series and Northern Spy. The objective of this work was to develop a series which were resistant to root aphids. Since they are highly resistant to the insect, this series should be of interest to any nurseryman where root aphids are a problem. The fruiting characteristics are probably not superior to that of the EM series.

The outstanding one is MM 104. It has about the same vigor as EM II but it bears earlier and gives a heavier crop during the first ten years in the orchard. It is not a small dwarf tree. None of the MM series will develop a tree as small as EM IX or EM VII. In Germany, it was found that these stocks are extremely tender. In preliminary trials at Ottawa, the MM rootstocks have shown considerable winter injury.

MR. HESS: Have the Paradise and Doucin apples, which were formerly used in Europe, been discarded?

MR. BLAIR: They have not been discarded. EM II is Doucin "English Paradise" and is one of the most widely used in England. EM I is Broad-leaf "English Paradise." These European rootstocks have been classified at the East Malling Station and are now known as the EM series.

PRESIDENT FILLMORE: This afternoon we have with us, Mr. R. C. Simpson of the Simpson Orchard Company, Vincennes, Indiana. Mr Simpson has had a long experience in the propagation and production of ornamental crabs. He was educated at Purdue University, but this afternoon he is going to give a practical talk on the propagation of apples by budding and grafting.

Mr. Simpson presented his talk, entitled "The Propagation of *Malus* by Budding and Grafting." (Applause)

THE PROPAGATION OF MALUS BY BUDDING AND GRAFTING

ROBERT C. SIMPSON
Simpson Orchard Company
Vincennes, Indiana

Propagation of horticultural plants by budding and grafting is one of the oldest horticultural practices. In ancient Greece the technique was well known and stock and scion effects noted. Today the actual mechanics are commonly known and relatively simple. Results, however, may depend upon a long series of factors.

First I will briefly outline our operation, then mention some of the problems we have encountered. Finally I will go over some of the points we think we have learned. And may I add, I do not presume to speak as an authority, only as one intensely interested in the subject. There are many present who have had more years of experience. If I draw conclusions they know to be in error, I and the rest present will welcome correction.

Our understocks are ordered on a five year basis to obtain a price discount, with minor seasonal adjustments made usually by July. The understocks arrive in January or early February. These are unpacked,

the roots pruned to 3 or 4 inches, any low branches or double stems removed and, if possible, buds near the crown rubbed off. Most apple buds lie too close to be removed. Plum and mahaleb often have prominent buds which if not rubbed off, will later cause branching in the area to be budded. The seedlings for budding are then repacked and stored till planting time. Seedlings for root grafts may be branch rooted or straight rooted. The latter are not root pruned of course. For apple and crab the whip or tongue graft gives a firm union. We match root and scion as closely as possible for diameter, bind the union with grafting tape and dip the scion in a special dip wax we make up. The grafts are then stored until planting time.

Our grafts are planted 6" by 6" in raised beds in a lath house. We have secured much greater growth and losses have been far less than with field planted grafts. The more vigorous varieties usually make four to six foot whips the first season, twice the growth of plants grown in full sun. After one season the grafts are sold or lined out in the field similarly to the understocks for budding.

Seedlings for summer budding are set in the field as early in the spring as possible. We use a two row trencher to permit two row cultivation. Cultivation time is reduced and only alternate middles are compacted by the tractor wheels. The seedlings are set by hand, the soil pressed with the feet and then firmed hard by a heavy packer that has been in use well over 50 years. If properly packed they cannot be pulled up without stripping the roots from the seedling.

It is important that the seedlings be kept growing vigorously. Cultivation after every rain is the rule, with hand hoeing as needed. The trees are sprayed three or four times at two to three week intervals beginning about June 1; after that, only as often as necessary to control caterpillars and green aphids. Ferbam is used until danger of scab is past. DDT, BHC and a spreader are used throughout the season for wooly aphids, green aphids and caterpillars.

Budding is done in late August or early September, late enough that few if any buds will start growth before winter. The trees are cut back to the bud in early March. Where the bud stand has been poor, the trees are inspected and those with live buds marked for cutting. The others are not cut back but rebudded as soon as the bark will peel, dormant buds from stored scions being used. In about two weeks these seedling tops are cut back severely. As soon as the buds have united or show signs of growth, the remainder of the seedling top is removed.

Careful cultivation and hoeing is necessary as young crab shoots are very easily broken loose at the union. Most varieties must be staked to prevent possible heavy losses from wind and beating rain. This is done as the new growth reaches a height of eight to ten inches. A few varieties as Hopa and Eley are not as easily broken off and need not be staked. Neither do the native types as Bechtel's and Charlotte. These are flexible and bend with the wind where most other crab varieties quickly stiffen and are easily broken from the seedling stub. Scheidecker is one of the worst for this. A few varieties must be staked as high as four feet to maintain an upright head and straight stem.

Many crab varieties continue to grow until after several hard freezes so our crabs are the last stock to be dug. An ancient digger, once

pulled by some ten or fifteen teams is now pulled by tractor and 200 foot cables. One and sometimes two men with spades assist when trees are pulled. This is more costly but saves broken roots and branches. The trees are tied in bundles as large as can be handled conveniently and hauled to storage for grading during the winter.

To facilitate field handling and prevent mixtures at digging time, all trees are carefully checked for variety and paint coded with distinct colors of enamel. Thus each tree carries its own label and makes handling easier and more accurate. Even if there should have rapid and accurate separation possible at digging time. This coding is extremely important and is never delegated to any of the help.

The graded trees are held in refrigerated storage until the end of the shipping season. Usually those unsold are re-planted 3 feet apart in 4 foot rows for growing on to larger sizes.

PROBLEMS

Before discussing some of the things we have learned about propagation of crabs, I would like to go over some of the problems in budding or grafting the crabs.

For grafting, the wood of some varieties is very slender. Others produce many spurs and only short terminal shoots. Thus ample scion wood of desirable size may be a problem.

For budding; the crabs pose a number of problems. With many varieties the wood is hard, the bark very thin or the scions very slender. Some crabs have a hard hump beneath the bud making it difficult to make a proper cut. Others have a depression beneath the bud so it is difficult to get enough tissue beneath the bud without cutting too much wood above and below the bud. Buds and leaf petioles vary greatly in size, making some very tedious to handle.

Some varieties for us have given consistently poor stands, or a good stand one year and a very poor one the next. Katherine has always been difficult and Dorothea variable from year to year. What we have obtained as Jay Darling has given such extremely poor stands each of four years that we dropped it. We have not been able to determine why apparently excellent scions of Katherine and Dorothea have been so unpredictable.

If budded early in the season some crab varieties start growth, before winter usually in a horizontal direction. This may produce crooked shanks the next year.

The manner of growth of some varieties makes selection of good buds a problem. Some of the native types like Prince Georges produce many short spurs and terminals of only a few buds which do not mature until very late. Katherine continues to grow until late in the season with long shoots and soft immature wood. Some kinds produce slender, willowy growths as Parkman. Branches of Tanner are little larger than a straw with very close-set buds.

Something resembling blight may kill the new growth when 12 to 18 inches in height. We have had this with Katherine, astrosanguinea and a few others. Pathologists at Purdue found no fire blight infection and suggested delayed winter injury.

Some crabs grow slowly and tend to force numerous suckers from deep roots as well as just below the bud. Sargent is one of the worst. With grafts the root is relatively weaker and there is less suckering.

Some varieties tend to produce only a whip the first year and few branches later. They do not respond well to tipping. This is true of Van Eseltine, baccata Jacki and spectabilis Riversi.

The wood of many crabs is very brittle. Special care is necessary at all times after the wood has hardened or trees will be marred by loss of branches which tend to tear out part of the main stem. Dorothea, Scheidecker and floribunda are among these.

Most budded crabs must be staked from the time they are 12 to 14 inches high. The stem stiffens rapidly close behind the growing tip long before a union is established at the base. Strong winds, driving rain, or brushing by cultivator or hoe handle will cause the shoot to break away. This has been one of our most serious causes of losses, even with staked trees. We do not stake Hopa, Eley and the native types as they unite firmly and the new growth is more flexible. Scheidecker may go down nearly 100% if not staked.

Wooly aphids and accompanying hairy root condition are a problem. Unless woolly aphids are controlled losses from culling may run to 75%. BHC is the most effective spray but it must be applied thoroughly with some running down around the base of the trees. Since adopting this schedule we rarely find serious root injury.

Apple seedlings are very susceptible to attack by blue mold, especially if held in a poorly ventilated common storage or cellar. This will continue to develop after the understocks are planted, finally rotting most of the deeper roots. Puratized is a safe and effective eradicant.

WHAT WE THINK WE HAVE LEARNED

Some basic points need merely be mentioned. Use of healthy vigorous scion wood, healthy disease free understocks, and true to name sources need no discussion.

There are four common propagation methods for the crabs: root grafting, top working, spring budding with dormant buds and summer budding.

Scions for grafting are best selected early in the winter before warm spells have started any development. These keep best if coated with a flexible dip wax, and must be kept dormant. The dip wax formula we like best is that of Ohio State University (Bulletin 510) of rosin, linseed oil and paraffin. Properly applied this is very adhesive, comparatively flexible and yet not sticky. It will not flake off unless applied to cool or to damp scions. Once dormant scions so treated were left in a storage cellar all one summer and still showed green bark the following spring, a full year after collection.

For topworking established trees we use dipped scions. The cleft or cut surface is sealed with hand wax. For coating large stubs we have found asphalt emulsion roofing paint much the best. It is non-toxic and adheres to the moist, freshly cut wood. When smaller limbs are whip grafted, a much smoother union is obtained if budding rubbers are used to bind the stock and scion lips before the hand wax is applied. Trow-

bridge prepared wax is very adhesive, is transparent, and the clearly visible rubber band can later be cut through the wax.

For whole root or crown gratting, branch rooted seedlings are preferred. These will produce more uniform and vigorous trees with better branched roots. Straight rooted seedlings are an advantage where understocks are limited or expensive or where trees are desired on their own root and shorter scion will give more growth the first year. A scion with roots will result in greater variation in initial tree size. These trees also will have deeper roots with less side branching. A long scion and short piece root is used where trees are desired on their own roots. A longer root and shorter scion will give more growth the first year. A scion with two or three buds above the graft union is adequate. An overall length for the completed graft should be around eight inches. The stem diameter varies greatly at and just above the seedling crown permitting variation of cut for more accurate matching of stock and scion. This in turn gives a cleaner union.

For grafting, No. 1 seedlings 3/16 to 1/4 inch in caliper are about right for crab and apple grafts. For field budding the 1/4 inch up size will develop into larger trees. The size of seedling at budding time has a direct relation to the size tree it will produce.

Dormant budding is done as early in the spring as the bark will peel. We prefer to use the waxed scions as the stiff coating prevents damage to the bud as it is inserted. Drying out is also reduced to a minimum. The seedling tops are cut back one half within about ten days, and removed entirely as soon as the inserted bud begins to break or has had time to unite with the stock. Some varieties will not start until the top is completely removed while others will. The dormant bud shield is cut with a little more wood than for summer budding and inserted in the same T-shaped cut.

Summer budding is the simplest, most rapid method of propagating the crabs and produces the largest trees most quickly. With good soil, a favorable season and a reasonably vigorous variety it is possible to produce many well branched one year trees in the 5 to 6 foot size. This is because the one year top has a three year root system. Usually a root graft requires three years to reach the same size, perhaps longer.

For field budding we prefer apple to Hopa seedlings. For us the Hopa seedlings have been much more variable in every respect. Seedlings with purple wood are too easily confused with purple wooded varities. Good apple seedlings are much more uniform and the shoots from below the bud not easily confused with the variety. Where extreme hardiness is a factor, Hopa seedlings may be superior.

Selection of bud wood is important. All important of course is use of stock true to name. Wood from one year trees in the nursery row has given good results in some cases but wood from older trees is desirable and ripens earlier. Whether the scion buds are fruiting or vegetative seems unimportant.

Best buds come from the middle two thirds of current seasons wood. Buds from near the base are usually smaller, less easily inserted and often start out at a wider angle. If shoot growth has terminated and begun to harden, good results may be obtained from buds as near the tip as a good cut can be made. With thicker barked crabs having buds more like the

commercial apple, good results can be secured by shucking the buds. With thin barked varieties of the floribunda type it is better to cut a shield to include some wood. Our problem varieties have been those with small or sunken buds, thin bark and hard wood. Among these are floribunda, atrosanguinea, hupehensis, Parkman, Scheideckeri and Katherine. In most cases varieties with softer wood, larger buds, thicker leaf petioles, and thick bark have given the best stands. In this class are such varieties as Almey, Eley, Hopa, Crimson Brilliant, spectabilis and the native forms. Varieties such as Zumi, calocarpa and Sargenti must be cut with a very short nosed or small shield because of the hard bump beneath the bud.

The proper side of the seedling to bud is debateable. For mechanical reasons the bud should be inserted on the side toward prevailing winds as the developing shoot is more likely to be loosened by wind or rain. Buds receiving very hot sunshine after insertion or during the winter may be injured where buds to the north are protected from extremes of temperature and sudden changes. If buds are placed in line with the row the new shoots are more easily lost during hoeing, those toward the middle by cultivation. The west or north-west side would seem best with rows running roughly east and west.

Staking is a necessity with most crab varieties. We once lost 90 per cent of our Scheideckeri and micromalus from a driving rain while adjoining rows of Hopa, Eley and Arnold suffered only occasional losses. Staking must be done by the time the shoots are high enough to be tied, or about 12 inches. Number eight wire stakes 30 inches long are adequate. We have found the round "Plant Ties" better than "Twist-Ems." The ends of these are so wrapped around the stake that they can be pulled loose and raised as the shoot grows. A permanent twist is made when the tie nears the top of the stake or at about 18 inches.

Some varieties require use of five foot stakes in order to secure a reasonably upright stem. Among these are Bob White, Katherine, floribunda, Parkman and hupehensis. Otherwise they lean badly from the 18 inch tie.

Why some varieties are so difficult we have not been able to determine. Katherine has always been difficult, whether buds, root grafts or topworked. This year we had a very poor stand and re-budded. These later buds were still alive in early November but no union had taken place. Dorothea and Scheideckeri in one field were 60 per cent alive while in another field nearly all buds had taken. Weather and soil undoubtedly play a part as does the type of scion and the skill of the budder. Variety, however, is an even greater factor.

In concluding, the actual mechanics of budding and grafting the crabs is simple and results with many varieties no problem. Unfortunately two of the fine new varieties, Dorothea and Katherine are among the difficult ones. The crabs are peculiar in the great variation in characteristics of the scion wood. Budding or grafting becomes an entirely different problem as one changes from variety to variety.

I have not mentioned propagation by stem or root cuttings. I feel sure some of the crabs can be propagated in this manner. Eleyi for instance will root above the bud union if planted deep and probably if

mounded heavily. Hopa similarly planted has never produced scion root for us. Once on its own roots, root cuttings should be possible.

Again I would like to mention the great advantage of using a paint code where large numbers of trees in many varieties must be handled. We dig, bunch and store some forty varieties of crabs. Labels are seldom used until final grading when variety and size are indicated.

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PRESIDENT FILLMORE: Thank you, Mr. Simpson. It takes years of experience and observation to be able to talk like that. Are there any questions for Mr. Simpson?

MR. GERALD H. VERKADE (Verkade's Nursery, New London, Conn.): Did I understand you to say that you dip the budding scions in wax?

MR. SIMPSON: We use wax for dormant buds only. We do not use it for summer budding.

MR. VERKADE: I know you graft cherries. What do you tie cherries with?

MR. SIMPSON: We just use regular banding rubbers on everything for summer budding. We try to wrap them instead of tying. If you don't pull too hard, you can practically seal them. By properly putting the rubbers on, you can practically make an airtight seal.

MR. VERKADE: When do you bud the cherries?

MR. SIMPSON: In August.

MR. CARL E. KERN (Wyoming Nurseries, Cincinnati, Ohio): Do you use apple understock for grafting Bechtel's crab?

MR. SIMPSON: Yes, we do.

MR. KERN: Most nurseries will bud or graft Bechtel's crab on a common apple seedling. This is a mistake because the two are incompatible. From experience, I know that when the Bechtel's crab gets older, it forms a bowl, and at the end of ten or fifteen years the plant will blow over.

MR. SIMPSON: We have had one in the yard for twenty years. The top wants to sucker. We have to keep cutting the suckers off at the ground. The reason we don't grow it is because it is susceptible to disease.

MR. CONSTANT DE GROOT (Sheridan Nurseries, Sheridan, Ont.): Bechtel's crab or *M. ioensis,* is related to Dorothea, that is why he hasn't obtained results.

MR. SIMPSON: I believe that according to Wyman's "Crabapples in America," it is *M. floribunda.* It is not *M. ioensis.*

MR. LOUIS VANDERBROOK (Vanderbrook's Nursery, Manchester, Conn.): How do you prevent rabbit damage on the crabs?

MR. SIMPSON: If the rabbits chew them it is usually above the bud. We use a full strength lime sulphur paint on the stems. We haven't had trouble.

MR. WILLIAM FLEMER III (Princeton Nurseries, Princeton, N.J.): We had the same trouble with Katherine until we started budding it and Dorothea on *M. baccata*. They take very well and grow vigorously. The same with *M. ionensis* 23. When you bud on *M. ionensis* and *M. corneria* seedlings, which are American types, they grow at least a third larger in a given length of time.

MR. SIMPSON: I have not tried that, however I will.

MR. ROSCOE FILLMORE: We have a lot of complaint from our customers that it takes too many years to bring plants into bloom when they are on Dorothea. What is the reason?

MR. SIMPSON: I would guess that it has to do with vigor and growth. I am merely going by observations in this case. With Dorothea, if you have a strong stock, we can count on one-year trees blooming well. Dorothea, Katherine, and probably Scheidecker, are outstanding. You can count on almost 100 percent blooming. Van Ess is another one that blooms very freely as a one-year whip.

MR. ROGER COGGESHALL (Arnold Arboretum, Jamaica Plains, Mass.): At the arboretum, we use *M. baccata* understock for budding Dorothea and the take is almost perfect. Also the plants set flower buds the second year from budding.

PRESIDENT FILLMORE: I should like to take this opportunity to thank the Moderator, Mr. Blair, and the other speakers, Dr. Nelson and Mr. Simpson, for the excellent roundtable discussion of Malus propagation. The meeting is adjourned until 8:00 P.M. this evening.

PLANT PROPAGATION QUESTION BOX

FRIDAY EVENING SESSION

December 16, 1955

The Plant Propagation Question Box Session of the Fifth Annual Meeting convened at 8:00 P.M. Mr. Louis C. Vanderbrook, Vanderbrook Nurseries, Manchester, Conn., was the moderator for the evening.

The transcript of this successful session of the annual Meeting is not included in the Proceedings.