5. Maynard, B. and N. Bassuk. 1985. Etiolation as a tool for rooting cuttings of difficult-to-root woody plants. *Proc. Inter. Plant Prop. Soc.* 35:488–495.
6. Maynard, B. and N. Bassuk. 1987. Stockplant Etiolation and blanching of woody plants prior to cutting propagation. *J. Amer. Soc. Hort. Sci.* 112(2):273–276.
7. Maynard, B. and N. Bassuk. 1987. 'Understanding the dark—researchers grow plants under cover for better cuttings.' *American Nurseryman* April 1,:124–131.

VEGETABLE PRODUCTION IN AUSTRALIA WITH EMPHASIS ON THE POTATO

DOUG F. HOCKING[1]

NSW Agriculture and Fisheries
Division of Plant Industries
Sydney, New South Wales

To describe the Australian vegetable industry of 1988 in a short treatise is almost impossible. I consider there are four key elements that make up the industry. They are marketing, technology, the environment, and industry organization.

Marketing. There is no doubt the vegetable industry is consumer driven and the sooner that is fully realized, the better. Buyers are no longer prepared to take what growers or agents think they want. Vegetables are competing with a whole range of other foodstuffs and as difficult as it may be to change vegetable products, it must be done. The customer is always right.

The marketing of vegetables starts when a grower first decides what type of vegetable to grow and the cultivar and the production system he will use. These all influence the product he finally sells. In Australia many growers make these decisions on what they did last year or perhaps what their agents or neighbours tell them. In Sydney we have Flemington Markets, one of the largest wholesale markets in the world. The agent/merchant system has an enormous influence on what is produced. A lot of produce that is sold in these markets comes from interstate and these growers rely heavily on their agents for advice. The development of rapid road transport has meant vegetables from anywhere in Australia can be economically marketed in Sydney. The increase in the export market has probably been the most significant change in vegetable marketing in the past five years. This market has grown from $15 m in 1981/82 to $60 m in 1986/87.

Technology. Whilst the industry is market-driven the technology must be available to produce the product. Basic vegetable research and development in Australia is limited compared to the size of the industry. Production system development has largely come from taking overseas technology and developing it to our local

[1] Director, Plant Regulatory Services

environment. To the credit of individual growers, they have been as expert as anybody at this. Some of the key areas in technology that influence vegetable production are cultivars, pest and disease and weed control, nutrition, irrigation, mechanization, and post-harvest.

The Environment. The Australian continent stretches across a wide range of environments, from the tropics in the north to the temperate regions of the south. As stated before, the development of rapid transport put all these regions within an economic distance of the major population centres. For consumers it means most products are available fresh all year round. Tomatoes, potatoes, and cucurbits are prime examples of this. For the industry it has meant a redistribution of growing areas and, a continuous year round supply of major vegetable types.

Industry Organization. For a commodity the population is so dependent on for its survival, I have always found somewhat disturbing the lack of an adequately funded central organization of producers. The decision to grow or not to grow is largely based on supply and demand which quite often results in large fluctuations in supply. The lack of effective organizations means the Government does not have representative groups to consult with when making important policy decisions. For instance, it has meant a lack of funds for research, the likes of which have helped other industries prosper and develop. If the Australian vegetable industry is to develop further, it must have an adequately funded central organization with skilled executive staff, not the current situation where it relies heavily on the charity of its members to perform industry functions.

POTATOES

I would now like to address the actual propagation of vegetable crops in Australia. However, to discuss the propagation of all vegetable crops in the allocated time would be impossible. So I have decided to concentrate on the major vegetable crop in the world and Australia, that is, of course, potatoes.

Potato Propagation in Australia. As potatoes are vegetatively propagated they pose special problems in breeding, cultivar evaluation and development and, of course, commercial "seed" multiplication. In Australia the problems of viral, fungal, and bacterial disease transmission in potato production have been addressed for many years. The maintenance of clean, true-to-type "seed" lines in highland "seed" producing areas has been conducted since the mid to late 1800s. Much of this development started after the gold rush of the 1850s which, of course, was concentrated in some of the current "seed" growing areas of the central highlands of Victoria and the central tablelands of NSW. These areas, because of their altitude and relative isolation, have low aphid population, the princi-

pal vectors of the major virus diseases.

"Seed" potato growers, as in so many other horticultural industries, maintained their own "seed" lines by a system called "Stud plotting". The growers made their own clonal selections and multiplied these up. Stud plots were carefully rogued for diseased and off-type plants, so that each year a stud plot big enough to produce sufficient tubers to plant the growers commercial "seed" crop was grown. This form of "seed" production became somewhat of an art form with quite a lot of folklore and mystique surrounding it. It probably reached its peak of skills and dedication during the 1930s–60s. In NSW and indeed other States the growers organized themselves into co-operatives to run certification schemes, with inspection and certification of crops done by the State Departments of Agriculture.

At its peak this system of "seed" production and certification proved to be very effective. But, as in all industries, change seemed to be inevitable. The economic pressure for higher yields of specialist end use potatoes saw demands placed on these schemes that they couldn't meet. This came particularly from the processing industries. With each grower producing his own line of "seed", potential yield between "seed" lines was very variable, both genetically and disease wise. Also, because of slow multiplication using whole tubers as the propagule, the industry was slow to adopt and multiply new cultivars.

Potato "Seed" Production Today. The system of potato propagation and "seed" production being used in Australia today has come about for several reasons. Some I have already mentioned above.

—Industry requires "seed" uniform and true to type.
—Tuber transmitted diseases must be kept to an absolute minimum.
—New cultivars must be brought into commercial production as rapidly as possible.
—Total amount of "seed" required could not be catered for under the "stud plot" system.
—Containing the cost of commercial certified "seed" potatoes.

During the 1960s it was found the potato was particularly suited to aseptic micropropagation. This led scientists and practical horticulturists to a whole new concept of potato propagation and multiplication.

Micropropagation of Potatoes. Aseptic micropropagation was not the first change in potato multiplication. It was in fact preceded by a system using stem cuttings that was developed in Australia by Dr. Peter Goodwin of the Sydney University. The system involved taking stem cuttings from virus-indexed mother plants and growing them in aphid-proof screenhouses in sterile potting mix. The stem cuttings, of course, produced mini tubers. As growing plants became large enough, more stem cuttings were

taken and quite rapid plant multiplication resulted. Whilst this system was quite effective, it was never adopted because of the development of aseptic micropropagation. This was a logical development that used the same concepts but gave even more rapid multiplication and reduced the risk of disease infection even further. The system involves establishing a nuclear plantlet that is apparently free of pathogens. Nodal cuttings are taken from this plantlet and as plantlets grow further propagation takes place. Once enough plantlets are multiplied they are then planted out into sterile potting mixture in aphid-proof screenhouses to produce mini tubers. Depending on the cultivar, the average number of mini tubers produced per plant varies from 3 to 6. These mini tubers are then taken to producing areas for field multiplication. Depending on the scheme, this can take from 3 to 6 generations before commercial "seed" is available. These field generations grow under strict hygiene and isolation from other generations. Monitoring for disease status is also carried out. The advantage of this method is large numbers of mini tubers can be produced in controlled conditions free of disease vectors. Whilst the plantlets are in the screenhouses, disease status is closely monitored using such techniques as ELISA.

The Future. It is difficult to pontificate on the future techniques for potato propagation in Australia. One thing is for certain, potatoes will remain as our number one vegetable and a staple of the Australian diet. In terms of propagation techniques there are at least two systems that should be given small scale commercial testing. However, the real restriction on the future is the "seed" production industry itself. On past performance the "seed" growers have been unwilling to accept change. The schemes described above have been heavily subsidized by Government and still the scheme in NSW is in danger of collapse due to lack of grower support. This is in spite of strong pressure from end users for "seed" of limited generation origin. As propagators you are, no doubt, interested in the new techniques available.

The two techniques that I believe have prospects for the future are true potato seed (TPS) and micro tubers.

True Potato Seed. True potato seed (TPS) has long been considered as an alternative method for potato multiplication. However, serious research and development only really started in the mid 70s at the International Potato Centre (CIP) in Peru. Under certain conditions all potatoes will set berries from the flowers. It is from these berries that seed is collected and, after a period of dormancy, can be planted and a tuber-bearing potato plant will result. At this stage TPS is mainly being researched for farmers in the developing countries where it has several advantages. However, most of these advantages could be extrapolated to Australia. Some of them are:

—Reduced cost of planting material.
—Minimizes spread of tuber-transmitted diseases.
—Releases for human consumption the large volume of potatoes previously used for "seed."
—Simplifies "seed" storage and makes high quality planting material available at optimal planting times.
—Reduces cost of planting material in certain circumstances.

The production of TPS is not easy and involves the manipulation of the growing environment through plant density, irrigation, nutrition, and the use of growth regulators. Some cultivars are more prolific seed producers than others and these cultivars may not suit sophisticated end use patterns.

Once the seed is produced and ready for planting, it can be used in two ways. It can either be planted into a nursery and seedling tubers produced for further planting in the field, or, container grown seedlings produced and planted direct into the field. In some instance seed has been directly sown into the field, but with mixed results. When all aspects of production are suitable, up to 45 tonnes/ha are produced using TPS.

Micro Tuber Production. A major disadvantage of the micropropagation now being used in Australian seed schemes is the transplanting phase from test tubes to potting mixture in the open environment. This is the most delicate stage and also the most expensive part of the multiplication process. To overcome this problem, the technique of producing micro tubers in tissue culture has been developed.

Micro tubers like the mini tubers are really only a smaller version of ordinary tubers. Average size is about 8 to 10 mm in diameter. By manipulating the growing environment through nutrition, daylength, and growth regulators, in-vitro plantlets can be induced to set tubers.

The major advantage of micro tubers is that they are more robust than plantlets and can be planted directly into nursery beds or carefully controlled field conditions for further multiplication.

Container Grown Seedlings. This involves the production of micropropagated plantlets that are then grown in seedling containers for hardening off and then direct transplanting into the field. This system is being successfully used in Australia for initial rapid multiplication. It avoids the production of mini tubers in sterile potting mixtures in insect-proof screenhouses. However, it does have problems. In the short time (10 to 14 days) the plantlets are in the cell, only a very weak root system is developed. This has been somewhat overcome by the use of degradable paper pots.

REFERENCES

Australian Bureau of Statistics.

International Potato Centre 1986. Annual Report CIP 1985 Lima, Peru 176 p.

CIP Circular Vol. 13, No. 4, Dec. 1985. Induction and use of in-vitro potato tubers. P. Tovar *et al.* CIP Lima, Peru.