OF FRUIT IN MISSOURI

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For the fruit grower, Missouri is still a border state. Splendid as are the opportunities offered in this state through favorable soils and ready markets, certain characteristics of the climate involve even more nicety of adjustment in the management of fruit plantations than is necessary to the north or to the south.

The northern grower knows that his trees or vines will be exposed every winter to severe cold and as summer closes he shapes his treatment of them to favor maturity, which is his best preventive of injury from cold. Warm mid-winter weather disturbs his calculations but little, for he gets little of it. He has more to fear from moderate cold in early winter than from more rigorous cold later. To guard against it he tries to prevent late growth in his trees.

The southern grower does not need to guard very carefully against cold early in the winter, for it rarely reaches him. His great fear is a period of warm weather in January or February. Only a little of this will start the peach buds into development, invisible externally unless possibly revealed by a certain swelling of the buds, but making them much more tender. In this stage a very moderate amount of freezing will kill them. They may survive considerable cold in December only to perish in milder weather in February. To prevent this premature starting of the buds, the southern grower prolongs growth late into the fall. Trees that grow vigorously late in the season are not so likely to start unduly early the next year and are, in southern regions, less likely to suffer from winter injury.

## MISSOURI'S INTERMEDIATE POSITION

Between these regions lies Missouri. On the north is a state that is, in the main, too cold for peaches, where early maturity is all important to the fruit grower, where clean cultivation is dangerous because it induces late growth and consequent winter injury. On the south is a cotton state, where the currant is almost unknown and the raspberry rarer than the peach is in the northern neighbor, and where premature development of the buds is the grower's chief fear.

In Missouri these regions meet. They do more: they overlap. A

Missouri winter may be as mild as that of tidewater Virginia or colder than the Niagara peach belt. The same winter—even the same week—may bring warm air from the south and bitter cold from the north. Fruit plantations are subject to injuries from early cold, from intense cold and from moderate cold following warm weather. If the fruit grower strives to attain early maturity to guard against early cold and intense cold he invites injury from premature starting; if he cultivates late to guard against the latter, he invites injury from the former.

### INVESTIGATIONS

It is not strange, therefore, that for many years the Horticultural Department of the Missouri Agricultural Experiment Station has considered investigations on hardiness to be among its most important activities and that some of its most outstanding research has been in this or intimately related fields. The work of Chandler showing the practicability of guarding against certain forms of injury by cultural practices has become common knowledge. The work of Hooker and of Rosa showing the real basis of hardiness, is bound to be of great convenience in further investigation and shows that hardiness is a condition, rather than a quality. Howard's work has shed much light on some very practical problems in a common type of winter injury.

Many questions relating to hardiness are yet unanswered. Nevertheless a considerable fund of information has been accumulated from investigations and experience within and without the state. Some of this is already widely diffused. Growers in general understand the danger to peach buds from premature development in the winter; this condition and the measures to correct it by prolonging growth and deferring the beginning of the rest period need not be detailed here.

### IMMATURITY INJURIES

Less conspicuous, slower in fruition and in some respects more complicated, the injuries from immaturity are less generally understood. In some cases the damage is recognized, but given some other name and the underlying cause not understood.

### CROWN ROT

A tree does not mature simultaneously in all its parts. The maturing processes generally set in somewhere in the branches and progress in both directions. The crown, that is, the part of the trunk near the ground, the crotches and the tips of the branches mature last. Consequently a sharp autumnal or early winter freeze may find part of the tree hardy, because mature, and other parts tender, because immature. Crown rot in Grimes and crown rot and crotch injury in Stayman Winesap are frequently noted, though the connection with winter injury is not generally appreciated.

A small amount of killing of bark or wood is not in itself a serious

matter. It may check the vigor of the tree somewhat and still pass unnoticed for several years. If the area involved is small it may become covered in by new growth and no real harm come from it. More frequently, however, a complication, slow in its operation but serious in its consequences, sets in. Certain fungi start growth upon the dead tissue, thus gaining entrance to the tree and once established they frequently invade sound wood and some even attack live wood. Then their growth is limited only by the growth of the tree. As the tree grows the fungus advances, eating out the wood and making the hollow-hearted or "punk" tree or limb. If the tree slackens in growth the fungus gains; if the tree bears a heavy crop, a combination of rain, wind and crop is likely to cause the breaking of a branch or the trunk.

It is the fungus that does the damage but winter injury supplies the dead tissue which enables the fungus to gain a foothold. Without the winter injury the fungus attack would not have been possible. Bad as the attacks of blister canker and similar fungi undoubtedly are, they are sometimes blamed for the work of other fungi that follow winter injury.

### BLOSSOM INJURY

During the past winter, a rather extensive killing of blossom buds, clearly traceable to an immature condition of the trees, occurred in the Jonathans at Columbia. The blossoms within the buds were killed, but the leafy parts of the same buds survived. This form of injury has not heretofore been reported outside of Montana; but, since it is detected only by very careful examination, it seems probable that it may be a rather common occurrence and may explain some cases of supposed failure of apple trees to form fruit buds when they should. One point, in this connection should be emphasized: that is the difference between this type of bud killing and that found in the peach. In the latter fruit the cause of killing in this section is generally premature starting from dormancy; in the apple the injury occurred before Christmas and all indications point to immaturity as the chief factor.

### INJURIES TO NURSERY STOCK

Nursery stock is particularly subject to winter injury. Here again the difficulty is that the injury is frequently not great enough to kill the trees outright, but the consequences are often of great importance. Two rather typical instances may be cited.

In the spring of 1920 a block of 40 acres in Boone County was set to apple trees. The varieties ordered were Jonathan, Winesap, Rome and Wealthy. The trees were received in the spring. At the time of planting a discoloration of the roots of the Winesap was very noticeable. The outer wood was bluish black. The worst cases were rejected and the milder cases planted. The following summer was not particularly hard on young trees, but the percentage of deaths in these Winesap trees was far greater than that in the other varieties.

The history of the trees prior to delivery was not learned. How-

ever, the trouble was not confined to this particular lot of trees; consequently it undoubtedly occurred before the trees were shipped from the nursery.

Weather conditions in this section are not ordinarily severe enough to produce root injury of the type found in this case in trees standing in the nursery row. A rather prolonged period of intense cold with little or no snow covering is necessary for this, because the soil protects the roots so that as trees stand in the nursery the tops are far more tender. Once the trees are dug, however, conditions are reversed and the roots become the most tender part. They are killed at temperatures only a little below freezing. Consequently it seems probable that the injury in this case was received after the trees were dug and before they were shipped. A slight frost in the field or a slight freeze in the storage shed would have been sufficient to inflict the injury described here.

The fact that Winesaps alone were injured in this case probably does not mean that this variety makes the roots on which it is worked more tender but rather that only the particular lot from which these trees were taken was exposed to damaging conditions.

Another case of injury to nursery stock has come to the attention of this Station. In this instance the roots were not injured; consequently the injury must have occurred in the nursery before the trees were dug. This injury occurred some time in the winter of 1917-1918, possibly in October with a temperature no lower than 20°F. The only evidence of its occurrence was a slight discoloration of the wood, affecting several varieties alike and involving upwards of 1500 trees. It was noticed at the time of planting but not considered serious enough to do any harm. So it undoubtedly would have proved had not infection occurred at the points where injured tissue was exposed in pruning.

The nature of the fungus infecting these wounds has been stated in connection with the discussion of crown rot and crotch injury. In this case its development was slow at first and the trees grew vigorously. However, as it gradually invaded new tissue a limb here and there died and pruning wounds failed to heal. It was only when these manifestations appeared that the infection became known. The procedure carried out to remedy this condition, involved cutting these trees back to unaffected tissue—in many cases close to the ground—and grafting. The grafts seemed to secure more rapid rejuvenation than would be secured from sprouts.

This treatment sacrificed the growth of four seasons in the orchard. It was, however, the only way in which perfectly sound trees could be assured. Without it the trees would have lived to bear a few crops, but their tenure would have been short.

### INJURIES TO THE RASPBERRY

The raspberry presents two curious paradoxes. A native of northern states, hardy in the north, it suffers more or less every year from winter injury in Missouri. Furthermore, though the growing season in Missouri is longer than it is in many sections where the raspberry is hardy, this

fruit suffers from immaturity. Therein lies the difficulty. Missouri growing seasons are, perhaps, too long for this fruit. The raspberry is adjusted to a shorter, cooler growing season. In the heat and dryness of midsummer it stops growing and then, with the cooler and moister weather of September it resumes growth. The canes are frequently more mature in August than they are in October, and unless the autumn changes very gradually into winter they are likely to be exposed to injurious cold before they have reached a resistant condition.

The standard preventive of immaturity in northern states is early cessation of cultivation or complete abandonment of the practice in favor of some sort of sod management. Whether this holds true for Missouri is not clear. It certainly is not true in the raspberry. Fall blossoming is certainly more common in trees standing in locations such that they mature early and resume growth in wet autumns. Cultivation should be suspended no more than is necessary during picking. Every effort that will prolong the first growth diminishes the probability of extensive second growth.

Even in New York, with a shorter growing season, it has been found that under some circumstances shoots produced after the first shoots had been cut off close to the ground early in the growing season withstood the winter better than the first growth shoots on unpruned plants. Experimental evidence to this effect is unfortunately lacking at present in Missouri. It seems, however, that this possibility may have even wider application in Missouri. Ordinarily there are two periods of cane growth here; the first produces shoots which mature early and often resume growth only to be injured because immature; the second produces shoots which start growth too late to mature. The problem evidently is either to produce shoots starting between these two periods and to force them into sufficient growth to be productive or else to prolong the growth of the first shoots sufficiently to prevent their second growth.

### SUN SCALD

On the southwest sides of many trees are found areas of dead bark. This particular type of injury is generally due to heating from sunshine during the warmest hours of the day, followed by a rapid fall in temperature during the night. This change may be extensive—from 70° or 80°F. to below freezing—and rapid. In this case it is the speed of the change that is injurious. The southwest side is most involved because it is the side where the change is greatest and most rapid. This injury is more likely to occur in late winter, though it may occur in the fall and a similar killing has been observed in young trees during the summer, merely from excessive heat. Trees from three to eight years of age seem most subject to this injury.

By itself this injury interferes somewhat with the movement of sap. Of greater importance is the entrance it offers to fungi of the type mentioned as concerned with crown rot. Many cases of hollow heart can be traced to this beginning.

Prevention can be accomplished in two ways: (1) a piece of board driven into the ground so that it will shade the southwest side of the trunk from noon till three o'clock, (2) low heading so that the top will afford at least partial shade. Whitewashing is equally helpful, but requires frequent renewal.

### RELATIVE PROBABILITIES

It is evident that numerous forms of winter injury are possible, or even likely, in Missouri. Fortunately they do not ordinarily present themselves simultaneously or in any one fruit. South of the Missouri River the problem is prevailingly one of preventing premature development after midwinter. Northward from the river immaturity becomes increasingly important. With the peach premature development is the greatest danger; with the apple, immaturity. As the two fruits grow in close proximity in the University orchard at Columbia, the peach seems actually to suffer less from immaturity injuries in the ordinary winter than the apple.

Occasionally, it is true, this section will be visited by winters of extreme cold, such as that of 1911-1912 or 1917-1918. In such winters the peach tree that has been forced to late growth will suffer more than the apple, and the injury is more lasting than the mere destruction of a single crop by killing of the buds, characteristic of the other type of winter. However, the framework of the peach tree is less permanent than that of the apple. It is cut back heavily and is normally short lived. Furthermore the chances of such severe injury from Columbia south are less than the chances of loss of fruit buds from premature development.

From the Missouri River northward, however, the probabilities shift. The chances of immaturity injury rather overbalance those of the other sort. Along the Missouri River, the chances of injury appear about equal. At Columbia some blossoms survived the winter eight years in thirteen. But in addition, spring frosts caught some of those crops that survived the winter. This particular region must be considered a no-man's land for peach production. In it there is possibility of great reward, but the danger is great. There is prospect of the production by breeding of a peach that will remain dormant until late winter, but that is of little help to the present grower.

For the apple grower the great consideration is maturity. His trees are not likely to be killed outright and he is therefore likely to ignore the minor injuries that may have grave consequences. Preventive methods are best, but remedial measures are often necessary.

### PREVENTIVE METHODS

Preventive methods are largely cultural. In the case of the Grimes, however, the grower is warranted in an additional precaution. This variety is much more subject to crown or collar rot than most other varieties; consequently the man who intends to grow it should plant something else and later graft over to Grimes. The ideal stock for this pur-

pose is yet to be determined. Delicious is used rather extensively and with apparently good results, but until its resistance to blister canker is more definitely established it cannot be given an unqualified recommendation. Northern Spy has been found unsatisfactory in the lighter soils, but in rather heavy soil it is reported as making a very satisfactory stock. In the University orchard at Columbia, on a rather heavy loam, it is rather outgrown by Ben Davis grafted in it. Minkler seems worthy of trial as a stock. Double-worked Grimes trees are now offered for sale by some nurseries. These have a seedling root, resistant collar and Grimes tops and of course need no grafting after they are set. Naturally they cost more than ordinary trees. It is probable that Stayman could be more advantageously grown in a similar manner.

### REMEDIAL METHODS

Remedial measures, invoked after the damage is done, are based on one principle, to wit: injured wood should not be exposed. If the injury is confined to the tips the injured wood may be cut away, taking precaution that the cut surface exposes no injured tissue. Wounds that will require much time in healing should be protected. If the injury is so general that removal of the injured wood is impossible, pruning should be suspended until cuts can be made into new growth produced after the freeze. In practice this will be difficult, for no matter how long it is delayed, whenever pruning is resumed some branches will be inadvertently cut back to injured wood. In these cases the wounds should be protected. It should be remembered that so long as the injured wood is sealed tight within sound wood it is harmless and that whenever it is exposed it is a culture medium for a growth that may ultimately destroy the tree.