GRAPE STOCKS FOR AMERICAN GRAPES

U. P. HEDRICK

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GRAPE STOCKS FOR AMERICAN GRAPES.

U. P. HEDRICK.

SUMMARY.

Different species of grapes show wide variations in adaptability to natural and cultural conditions. Cannot grape-growers take advantage of these variations and graft varieties that fail under some conditions on roots of those that thrive under the same conditions?

The possibility of improving the viticulture of New York by such grafting was the inspiration of an experiment at this Station to test various root stocks for the best varieties of American grapes.

In this experiment three groups of varieties have been grafted on St. George, Riparia Gloire and Clevener stocks and a fourth group on their own roots. The varieties grafted on these stocks were: Agawam, Barry, Brighton, Brilliant, Campbell Early, Catawba, Concord, Delaware, Goff, Herbert, Iona, Jefferson, Lindley, Mills, Niagara, Regal, Vergennes, Winchell and Worden.

The experiment was tried on the farm of I. A. Wilcox, of Portland, Chautauqua County, New York, in the Chautauqua Grape Belt. The vines were grown in two plats on two kinds of soil — Dunkirk gravel and Dunkirk clay. The planting plan and all of the vineyard operations were those common in commercial vineyards.

The original plan was to graft only on growing stocks but the loss of a large proportion of the grafted plants the first few years made it necessary to resort to bench-grafting on rooted plants as well. Later experiences show that bench-grafting on cuttings is probably the best method of starting a grafted vineyard.

Yearly accounts of the vineyard show that the vines passed through many vicissitudes. The experiment was started in 1902 when St. George and Riparia Gloire stocks from California were set and grafted in the field. Many of these died the first year.
The winter of 1903-04 was unusually severe and many more vines were either killed or so severely injured that they died during the next two years. The vines on St. George, a very deep-rooting grape, withstood the cold best. Fidia, the grape root-worm, was found in the vineyards early in the life of the vines and did much damage in some years. In the years of 1907 and 1909 the crops were ruined by hail.

But despite these serious setbacks it was evident throughout the experiment that the grafted grapes were better vines. And so, though the experiment is a partial failure through accidents, the results are thought to be worth publishing.

Tables II and III show that the grafted grapes are more productive than those on their own roots. As an example of the differences in yield, a summary of the data for 1911 from Table III may be given. In this year, an average of all the varieties on own roots yielded at the rate of 4.39 tons per acre; on St. George, 5.36 tons; on Gloire, 5.32 tons; on Clevener, 5.62 tons. The crops on the grafted vines were increased through the setting of more bunches and the development of larger bunches and berries.

The grapes on the grafted vines ripen a few days earlier than those on their own roots. This holds, in particular, as regards Gloire and Clevener, while with St. George a few varieties were retarded in ripening. Time of maturity is very important in this region, where there is danger of early frost to late ripening sorts and where it is often desirable to retard the harvest time of early grapes.

In the behavior of the vines the results correspond closely with those given for yields. In the relative growth ratings of varieties on different stocks the varieties on their own roots were rated in vigor at 40; on St. George, at 63.2; on Gloire, at 65.2; on Clevener, at 67.9. There is no way of deciding how much the thrift of the vines depends on adaptability to soil and how much on other factors. Since all of the varieties were more productive and vigorous on grafted vines than on their own roots, it may be said that a high degree of congeniality exists between the stocks and varieties under test.

The experiment suggests that it would be profitable to grow some of the fancy grapes of the region on grafted vines and that
it is well within the bounds of possibility that main-crop grapes can be profitably grafted.

It is recommended that grape-growers try small vineyards of grafted grapes, using as stocks the three tried in this experiment.

For procedure in growing a grafted vineyard the experiences given in this Bulletin should be taken in account, supplemented by a study of methods in California where grafted vineyards are commonly grown. Some of the practices in California are discussed on pages 512-514 but a more extended study of them should be made before engaging largely in growing grafted grapes.

This Station is repeating this experiment; it is hoped under more favorable circumstances.

INTRODUCTION.

The several species from which come cultivated grapes show wide variations in adaptability to natural and cultural conditions. Thus, cultivated Labruscas prefer loose, warm, sandy or gravelly soils; in the vineyard, Riparia varieties like a somewhat richer and heavier soil; the offspring of *Vitis aestivalis* thrive on lighter and shallower soils than even the Labruscas; *Vitis rupestris*, under cultivation, is better adapted than any other species to hard, dry soils. The species named respond quite differently to heat, cold, shade or sunshine and to moisture; they have varying capacities to withstand insects and fungi; and the productivity, the longevity and the size of the vine depend largely upon the species. The manifold types of grapes, too, behave quite differently under such cultural operations as propagation, cultivation and spraying.

The query, then, at once arises, "Cannot grape-growers take advantage of the variations in grapes and graft varieties that fail in some soils or climates, or because of certain insects or fungi, or that are not easily propagated or are short-lived, on roots of species that withstand these adverse conditions?" The signal success achieved in grafting varieties of *Vitis vinifera*, especially susceptible to attacks of phylloxera, on roots of species resistant to this insect, suggests that these other troubles may be more or
less overcome by grafting on roots of species free from these weaknesses. It was considered possible to improve the viticulture of New York by such grafting; and this possibility was the inspiration of an experiment at this Station to test various root stocks for the best varieties of American grapes. This bulletin is a report on the experiment — an experiment, however, it must be quickly said, which does not cover the broad field indicated in the opening paragraph, but a very limited one now to be outlined.

THE PROBLEM STATED.

The grapes in the work in hand are American grapes and more especially the hybrids between cultivated natives and varieties of Vitis vinifera. The attempt has been made to grow these grapes on stocks that were thought to be more vigorous, harder to cold, better adapted to certain soils, more resistant to phylloxera and the fidia, that were easily propagated and that quickly made good unions in grafting. Will grafting on these selected root stocks or on any others prove profitable in commercial vineyards? The outstanding features of this experiment, most of which are but touched upon in this report, were, it was believed, fraught with far-reaching consequences to grape-growers — not merely a technical problem.

STARTING THE EXPERIMENT.
MATERIALS.

Stocks.— Through many experiments, followed by trials everywhere in vineyards, the French and the Californians developed stocks for nearly all conditions of grape-growing. The choice with these experienced vineyardists depends upon the variety to be worked on the stock, adaptation to soils, the purpose for which the grapes are to be grown and the adverse condition to be overcome by grafting. From the many stocks in use at home and abroad for Vinifera varieties, two were chosen for New York, St. George and Riparia Gloire. Since there are a few vineyards in this State grafted on the Clevener, a vigorous, healthy, direct producer of the
region, this grape was included as a stock in the test. In the experiment there are, then, three groups of grafted varieties to be compared with a fourth in which the vines are on their own roots. The botanical and horticultural characteristics of the stocks or fruits are not important at this time; but the merits and defects of the varieties as stocks, especially as to adaptations to soils, must be indicated. Since the first two stocks are hardly known on the Atlantic seaboard, what is said of them is based largely on their behavior in California and France.

St. George.—This grape, known nearly as well by its synonym, Rupestris du Lot, is a variety of Vitis rupestris, an inhabitant of Texas and the Southwest though ranging sparingly north and east and west of the State named to considerable distances. The species and this variety of it in particular, are pre-eminently well adapted to sandy, gravelly, rocky soils. St. George has remarkably strong roots which force themselves deeply into even very compact soils if the water table be not too near the surface. Its habit of deep rooting enables it to withstand drouths and seemingly, from this experiment, the roots withstand cold. The variety is very vigorous and communicates its strength to its grafts. It roots readily in the nursery and makes a very good union in grafting with either Vinifera varieties or other American species. It is by no means the most resistant stock to phylloxera but this need concern eastern growers but little. The chief defect of this stock as it grows in New York is that it suckers too freely.

Riparia Gloire de Montpellier.—This stock, known for short as Riparia Gloire, is, as its name suggests, a division of the well known Vitis riparia, the most widely distributed species of American grapes, ranging, in one region or another, eastward from the Rocky mountains to the Atlantic in the United States. The roots of this species and of its variety under consideration, quite unlike those of St. George, are small, hard, numerous, branch freely, and feed close to the surface of the ground. This stock grows best in deep rich soils which must not approach either extreme of wetness or dryness. Riparia Gloire is exceedingly
vigorous, even for the strong-growing species to which it belongs, and imparts its vigor to vines worked on it. Where hardiness is a factor in grape-growing, this stock should prove of value. As with all Riparias this variety grows readily from cuttings and makes a good stock for grafting, uniting freely and usually permanently with other species. Riparia Gloire, as are all of its species, is very resistant to phylloxera. The principal defect of this stock in California and Europe is that it is very particular as to soils. In our own experiment, there is a tendency for the cion to overgrow the stock.

* Clevener.— This variety is a well known wine-grape in New York. It is a hybrid between *Vitis labrusca* and *Vitis riparia* with some characters suggesting that one of its parents might have blood of *Vitis aestivalis*. The vine is a rampant grower, hardy, succeeds in various soils and is probably adapted to a greater range of soils in this region than either of the other stocks discussed. It unites readily with other grapes and bears its grafts well. Although not tested thoroughly as regards phylloxera, it is probably as resistant as Riparia Gloire. In the past this has been considered the standard stock upon which to graft in this State.

*Varieties used as grafts.*— The varieties used as grafts in the experiment are, with one or two exceptions, the grapes most grown in commercial and home vineyards in New York. The selection of these varieties out of hundreds from which to choose, was dictated by varied considerations, chief of which were defects in adaptability to soil, climate and other environmental conditions which it was thought top-working might overcome. The grapes are so well known that there is no need of varietal description of any of them but all will be interested in knowing what considerations led to the selection of each variety.

*Agawam.*—Agawam is the most widely grown of Rogers' hybrids in the United States. It does pre-eminently well, however, only on heavy or clay soils and in many localities does not yield satisfactorily. In severe winters it is precariously hardy in New York.
Barry.—This is one of our best-flavored and longest-keeping hybrid grapes, resembling in color, flavor and keeping quality its European parent, Black Hamburg. Unfortunately it is not productive and it was hoped that it might be made to yield more by grafting on another stock.

Brighton.—Brighton is one of the few Labrusca-Vinifera hybrids which have attained prominence in commercial vineyards. The variety, however, has two most serious defects. It is selfsterile and it rapidly deteriorates in quality after picking. There was the possibility that working on another stock might influence the latter quality somewhat.

Brilliant.—Brilliant is a handsome, well-flavored, red grape, a cross between Lindley and Delaware, with such excellent keeping and shipping qualities that it might be grown with great profit in New York were it not for three faults—the bunches are variable in size and ripen unevenly, and in some soils the vines lack in productiveness. It was hoped that grafting on another stock might at least mitigate these faults somewhat.

Campbell Early.—At its best Campbell Early is unsurpassed in bunch, berry and vine by any American grape. But in most localities the variety falls far short of the perfection just indicated because it is adapted to but few soils and must have particular climatic and moisture conditions. Grafting on some other stock may lessen or do away with these weaknesses.

Catawba.—Catawba thrives in a great variety of soils and under various moisture and climatic conditions. It is the standard red grape of the markets of eastern America, more largely grown than any other red sort, but its cultivation could be still further extended in New York were it not for the fact that it ripens a week too late to be certain except in favored localities. In Europe and California, some varieties ripen a week or more earlier if grown on other than their own roots—hence, the trial of Catawba in this experiment.

Concord.—The Concord, known by all, is the dominant type of our native grapes, taking first place in American viticulture because of the elasticity of its constitution whereby it adapts itself
to varying conditions. Its use in this experiment is for purposes of comparison as to its behavior on different stocks rather than with the hope of correcting defects of adaptability.

_Delaware._—Delaware is the standard in quality of all American grapes found on the markets. The variety, however, makes a very slow growth and is very capricious in certain soils. It would be a boon, indeed, if grape-growers could overcome these faults by grafting.

_Goff._—Goff, a variety originating at this Station, is hardly surpassed in fruit characters but falls far short in bunch and vine characters. It was hoped that these might be improved by grafting.

_Herbert._—Herbert, another of Rogers' hybrids, very similar to Barry in characteristics, is as near perfection in fruit characters as we have yet attained in the evolution of American grapes but is very capricious as to soils. It was especially hoped that this splendid grape would do better grafted than on its own roots.

_Iona._—Iona is unsurpassed among American grapes for delicacy and sprightliness of flavor, keeping quality, and in making wines and champagne. But to be grown at all well it must have a soil exactly suited to its needs. It requires a deep, dry, sandy or gravelly clay and will not thrive on black loams or on poor sands or gravels—hence, the attempt to graft it on a stock more adaptable to soils.

_Jefferson._—Jefferson is a cross between Concord and Iona, the good qualities of both parents showing. Unfortunately, it is a little too late and a little too tender to cold for a commercial variety, faults which it was hoped might be remedied by growing it on other roots than its own.

_Lindley._—All concede that Lindley is the best one of the red grapes among the hybrids grown by Rogers. Yet it is little known commercially because of precariousness in bearing and lack of adaptation to some soils. Top-working might help overcome these defects.

_Mills._—Of all our cultivated grapes, Mills probably varies most under different cultural conditions and because of this is
placed by some among the best sorts and by others is said to be worthless. There was the possibility that it might be top-worked on some stock which would cause it to bear more uniformly and larger crops of better fruit.

*Niagara.*—Niagara is the leading green grape east of the Rocky mountains, but it would be greatly improved for commercial vineyards if grafting on another stock should make it a little hardier and more productive.

*Regal.*—This variety is worthy extensive trial in the vineyards of New York, not, at the time this experiment was started, at least, having been well tested. It was thought deserving a trial and on other roots than its own.

*Vergennes.*—Vergennes is exceedingly variable in size of bunches and berries and in time of ripening. The vine, too, has a sprawling habit of growth. It is known that the last named fault can be corrected by grafting and there was the possibility that the other two could be, in which case this variety, because of the attractive appearance, high flavor, long-keeping quality of the fruit and the regularity with which it bears, would be a very profitable grape to grow.

*Winchell.*—The vines of Winchell are nearly perfect in hardiness, productiveness, and adaptability to soils; and the fruit characters are, in the main, good. The bunches, however, are small, loose and straggling, characteristics which might change if the vines were on other stocks.

*Worden.*—Worden possesses most of the good and bad qualities of Concord, differing chiefly in being a little earlier and having larger, sweeter and juicier berries. It is, however, a little more fastidious as to soils, a character which might change were the variety grafted on the stocks under trial.

**SITE OF THE EXPERIMENT.**

*Location.*—The experimental vineyard is located on the farm of I. A. Wilcox, about one mile south of Portland, Chautauqua County, New York. Portland is near the middle of the Chautau-
qua Grape Belt, a strip of land from two to six miles wide extending along the shore of Lake Erie for about 35 miles. This belt is recognized as the most important grape area east of the Pacific Coast. Though narrow, the strip is so variable in topography, climate and soil that the environment of the experiment should be noted carefully, for there is a marked difference in yield and quality of grapes in vineyards which seemingly differ but little in the natural factors named.

*Topography.*—The Chautauqua Grape Belt is divided lengthwise, parallel to the lake, by a high escarpment, the "Hill" of the region. The land between the escarpment and the lake is the Erie lowlands, the surface and soil of which are comparatively uniform. From the crest of the escarpment the land gradually ascends in an undulating, sometimes hilly plain, the "uplands" of the grape belt. The Wilcox farm is in the uplands, about 2½ miles from Lake Erie and at an altitude of 200 feet above it.

*Climate.*—The lowlands and uplands differ considerably in climate, due to local topography, and grape-growers in the belt generally believe that peculiarities of climate have much influence on the growth of grapes in the region. It is held, with some show of data to substantiate the belief, that the rainfall is greater and the mean temperature lower on the uplands than on the lowlands. The prevailing winds are from the west and south.

*Soils.*—The soils of the Chautauqua Belt are of glacial origin and contain much foreign material in the shape of boulders, small stones, gravel and finer debris. Yet, in some vineyards, the soil corresponds so closely with the rocks underneath as to indicate that the upper layer is of local origin. Practically all of the vineyards are on one or another of the several soils of the Dunkirk series. Many vineyards, as is the case with this experimental one, are growing on two or more quite distinct soils.

*Vineyard plats.*—The experimental vineyard is planted on two somewhat distinct soils on the Wilcox farm. One division is on Dunkirk gravel, which many vineyardists believe grows grapes of
superior quality and upon which the grapes ripen a few days in advance of those on other soils. The plat on this soil contains about one acre upon which are set 600 vines. The other division of the vineyard is on Dunkirk clay, a soil more retentive of moisture than the other soils of the belt and more productive but on which the grapes are comparatively late in ripening. Of this clay land the experiment included about two-fifths of an acre, containing 225 vines. The vines behaved much the same on these two plats—quite contrary to expectations.

**THE VINEYARDS.**

*Planting plan.*—The grapes in both plats were set nine feet apart in rows eight feet apart. In the smaller plat, Plat I, there are nine rows containing twenty-five vines each; in the larger plat, Plat II, twelve rows of fifty vines each. The plan of the experiment calls for numbers of the varieties as given in the diagram on the next page.

The vineyard was laid out and planted under the general direction of Professor S. A. Beach, who planned the experiment, in May, 1902. Professor Beach directed the test until August, 1905, when the writer took charge. The original plan was to graft all vines in the vineyard and plantings of the stock for this purpose were made in late May, 1902. At this time, 225 vines each of Riparia Gloire and St. George were set in the experimental plats. The Clevener stocks could not be set until the spring of 1903.

Unfortunately a poor start was made with the vines for stocks. The plants had to be ordered from California and the long trip across the continent, with vines severely root-pruned and not good to start with, so weakened them that the loss at planting was great. Of the St. George plants 49 died and of the Riparia Gloire 206. In the fall of 1902 the vacancies in the plats of these two stocks were filled and all of the varieties on their own roots were set.

*Grafting.*—Grape-grafting is as old as grape-growing. At least, more or less precise methods are given for the operation in the earliest printed cultural directions for this fruit. It would seem
### Vineyard I

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<td>Own Roots</td>
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<tr>
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### Diagram I — Plat of Experimental Vineyards Showing Arrangement of Varieties.
that grafting should be a kindergarten operation in vine-growing and that all who work with grapes should know how to graft them. Yet grafted vines cannot be found in many grape regions of eastern America and grape-grafting is nowhere common. The lack of knowledge on the subject warrants a rather full description of the methods used in this experiment — a description all the more necessary because of many failures in grafting.

The original plan was to graft only on growing stocks but the loss of a large proportion of the grafted plants the first few years made it necessary to resort to bench-grafting as well. We have, therefore, two methods to describe.

*Grafting on growing stocks.*— The grape stocks were set in the vineyard one year before grafting. The stocks came to the Station as shown in Plate I and were severely cut back, root and branch. They were planted and subsequently cared for as ungrafted grape vines are ordinarily grown. The young plants did not make a satisfactory start nor did they grow well during the summer and this unsatisfactory first season was undoubtedly the cause of many failures of vines subsequently.

The cions, each containing two eyes, were cut in the fall and buried in sand over winter. So far as appears from the records, there was no selection of cions from fertile canes or vines nor would such be the practice if the work were to be done now. At the present time in grafting, precautions are taken to procure cions from healthy, mature plants; and it is presumed that in this experiment they were thus selected. Cions from young, weakened, or diseased vines are not well lignified and do not form calluses readily, probably because of a deficiency in reserve food materials. The cions were six to eight inches long, the length depending upon that of the internodes. The average diameter was about one-third of an inch though this varied somewhat in accordance with the variety.

The first grafting was done in May, 1903. The question may well arise here as to whether this was the best time for field grafting. Subsequent experience leads to the conclusion, one also
reached by others, that the union is best if grafting be done when the stock is not in full sap. Callous tissue does not develop well when the vine is bleeding badly and the operation should, therefore, be done just before or just after the period of greatest activity of sap. If done while the sap is in full flow the rooted stock should be cut a few days before grafting. It is held in France that heavy rains during grafting are almost fatal to success and that the grafts must not be maintained under any circumstances in surroundings excessively damp.

Preparatory to grafting, the earth was removed from around the stocks to a depth of a few inches. The vines were then decapitated just below the surface of the ground and at right angles with the axis of the stock. The stock thus prepared was grafted with the ordinary cleft graft, but one cion being used, however. Precaution was taken to make the wedge of the graft at a node. After the insertion of the cion the graft was securely tied with raffia and covered with grafting wax and the vine mounded up to the upper bud of the cion with fresh earth carefully firmed. Later experiences show a much higher percentage of good grafts if grafting wax is not used, probably because the flowing sap escapes more readily. The mound is important and should be made of soil not too stiff and wet and yet firm enough to maintain an even temperature, prevent too rapid evaporation and guard the cion against being blown or knocked out.

Late in the season all of the vines were examined for a count of live and healthy plants and to remove roots which had developed from the cions. In the light of more recent experience, it is probable that the vines suffered from not having the roots of the cions removed earlier in the season — say July or August; for, since the cions were nourished partly by their own roots the root-systems of the stocks, having less to do, did not make the greatest possible growth and suffered to that extent. Eventually this probably reacted on the whole vine. The advice may be offered, in which more experienced grafters generally agree, to sever the roots of the cion as soon as possible. If the raffia has not rotted when the
Plate IV.—Different Stages of Grafting.
(Succession is from right to left.)
roots are removed, it should be cut. It may be necessary to sever
the roots of cions twice during the first season, each time earthing
up as at first though not as high. The mistake was made, and here
the novice will often fail, of putting some of the grafts too deep, as
the result of which some vines grew on their own roots and the
object of grafting was thwarted. Plate II shows such vines.

The earth was not leveled about the vines until the following
spring, but served during the winter to protect the poorly lignified
grafts from frost and to prevent blowing out of the cions. The
vines were not staked the first year after grafting but this
would have been a profitable precaution since a number broke
either at the graft or more often just below, where the stock was
frequently smaller than the cion, possibly from the fact that roots
had been allowed to remain too long on the cion. Many suckers
appeared from the stocks, especially from the St. George, and were
removed as quickly as the work could conveniently be done. The
suckering of St. George must be set down as a serious fault of this
stock. Plate III illustrates the suckering habit.

The plan to graft all vines in situ had to be abandoned, as before
stated, because the loss of many plants made apparent the necessity
of having on hand a surplus of grafted vines for the first few
years of the experiment. To secure such a surplus it was neces-
sary to resort to bench-grafting.

Bench-grafting.— The cions for the bench-grafts were pre-
pared as for the grafting in the field. The root-stocks were the
same as those set in the field but received, of course, some pre-
liminary preparation. Roots and tops were cut back severely, the
former to a few inches in length — we now cut back to an inch,
for when longer they prove troublesome in handling. The mistake
was made of grafting some of the stocks on the growth of the pre-
vious year the result being a great number of suckers which would
not have grown, in such numbers at least, had all been grafted on
the wood of the original cutting. The bench-grafting was done in
late March and early April after which the grafts were stored
away for callousing.
The whip-graft, known by all fruit-growers, was used in bench-grafting. Of the several methods of cutting cion and stock preparatory to uniting them, the style used was similar to the whip-grafting of nursery stock—illustrated in Plate IV. Grape-growers often ask what graft to use in bench-grafting. The choice must depend upon the material and the graft must be used which, with the material in hand, will best bring the cambium layer of stock and cion into juxtaposition and hold them there until the parts are firmly united. The method used in this experiment seemed to answer the purposes best and at the same time was easily performed. Of all grafts, this one mutilates and exposes the plant tissues as little as any.

A few brief statements in regard to making whip-grafts may not be out of place. The aim should be to make the cut of the stock duplicate that of the cion so that the cut surfaces cover as nearly as possible. The cut is made with one motion of the knife and with a quick, sliding movement. The length of the cut surface depends upon the diameter of stock and cion—the thinner the wood the longer the surface, which will usually be in length from three to four times the diameter of the graft. The tongues are cut and under no circumstances split. The tongue begins about one-third of the length of the beveled surface and extends a little more than one-half of the remaining surface. When stock and cion are joined, the cut surfaces should exactly cover without projections or on the other hand without any exposure of cut surface. No matter how firm the graft may seem after the parts are placed together, tying is necessary. For this purpose, use raffia or waxed string. Though the grafts for this experiment were waxed, this operation is not necessary and in fact is undesirable.

As soon as made the grafts should be placed under conditions favorable for callousing and uniting the cut surfaces, and the rooting of the stock. Favorable conditions for these vital actions can be had only in a specially prepared place where moisture, temperature and aeration can be controlled. Such a callousing bed can be made of sand or of clean sphagnum moss, in either case under
cover. The bundles of grafts are placed in the bed, cions uppermost, and the bed is then filled with the material in the interstices in and about the bundles, to a depth of a few inches above the cions. Air there must always be. Heat and moisture can be supplied as is necessary to force or retard vital action in the grafts. At least one month is required for the formation of a proper union, such as is shown in Plate V. Finally the grafts are planted in nursery rows where care may be given them and in a soil and under conditions to make them grow vigorously.

It must not be inferred that the methods of grafting used for this experiment are necessarily the best. Any one contemplating growing a grafted vineyard would do well to study other methods. The Californians have developed vineyard graftage to a high degree and the experiment station at Berkeley, California, would probably furnish literature to the limited number that are likely to wish information on grafting grapes in New York. In that State, bench-grafting cuttings, a method not used in this experiment though now in use at this Station, is found more satisfactory than bench-grafting roots or grafting in the field. The method, so far as uniting stock and cion are concerned, is the same as that employed in bench-grafting cions on rooted cuttings.

ANNUAL REPORTS ON THE EXPERIMENT.

The progress of the experiment is best told by giving an annual report of the vineyard. The account shows that the vines have had nearly all the ills that grape flesh is heir to—some of the plants seemingly have the proverbial nine lives of a cat. The vicissitudes of the experiment are set forth in full, for unless one is conversant with them, the experimental value of the work cannot be gauged.

1902.—The vines of St. George and Riparia Gloire were set during the last few days of May. Mr. Wilcox, in charge of planting, reported, "the plants are a poor lot and not more than 50 per cent. will grow." In November the St. George vines were found to be in fair condition with but 49 dead or weak plants out of
225; of the 225 Riparia Gloire vines, 206 were dead. Late in the fall, all of the varieties on their own roots were set excepting three sorts which were put out early the next spring. For most part the vacancies in the Riparia Gloire plantation were from vines that failed to start either because originally poor stock or because weakened in the trans-continental shipment.

1903.—In the spring of this year the vacancies noted the preceding fall were filled and all of the Clevener vines were set. A surplus number of vines were bench-grafted and put in nursery rows for possible vacancies in future years. October 1 of this year, it was found that 17 Riparia Gloire stocks had died; 9 of St. George; 9 of Clevener; and 29 on their own roots. Of the grafts on Riparia Gloire 8 had died; 48 on St. George; and none on Clevener. The vines were pruned, tilled and otherwise cared for as in a commercial vineyard — this record need not be burdened with the details.

1904.—Upon examination in early May of this year many dead and weak vines were found. The greater number of these were plants on which cions had not united with the stock but which had been kept alive by roots from above the union. Most of these seemed to have been injured by the extreme cold of 1903–04. In digging plants to fill vacancies from nursery rows at the Station, it was found that the union of stock and cion was not so strong with bench-grafted plants as in the case of those grafted in the nursery row. Many of the bench-grafted plants bore roots from the cion, which were removed, and the plants set so that the union was about two inches below the surface of the ground. After planting, the vines were banked up nearly to the top of the cion. The following were the numbers reset on the different stocks: St. George, 85; Riparia Gloire, 56; on own roots, 48. All of the Clevener stock was grafted this spring, May 19 and 20. In the middle of May of this year the roots which had grown the preceding year from cions were removed. May 23 and 24, a new lot of plants were bench-grafted on the three stocks, buried until June 2 and then set in nursery rows at the experimental vineyard.
May 3, an application of acid phosphate at the rate of 600 pounds per acre and of muriate of potash at the rate of 400 pounds was made. A trellis for the plantation was erected this year.

1905.—The effects of the winter injury of 1903-04 showed more and more plainly as the season of 1904 advanced. Late in the fall the grand total of dead vines was found to be as set forth in Table I. It is not quite fair to attribute all of the deaths in the experimental plats to the severe cold but there is no other apparent reason for the wholesale dying of the vines; and grapes everywhere in the Chautauqua Belt died following this winter, so it is safe to say that those in this vineyard were almost wholly killed by cold. In the Wilcox vineyards adjoining the experimental plantations many vines, especially young ones, succumbed to the winter.

Table I.—Number and Percentage of Dead Vines of Grape Varieties Grown on Own Roots or Grafted — Spring, 1905.

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|        | 87      | 40.2        | 68        | 36.5       | 84        | 44.6      | 73        | 38.9      |
The numbers of vines of the several varieties are too small and the cause of death not quite certain enough to make definite statements as to what stocks and what varieties were most tender to cold; but the figures in the table may be regarded as suggestive of the hardiness to cold of stock and variety. These show that fewer vines on St. George died than on any other stock. We should not like to state it as a fact but it seems possible that the deep rooting habit of this stock may have fitted it best for withstanding cold.

After the injury of the calamitous freeze had been repaired as far as possible by resetting, old and new vines made a splendid growth in 1905, the season being most favorable. A considerable number of vines lagged in growth, however, still showing, it seemed to the observers, the effects of the cold of the winter preceding the last. As a commercial venture, and in the light of subsequent events as an experimental one, it would have been better to have dug the vines out in 1904 and to have begun anew.

1906.—The work this season began with the filling of vacancies, of which there were on Gloire stock, 34; on St. George, 27; on Clevener, 35; and on own roots, 9. The dead vines were, it may be assumed, weaklings injured by the freeze two winters past. This was the last setting made of which any account is to be taken. During the summer, as in all past seasons, the vineyard was left under thorough tillage, all suckers were removed, roots severed from cions and the best cultural treatment given. The effects of fidia, which had appeared in the vineyard a few years previous, began this year to show very perceptibly on some of the vines.

In the fall of this year for the first time a full record of the harvest was kept. A good many of the vines were not in bearing and the ages of those in fruit were so variable that the data have little value.

1907.—No items of experimental interest appear in the account of the work in the vineyard for this year. The vines are reported as making a good growth and as being free from pests of any kind excepting the fidia and this pest seemed to be succumbing to treatment and was not as bad as in previous years. During the
summer there were prospects for a good harvest but in August a hailstorm ruined the crop. The fruit was not picked as the crop had no experimental value. Even the vines were severely injured by the hail. Another episode of the year was a veritable scourge of leaf-hoppers which nearly defoliated the vines.

1908, 1909, 1910, 1911.—All vines to enter in the discussion in this Bulletin had come into bearing in or before 1908. The vineyard treatment during these years was that given commercial plantations in the Chautauqua Belt. Another disaster must be recorded for the year 1910 when a second hailstorm so damaged the crop that it could not be considered in the study of results.

RESULTS OF THE EXPERIMENT.

Grafted grapes have had a trial of eleven years in this experiment. In spite of the time that has been given to the work, of expense to meet every need of the vineyard, and of every precaution to carry on a careful trial, the results are not satisfactory. The data lack precision and fullness—lack quality and quantity. The start was on a road that seemed to lead straight ahead but there were so many obstacles in the way that progress was mostly through byways and backways. The experiment is all but a failure because of the loss of many vines at the start, because of poor stock, lack of knowledge of the best means of grafting, the freeze of 1904, the hailstorms of 1907 and 1910, and fidia.

Possibly no report should be made on an experiment that has suffered as has this one. But throughout the test the grafted vines have behaved differently from the ungrafted ones and in some respects they were better plants, so that it may be worth while to give the results of the experiment. Meanwhile we have started a similar experiment elsewhere from which we shall hope to give in time a more satisfactory report.

_Grafted vines are more fertile._—Greater fruitfulness has all along characterized the grafted vines. Yet it is most difficult to show on paper precisely how much more productive the grafted vines have been. There has been but one year, 1911, in which
proper comparisons of yields could be made. Early in the life of
the experiment the enormous death rate of the vines, as set forth
in the annual reports, vitiated any data to be had, because of the
differences in the ages of the plants, differences which became less
marked as all vines came into full bearing. When a sufficient
number of the vines came to an age and to a size where their
products could be somewhat accurately compared, fidia and hail-
storms all but ruined several crops. The data, then, to prove
greater productiveness of the grafted vines will not bear critical
analysis and are chiefly valuable because they substantiate the
impressions of all who have worked with the experiment.

Table II shows that all grafted vines are more productive than
those on their own roots. The figures in this table seem to show
that the varieties on Clevener stocks are most productive, those on
Gloire next, the varieties on St. George are third most productive
and those on their own roots are least productive. The following
is a summary: The average number of pounds per vine for the
four groups of stocks are: own roots, 7.6; St. George, 10; Gloire,

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11.2; Clevener, 11.9. From these figures may be roughly calculated the number of tons per acre as follows: own roots, 2.24; St. George, 3.02; Gloire, 3.38; Clevener, 3.59.

The question at once arises: Is the greater productiveness due to an influence of the stock on the cion or to the effects of grafting acting as annular incisions, the “ringing” of the grape-grower, are known to act? This question will be taken up later.

In Table III, the yields for 1911 are given. The crop of this year was the only one borne uniformly over both experimental plats, and this year having granted immunity from the troubles of other seasons. The figures of 1911, therefore, admit of somewhat closer analysis than those in Table II. Making the same calculations for the three stocks, the figures stand as follows: pounds per vine on own roots, 14.54; St. George, 17.72; Gloire, 17.59; Clevener, 18.60; tons per acre on own roots, 4.39; St. George, 5.36; Gloire, 5.32; Clevener, 5.62.

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Table III.—Average Yield per Vine of Own-root and Grafted Grape Varieties, 1911.
No attempt is made to compare the behavior of varieties and stocks in the two vineyards on slightly different soils. There were differences; but the figures, taken under the adverse conditions of the experiment, are in no way conclusive. Beside, the experiment was not well planned for a comparison of the two vineyards, since the varieties, with but three exceptions, are different and the numbers of vines of these are not the same.

The crop on the grafted vines was increased through the setting of more bunches and the growth of larger bunches and berries. The increase in number of bunches was easily determined by actual count but for the statement regarding size we have only the fact that the proportion of unmarketable grapes was greater on the ungrafted than on the top-worked vines. The greater fertility of the varieties on other than their own roots cannot be ascribed to larger vines. No data are available as to size of vines but judging by the eye alone the grafted vines do not make as much wood as do the varieties on their own roots.

The quality of the crop, color of fruit, keeping capacity, value of the grapes for wine or grape-juice, the latter depending largely on sugar and acid content, could not be considered in this experiment though it is probable that there are greater or less differences in all these characters— and all are very important.

So far as yield, at least, is concerned, the results of this experiment are in accord with those of many experimenters abroad and in California. So, too, in this State records of grafted vineyards, collected from grape-growers and the press, show that when a grape is grafted on a congenial stock the yield is generally greater than when the variety is grown on its own roots.

Time of maturity.—The grapes on the grafted vines ripen a few days earlier than those on their own roots. This statement holds, in particular, as regards Gloire and Clevener but it is not certain that there is a constant difference in the time of ripening between the same varieties on St. George and on own roots—in fact, some varieties on the last named stock were retarded in time of maturity. Ripening notes were not kept accurately enough nor
over a sufficient number of years to permit of more than these general statements in regard to maturity. In this region where time of maturity is so important because of danger of early frost to late-ripening sorts and where it is often desirable to retard the harvest time of early grapes, it is a matter of prime importance to know accurately what influence grafting on various stocks will have on this life event. It is hoped that an experiment under way may furnish more definite information.

Behavior of vines.—It is not fair to measure the effects of a treatment by the crop alone unless the whole life of the plant is considered, when, of course, the chief criterion is crop performance. But in a period of so few years as the one in which this experiment has been in progress it is quite possible for plants to have a high record of fruitfulness but at the expense of vigor and longevity of plant. It might well be expected that grafting grapes of one species on the roots of another would have very pronounced effects on the resulting plant. Thus, amount and character of annual growth, size, color and sparsity of foliage, diameter of trunk, together with the effects on such life events as leafing-time, blooming-time, fruiting-time and fall of leaf, are indispensable to a full knowledge of any treatment of vines. The behavior of the vines may follow from the mechanical effects of grafting, which is very improbable; or from adaptability, or lack of it, of variety or stock to the environment; or to congeniality or lack of it between stock and cion. The last two factors are worth discussing.

Adaptability of stock and variety to the Chautauqua Belt conditions.—The soil, climate and all conditions of environment must be favorable to both stock and cion in a grafted vineyard—the less favorable the poorer the grapes. All the varieties chosen for this experiment, with the exception of Goff, were sorts that are grown in the Chautauqua Belt and known to be adapted to the region except in certain characters which it was hoped would do better under grafting. The stocks were untried, but the adaptability of stocks that come from largely grown species that have been thoroughly tested elsewhere can be forecasted. The stocks
chosen were those supposed to be best adapted to the region. Nevertheless the diverse needs of stock and cion as to soil and climate and their diverse behavior as to congeniality, make the behavior of the vines in the experiment a complicated problem. Table IV gives ratings indicating the vigor of varieties on the several stocks. There is no way, however, of deciding how much of the thrift of the vines listed depends on adaptability and how much on other factors.

Congeniality between stock and cion.—There must be congeniality between stock and cion in successful grafting — that is, top and root must flourish approximately as if the cion were grafted on its own roots. Knowledge of the habitats of species enables one to predict very closely whether the varieties of that species will be adapted to soil or climate, but congeniality between varieties of different species can be ascertained only by grafting the one on the other. Europeans and Californians have found that there is a great difference in the congeniality of varieties on the several stocks upon which Vinifera grapes are grafted. Without doubt we shall find similar differences in grafting grapes of American species and must ascertain by actual test what the congenialities of varieties and stocks are before running risks by grafting for large vineyards.

The failures in this experiment teach little as to congeniality for it is of course impossible to say, from the few plants worked with, whether the failures were due to lack of affinity between stock and cion or to poor material or adverse environment. Uniformly good results with a variety or a stock do indicate congeniality and adaptability to the conditions in which the vines are growing as well.

In Table IV the relative ratings given the varieties on the several stocks and on their own roots show the vigor of the vines and where high ratings are given indicate that stock and cion are congenial and that both are adapted to their environment. The percentages are averages of all the vines of the varieties and were taken in 1910 when the vineyard had reached bearing age, when
insects and fungi were well under control and before the hailstorm
of that year ruined the crop. The ratings indicate vigor as judged
by the eye from general appearance of vines, and amount, size
and color of leaves.

**Table IV.—Relative Growth Rating of Grape Varieties on Different
Stocks in 1910.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Own roots</th>
<th>St. George</th>
<th>Gloire</th>
<th>Clevener</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agawam</td>
<td>50.4</td>
<td>65</td>
<td>57.7</td>
<td>65.5</td>
</tr>
<tr>
<td>Barry</td>
<td>45</td>
<td>48.7</td>
<td>68.3</td>
<td>81</td>
</tr>
<tr>
<td>Brighton</td>
<td>55</td>
<td>56</td>
<td>73.7</td>
<td>75</td>
</tr>
<tr>
<td>Brilliant</td>
<td>53.7</td>
<td>66</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Campbell</td>
<td>17.3</td>
<td>62.1</td>
<td>54.6</td>
<td>35</td>
</tr>
<tr>
<td>Catawba</td>
<td>40</td>
<td>74</td>
<td>70</td>
<td>81.6</td>
</tr>
<tr>
<td>Concord</td>
<td>46.0</td>
<td>94</td>
<td>90.7</td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td>46</td>
<td>60</td>
<td>68.7</td>
<td>81.6</td>
</tr>
<tr>
<td>Herbert</td>
<td>64.6</td>
<td>87.5</td>
<td>87.1</td>
<td></td>
</tr>
<tr>
<td>Iona</td>
<td>26.8</td>
<td>45.6</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Jefferson</td>
<td>36</td>
<td>38.3</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Lindley</td>
<td>55</td>
<td>63</td>
<td>75.5</td>
<td>93.3</td>
</tr>
<tr>
<td>Mills</td>
<td>58.6</td>
<td>60.4</td>
<td>60.5</td>
<td>60.5</td>
</tr>
<tr>
<td>Niagara</td>
<td>53.9</td>
<td>84.5</td>
<td>57.5</td>
<td>56.4</td>
</tr>
<tr>
<td>Regal</td>
<td>17.2</td>
<td>58</td>
<td>59.4</td>
<td>78.8</td>
</tr>
<tr>
<td>Goff</td>
<td>18</td>
<td>80</td>
<td>73.3</td>
<td>81.6</td>
</tr>
<tr>
<td>Vergennes</td>
<td>44.1</td>
<td>77.8</td>
<td>69.2</td>
<td>90.3</td>
</tr>
<tr>
<td>Wilder</td>
<td>40</td>
<td>58</td>
<td>60</td>
<td>66</td>
</tr>
<tr>
<td>Winchell</td>
<td>25</td>
<td>52.5</td>
<td>52.8</td>
<td>53</td>
</tr>
<tr>
<td>Worden</td>
<td>26.1</td>
<td>36</td>
<td>61.6</td>
<td>38.1</td>
</tr>
</tbody>
</table>

A comparison of this table with Tables II and III shows that
in the main the greater productiveness of the vines agrees largely
with vigor of vine. In the judgment of the writer the superiority
of the grafted vines is best shown by vigor as indicated in this
table. Grape-growers may well take note of the figures here set
forth.

**Resistance to insect and fungus pests.**—Species and even varie-
ties of grapes are very unequally subject to animal or fungus para-
sites. This elementary fact, impressed upon grape-growers from
the earliest times, would, of course, suggest observations as to the
resistance of the vines in this experiment to the various vineyard
fungi and insects. Pests there were in the vineyard in abundance, as the tales of tribulation told in the annual reports have shown, but the knowledge gained by the experimenters as to the comparative immunity of stocks and varieties is but a thing of shreds and patches and is hardly worth discussion.

Toward fungus diseases, chiefly the downy and powdery mildews, more particularly the latter though both of them were present nearly every season, the varieties, as would be expected, behaved on the grafted vines just as they did on their own roots. It has been well demonstrated in California and France that the stocks in this experiment, as well as all of the varieties on their own roots, behave differently under the attacks of phylloxera but this pest was at no time plentiful enough to furnish data for conclusions. The grape-root worm, *Fidia viticida*, has been ravaging the vineyards of the Chautauqua region for several years. The greatest disappointment in the work with this vineyard is that a detailed statement cannot be made of the differences between stocks or varieties on their own roots as to the attacks of *fidia*. There are differences and they are likely to prove as important with the *fidia* as with phylloxera, but this experiment has not furnished sufficient data to substantiate in detail the very general statement that this insect has its likes and dislikes among the stocks and varieties under trial.

*How does grafting cause its effects?*—The effects of grafting are so similar to those of annular incisions or injuries of any kind — greater productiveness, larger bunches and fruits, and earlier ripening — that one might well believe the mode of action to be the same. There is this difference, however — ringing acts but temporarily, only as long as the flow of sap through the cambium is interrupted, while the effects of grafting are permanent. The mechanical effect of grafting may be the same as that of ringing for the first year, or possibly two, but no longer. The similarity between grafting and ringing ceases as soon as stock and cion in the graft are completely united.

This experiment furnishes no facts as to how grafting causes its effects. It would seem, however, that it is not the operation itself
or any mechanical change but rather that it is due to some physiological disturbance. It may be due to a difference in the specific gravity in the sap of stock and cion. It may be that the food elaborated by the foliage of the cion is different from that which the stock would have had with its own foliage. Possibly it is insufficient nutrition of stock or cion. These are but conjectures as to how the vigor and productiveness are influenced. Another set of theories might be made as to causes of the varying adaptability of the grafted vines to soil and still another, as to why some rootstocks are inimical to phylloxera and fidia. They are thus briefly brought up to suggest further experimental work and to urge them, as physiological disturbances, as more probable causes than mechanical injuries.

Selection of stocks for grafting grapes.—It is necessary in seeking for a vine to be used as a rootstock to obtain a well-established variety which can be depended upon to behave in a uniform manner. Wild vines of any species would be quite too variable for practical purposes. Wild vines, too, as a rule are too slender of growth to bear the stockier cultivated grapes which when grafted on them overgrow the rootstock. The French, who have been pioneers in this work, have selected a number of strong-growing varieties of several American species and our growers are fortunate enough to have this very considerable help if they desire to try grafting. The behavior of the stocks in this experiment leads us to recommend all three for trial in commercial vineyards, though since Clevenner is exceedingly hard to find it may be necessary to start with St. George and Gloire both of which may be purchased at reasonable rates from California nurserymen. To these might well be added Riparia grand glabre and the two hybrids between Vitis riparia and Vitis rupestris known as 3306 and 3309.

Procedure in growing a grafted vineyard.—Should it be demonstrated that grapes of certain varieties can be more profitably grown on other roots than on their own and that grafting grapes is profitable, nurserymen or growers must raise stocks for grafting as well as varieties for cions. It is not within the province of this
report to give full directions for growing stocks but a few suggestions derived from practice in California are printed to forestall questions that will be asked.

Of the several ways of grafting it is probable that that in which the cion and stock are grafted as cuttings will be found most satisfactory. Bileo\textsuperscript{t},\textsuperscript{1} a leading authority on viticulture in California, compares the various methods of starting a resistant vineyard as follows:

"Bench grafting cuttings is unhesitatingly recommended for the following reasons:

1. Both stock and scion are young and of the same size. The unions are, therefore, strong and permanent.

2. The grafting is done under conditions favorable to rapid and effective work.

3. The grafting can be done in any weather, and may extend over three or four months. Bench grafting may be done on rainy days when other work is not pressing or cannot be done.

4. The work is more easily supervised. One man who thoroughly understands all details of the grafting can oversee the work of several unskilled workmen, which makes it possible to employ cheaper labor for much of the work.

5. The cultural conditions are more easily controlled. There is much less danger of inferior results due to excessively wet or dry weather during the growing season. In the nursery the vines can be cultivated, irrigated, and generally attended to much more perfectly than in the field.

6. A rigid selection of vines for planting can be made, rendering it possible to have nothing in the vineyard but strong plants and perfect unions.

7. As perfect a stand can be obtained in the vineyard the first year in any soil or season as can be obtained when planting the ordinary non-resistant vines.

8. The union of every vine can be placed exactly where we want it.

9. The land where the vineyard is to be planted can be used for other crops for one year longer than when field grafting is adopted.

10. All the cultural operations during the first year are much less expensive, as they are spread over a much smaller area of land. Two acres of nursery will produce enough bench grafts to plant one hundred acres of vineyard.

"In short, starting a resistant vineyard by means of bench grafts is much better than by any other method used at present because it is the least costly and gives the best results. This is true whether we produce our own bench grafts or whether we buy them at the present market rate. Growers are earnestly cautioned, however, against planting any bench grafts but the first choice. Second and third choice are little better than field grafts, and many have been offered for sale lately which are sure to give disappointment in the vineyard. There are several nurserymen in the State now who are producing No. 1 bench grafts which are equal, and for planting here perhaps superior, to any produced in Europe.

\textsuperscript{1}Bileo, California Sta. Bul. 180:142. 1906."
"With regard to nursery grafting and bench grafting roots, all that can be said in their favor is that they are fairly good methods when bench grafting cuttings is impracticable. They enable us to produce rooted grafts with stocks which, owing to the difficulty with which they root, are very difficult to bench graft as cuttings. By their means we are enabled to utilize resistant cuttings, which are too small to bench graft, and a larger percentage of well-grown grafted vines is obtained from the nursery.

"On the other hand, as the stock is at least two years old when grafted there is reason to fear that with some stocks many unions will fail as the vines become older. The vines are larger when they are taken from the nursery, which increases the cost of removal, and there is little if any gain in growth over bench grafts when planted in the vineyard. Finally, the method requires a year longer and is in every way more expensive.

"Of field grafting, nothing favorable can be said except that it is more generally understood and the expense and work are spread over several years instead of being principally in the first. Many of its disadvantages may be inferred from what has already been said of the advantages of bench grafting. The principal are the extreme difficulty of obtaining a perfect stand, the trouble with cion roots and stock suckers, the impossibility of detecting imperfect unions until the vines die, and finally the greater ultimate cost."

To produce cuttings for stocks mother vines must be planted and cultivated. Here, again, Bioletti gives excellent advice from which the following are extracts:

"In planting a vineyard of resistant vines for the production of cuttings to be used for grafting it is important that a suitable soil and location be chosen. In order to produce a large crop of good cuttings the soil should be naturally rich or heavily fertilized. The location should be one in which the wood always ripens early and thoroughly. Spring frosts are almost as unfavorable to the production of good cuttings as of grapes.

"All the usual stocks are vigorous growers, and as they are planted in fertile soil they should be given plenty of space. A distance of 9 feet by 9 feet or 8 feet by 10 feet is quite close enough. This will give about 500 vines to the acre. As a good vine properly cared for should produce 150 feet of good wood for bench grafting, the product of an acre would be about 75,000 cuttings.

"The varieties of resistant stocks which will in all probability be most used in California are Rupestris St. George (du Lot), Riparia X Rupestris 3306, Riparia X Rupestris 3309, Riparia Solonis 1616, Mourvedre X Rupestris 1202, Aramon X Rupestris 2, Riparia gloire, and Riparia grand glabre. These are all varieties which have given excellent results for years in Europe, and have all been tested successfully in California. Among them are varieties suitable for nearly all the vineyard soils of California, with perhaps the exception of some of the heavier clays.

"The methods of pruning and training mother vines of resistant varieties will differ in several important respects from the methods suitable for varieties grown for their fruit. In the latter case we should be careful to leave as many fruitful buds as the vine can utilize; in the former the fruit is of no value, and if any is produced it will be at the expense of the wood. Our object is to produce as much wood as possible.

"In accordance with this idea the mother vines are often pruned in such a way as to force out each year a growth of watersprouts from the old wood. All the canes on the vine are cut off as close to the stump as possible.
“It is doubtful if this is the best way. So many watersprouts are forced out that the labor and care of thinning them are expensive. If they are not thinned there is a large growth of wood, but the canes produced are short and thin, and, therefore, unsuitable for grafting stock. If this method is adopted from the beginning the vine is reduced to a prostrate stump, which makes cultivation difficult, and as the vine becomes old it becomes full of dead wood and difficult to prune.

“A better method is to give the vine a trunk and head exactly as in pruning ordinary vase-formed vines. A trunk from 15 to 18 inches high and with five or six arms will make a vine much easier to cultivate and prune and at least equally productive of good cuttings. In pruning, very short spurs are left, consisting simply of the base bud. The cane should be cut off through the first bud above the base bud. This will insure the starting of the base bud and will avoid the danger of injury which occurs when the cut is made too close to the bud which we desire to have grow.

“With this method of pruning the arms will lengthen so slowly that there will never be occasion to cut them back. During the spring and early summer all unnecessary shoots should be removed in order to throw all the vigor of the vine into those which remain.

“A good, strong vine in rich soil should produce from 150 to 300 feet of good grafting wood between one quarter and one half of an inch in diameter, and a certain amount of smaller wood good for rooting. Experience only will tell how many shoots should be left to a vine. It will depend on the age of the vine, the variety and the soil. If too few are left there is apt to be too much thick wood unsuitable for grafting, especially with certain varieties such as Rupestris St. George. If too many are left there will be too many small cuttings.

“Some varieties of stocks produce good grafting wood if the canes are allowed to grow over the surface of the ground without support. This has a tendency with some varieties to encourage the growth of laterals and to make the canes short and stocky.

““To overcome this defect high poles are sometimes placed at each vine, and the canes kept in an upright position by being tied to these poles. The poles are sometimes 15 or 20 feet high. This method produces an abundance of excellent grafting cuttings, but is expensive and troublesome. A more practical method is to put a high stake—10 feet high at the end of each row and to stretch a wire at that height along the row. The shoots are then trained up to this wire by means of strings renewed every year.”

Better care of vineyards needed for grafted grapes.—The use of grafted vines in New York vineyards will make necessary much better supplementary care in the culture of vineyards. This must not be counted in the least against grafting, for better care should be given this fruit in every grape-growing section of the State. Indeed, it is feared that the vineyardists of New York are nowadays our least caretaking horticulturists. Dead vines and somnolent vineyards are all too common. In fact, if there were no differences in yield due to the grafting, it could be said well within bounds, that since the cultivation of grapes as grafted plants enforces better care, grafting is well worth while.
Not only must better care be given to secure a good stand of vines in a grafted vineyard but different care must be given the same variety on different stocks. This will be true, very particularly, of pruning, but the stock may have to be taken into consideration in plowing, tilling, fertilizing and in treatment of phylloxera and fidia. It is true that the same treatment was given all of the vines in this experiment but only because identical treatment was a necessary condition of the experiment.

**Will it prove profitable to graft grapes in New York?**—Because of the many vicissitudes through which the vineyard has passed, it would not be safe to answer this question unqualifiedly. But beyond doubt the experiment demonstrates the possibility of growing grapes in this State on roots other than their own. It suggests that it would be a safe stroke of business to graft some of the choicely good grapes of the region on roots of any one of several stocks with the expectation of getting larger crops and a better product. From the behavior of the standard sorts in the experiment, it is well within the range of probability that even the main-crop grapes can be profitably grafted. A commercial plantation of a few acres of Concords, Niagaras, Catawbas or Delawares grafted on one of the three stocks used is well worth trying. The establishment of a grafted vineyard should present no great difficulties. The hard places have mostly been smoothed by the French and Californians and their experiences, with those given in this report, should be sufficient guide for any wide-awake grape-grower.