

lar seedlings are not a product of sexual pollination and are, therefore, vegetative extensions of their fruit bearing parents. Having originated from seed they are, so far as is known, free of virus. Now another question must be answered. How are nucellar seedlings separated from sexual seedlings? This is not easy to do. Some sexual seedlings can be identified by deviation in leaf structure and physical expression. The remaining seedlings must be allowed to grow to fruiting. Fruit from these trees is observed for a period of years to establish trueness to type. Many citrus varieties have been freed of virus using nucellar propagating techniques. The varieties which do not produce nucellar seedlings remain a problem. Many virus diseases which are not readily apparent can now be detected by indexing, grafting suspected tissue into a suitable indicator plant. Spread of virus can therefore be minimized by selecting bud wood only from fruit bearing trees which have been indexed and determined free of major virus problems. Indicator plants are not now available for all virus diseases.

Citrus plants mutate readily. Mutant strains have been propagated accidentally with catastrophic results. Growers have invested thousands of dollars in groves only to discover, when they began to bear fruit, that the fruit is off-type and of little value. The citrus nurseryman must be constantly alert to prevent introduction of off-type or mutant strains into the industry. All mutants are not necessarily bad. Many of the outstanding varieties of fruit grown today are the result of mutations, but improvement through mutation is rare. In spite of the fact that most citrus varieties are easy to reproduce, the nurseryman has more than his share of troubles. Virus, mutation, and the usual soil born diseases and parasites are enough to cause many sleepless nights.

VIRUS INACTIVATION IN STONE FRUITS

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Viruses in stone fruits generally have serious economic effects ranging from complete loss of crop, if not death of the tree, to subtle loss of vigor that often has been wrongly attributed to "poor culture," if noticed at all. Freedom from most, if not all, viruses is apparently desirable.

Propagators have the basic responsibility to see that virus-free propagating materials are used. Once infected, the tree is infected for life for all practical purposes. Every propagator should be familiar with the symptoms of virus diseases, indexing techniques, and means of achieving and maintaining virus freedom.

Many viruses are significantly spread only through use of infected propagating material, and simple knowledge and use of virus-free propagating material is all that is necessary for

control. Where natural spread occurs, control is achieved through isolation from infected hosts and vectors.

The key to practical virus control by the propagator, however, is the obtaining of virus freedom in the first place and the maintenance of this freedom from virus. For many stone fruit varieties this has been done so far by experiment station researchers as an extension of their study of fruit viruses. Agricultural regulatory authorities have set up so-called "certification" programs to ensure maintenance of freedom from virus. The most comprehensive and rigid program is probably that in California, covering not only stone fruits but many other fruit crops also.

What I would like particularly to emphasize is that the propagator, the commercial nurseryman, has the means available himself to carry out a practical virus-control program more efficiently, at less cost, than is done by government agencies, certainly less red tape. The taxpayer is now unnecessarily subsidizing virus certification programs or where nurserymen are paying fees they are very high if the costs are fully recovered.

The researcher should be relieved of routine service programs and left to do basic research. The basic techniques for virus control are worked out, though there are some problems that need to be overcome. The propagator or commercial nurseryman should assume a program for freedom from virus just as he has other pest control programs.

Regulatory authorities, as a matter of political principle, should stay out of certification programs that are no more than setting quality control standards. Regulatory authorities should be involved only where there is genuine public concern—only with those viruses that are both of serious economic consequence and spread beyond the control of the propagator or commercial nurseryman and the ultimate user, the orchardist. Generally these viruses are limited to certain areas and are already covered by quarantine programs.

The majority of stone fruit viruses are not known to spread except by propagation. Also the economic importance of many virus diseases is yet to be fully demonstrated. This should be done before regulatory authorities step in, since without this, genuine public concern cannot be proven.

Heat treatment to inactivate viruses in living plants is the technique that helps make a do-it-yourself virus-control program practical for the propagator or commercial nurseryman. The basic method presently used is to grow living plants in containers at temperatures of 98° to 100° F. for periods of four to six weeks. This standardized treatment will inactivate most viruses. Buds or cuttings taken from heat-treated plants can then be propagated free of virus. Where viruses are more resistant to heat, tip grafts from new shoots grown in the heat chamber will often be free of virus when buds or cuttings from old wood are not. There is good probability that those few vi-

ruses that are not now inactivated under heat treatment can be inactivated under refinements of the method.

Simple heat chambers of various sorts built very inexpensively or making use of existing facilities have been put into effect by a number of nurseries. In our own experience at Armstrong Nurseries, we have very easily inactivated ringspot in many stone-fruit varieties. Our facility was an existing 8' x 16' greenhouse with an oil heater and evaporative cooler, that was made into a heat chamber merely by putting in a new thermostat to cover the higher temperature range. This operates quite satisfactorily when outside temperatures are above 50° F. Temperatures are not always between 98° to 100°, being sometimes a few degrees higher and lower than that; however, this does not affect the results. No artificial light is used. Shading is provided by ordinary lath frames.

Indexing is accomplished by budding on to indicator hosts. Development of serological methods will eventually permit a quick chemical test.

For many varieties the use of heat treatment to eliminate virus is not necessary. Existing trees of varieties can be found free of virus. It can be quite tedious to find such a tree through indexing large numbers of trees; however, once such trees are located the varieties can be maintained free of virus quite easily. This has already been done for many stone-fruit varieties by researchers.

Heat treatment by the nurseryman has numerous advantages. It can be done cheaper than by the experiment stations and he can treat the varieties he wants when he wishes. This has competitive value. Where nurserymen are introducing new varieties and sports, it becomes a necessity. Also where there are particular selected strains or proven true-to-type varieties in a scion orchard, he can treat these and not have to accept varieties, from other and possibly unproven sources, put out by experiment stations. The procedure is simple and requires only a practical knowledge of viruses.

The nurseryman can cut costs by fitting his virus-control program to his own needs and needs of his customers. He takes reasonable risks. He must be familiar with virus diseases, periodically inspecting his scion orchard and indexing every few years for easily spreading common viruses such as ringspot. Ringspot apparently spreads by pollen. However, except for an awareness of them he can disregard the more serious viruses since those that spread naturally are controlled by quarantine. The remainder are transmitted through propagation only. Once clean the latter remain clean. Nurseries should obviously be outside quarantine areas.

Reasonable isolation of a virus-free scion orchard is only being practical. However, risks can be taken. Occasional infection of a scion tree with a common virus like ringspot can be tolerated, the tree being rogued when detected. More than one tree of a variety is usually present or a clean tree can be recov-

ered from the nursery stock. If necessary, heat treatment will clean it up.

The program outlined does imply the practical desirability of a scion orchard rather than cutting wood from miscellaneous orchards. Inspection of nursery stock should not be necessary other than routine observation than is done in any growing operation. With some knowledge of symptoms on nursery stock, the grower would be able to detect any significant virus infection. With a clean scion orchard the chance of any virus in the nursery stock would be very remote. Even if there was an occasional tree with a minor virus like ringspot, the significance to an ultimate user would be nil.

Official certification programs are expensive because of the inherent high overhead costs of government agencies and the unwillingness to take reasonable risks, "bending over backward" to ensure absolute freedom from all viruses in every nursery tree, with overly stringent indexing, isolation and inspection procedures, using highly trained personnel on routine matters that less skilled persons could do. The practical program outlined for nurserymen will achieve the same freedom from virus for all practical purposes.

In conclusion, it is suggested that commercial nurseries establish their own virus-control programs, with heat chambers, rather than let regulatory agencies pre-empt the field. Not only is it more practical and cheaper, but in principle the responsibility lies with the nurseryman. Most viruses are important as affecting tree quality, of concern only between the nurseryman and the orchardist. The regulatory agency has no business setting quality standards. As already pointed out, though, it should have the responsibility where certain viruses are of serious importance and spread beyond the control of nurserymen and orchardists — becoming of genuine public concern.

While I have been discussing stone fruits, I believe the same thing applies to other plants.

[*Editor's Note:* The following paper was presented by Dr. John Mahlstedt, Iowa State University].

PEACH BUD — GRAFT UNION ON *Prunus besseyi*^{1 2}

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Introduction

The use of selected rootstocks for dwarfing fruit and ornamental plants has been an established practice in Europe for many centuries (Dana, 1952 and Scholz, 1957). Only recently.

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