Propagation and Testing of Deciduous Fruit Trees for Viruses

Michael Barkley
NSW Agriculture, PMB 8, CAMDEN NSW 2570

INTRODUCTION

In researching and diagnosing virus diseases of deciduous fruit trees several propagation techniques were utilised and integrated with virus testing and elimination procedures. The aim of this work is to avail nurserymen and do-it-yourself growers the benefits of healthy propagating and planting material: improved profitability through higher nursery and fruit production efficiency.

The present work involves viruses but the principles and general approaches also apply to other plant pathogens, such as bacteria, fungi, and other infectious agents. Two notable differences are:

1) Fruit tree viruses depend on living hosts for their survival and dispersal.
2) Remediation of virus-infected plants on a commercial scale is impractical and not cost-effective.

The use of healthy plant propagating material prevents the spread of pathogens, reduces production costs for both nurserymen and growers, and helps meet consumer demand for a consistent, high quality product.

DETECTION

Usually healthy trees are more vigorous and yield more foliage, flowers, and fruit than infected trees. In nursery rows, virus-infected trees can be stunted or weak. As trees mature visible symptoms can appear, such as twisting of trunk or branches and distortion of fruit. Most virus-infected deciduous fruit trees show no obvious visible symptoms of infection. Viruses symptomless in their hosts can be detected using biological, biochemical, and molecular methods.

Herbaceous or woody indicators are used for biological detection; these are plants which express visible, diagnostic symptoms of one or more virus infections. For example, cucumber seedlings mechanically inoculated with leaf sap from an infected tree can produce yellow lesions. If grafted into sensitive woody hosts, tatterleaf symptoms may be produced, indicative of prunus necrotic ringspot virus.

Biological virus indexing in woody hosts is commonly done by chip budding pieces of bark either directly into a branch of an indicator, testing multiple samples on each branch, or inoculating a rootstock previously budded with the virus indicator variety. The resulting symptoms depend on the virus and indicator, varying from yellowing to epinasty to graft union and xylem disorders to death. Use of controlled environmental conditions can expedite symptom expression and enhance sensitivity and reliability of detection, particularly for milder strains of viruses.

ELIMINATION

Various propagation methods are used in eliminating viruses from fruit trees to produce healthy propagating material:

1) Selection, i.e. propagating successive buds onto individual rootstocks and selecting healthy propagations after testing.
2) Use of nucellar embryony (more appropriate for citrus than deciduous fruit).
3) Hot, moist air treatment (37C for 3 to 12 weeks) of entire trees followed by removing buds or shoot tips for grafting.
4) Micropropagation, using tissue culture, macro shoot tip grafting or in-vitro micro-shoot-tip grafting.
5) Hot water immersion followed by grafting buds onto healthy rootstocks or direct planting of cuttings.

BENEFITS OF HEALTHY PROPAGATING MATERIAL

The benefits of using healthy propagating material can range from 10% to 90% or higher, depending on the pathogen, host, and environmental factors. With virus-infected material, root strike of cuttings can be reduced 75% while bud failure can occur in up to 87% of propagations. Virus-infected deciduous fruit trees can produce 20% to 50% less fruit, half the canopy density, and up to 30 times more fruit with skin blemishes. Healthy propagating material also minimises wastage, presently a critical environmental and social issue.

POSITIVE SPIN OFFS

Evaluation of deciduous fruit tree hybrid crosses can be expedited by in vitro germination of seed extracted immediately after harvest and growing it under controlled environmental conditions. It is possible to obtain about 1 m of growth before winter and enable fruit buds to form 1 year earlier than seed which is stratified to fulfil normal winter dormancy.

Another positive spin-off exists for commercial-scale hot water treatment of propagules infected by viruses, bacteria, or fungi to meet certification or quarantine standards or enhance propagation success.

PRESENT CHALLENGES

Challenges encountered here include (a) overcoming "buttoning-off", where apical meristems mature and cease growing until next season, (b) browning of micrografted tissue of in-vitro plants, (c) overcoming leaf symptoms apparently associated with inadequate chilling requirement in seedlings obtained from same-season germinated seed, and (d) developing a cost-effective pathogen elimination method, particularly on a commercial scale.

CONCLUSIONS

Some of the propagation and virus elimination methods discussed here have proven cost-ineffective in Australia, even though they were performed under rather pragmatic, low-cost conditions. This includes tissue culture, in-vitro micro-shoot-tip grafting, hot moist air treatment, and to a lesser extent selection. Macro-shoot-tip grafting, in combination with hot water treatment, offers considerable promise but requires further substantiation before general acceptance.

Acknowledgments. This work was conducted with support from NSW Agriculture and research grants from NSW Horticultural Stock and Nurseries and the Australian Horticultural Research and Development Corporation.