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Carrot export growth depends on keeping cavity spot under control

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CARROT EXPORT GROWTH DEPENDS ON KEEPING CAVITY SPOT UNDER CONTROL

More than 90 per cent of carrots exported from Australia come from Western Australia, with exports from the State worth $32 million (fob) in 1997/98. The main export markets are in South East Asia and the demand for high quality carrots is increasing.

Carrots are grown all year round with irrigation on the sandy soils of the Swan Coastal Plain between Bunbury and Gingin and along the south coast near Augusta. Production systems are highly mechanised and very efficient.

Increasing demand for carrots can be met by increasing the area under production and improving marketable yields. Blunt-ended Nantes carrots are currently the most important varieties for export and are also replacing the more tapered Imperator varieties in the local market.

Cavity Spot

One of the most significant constraints to carrot production on existing sites is the soil-borne disease cavity spot. This disease has increased with carrot-cropping history, with most major growers now rating cavity spot as the most serious problem affecting production.

Cavity spots are sunken, brown, circular to elliptical lesions of 1-10mm wide and are sometimes surrounded by a pale halo. Affected carrots are unmarketable both locally and overseas.

A survey of more than 200 carrot crops carried out in 1990/91 revealed that cavity spot was present in almost half of the crops and produced a greater than 10 per cent yield loss in 16 per cent of the crops.

The Carrot Association for Research and Development ranked cavity spot as the
number one priority for industry research and development in a 1995 survey. Funding for a project was secured from the Horticultural Research and Development Corporation (HRDC).

Cavity spot is caused by a species of the soil-borne fungi, *Pythium*. In Western Australia, cavity spot is caused by *P. sulcatum*, but other species such as *P. violae* and *P. ultimum* are important overseas.

Agriculture Western Australia has been carrying out research for the past six years to develop integrated control of cavity spot. Various control measures have been investigated, including the use of tolerant varieties, rotation, chemical control, and the use of soil amendments.

**Tolerant varieties**

Identification of cavity spot tolerant varieties suitable for commercial production is a key component in controlling carrot diseases. This is done in a disease nursery at the Medina Research Station.

Agriculture Western Australia established the disease nursery in 1994. The site was infested with reject carrots from a commercial property where cavity spot was severe. The carrots were rotary hoed into the site, which was continuously cropped with the cavity spot susceptible variety Primo to build up disease levels.

Carrot varieties and advanced breeding lines for testing are sourced from Australian, French, Dutch, Danish, Japanese and American seed companies. The screening program for the trials is aimed mainly at Nantes varieties, though some Imperator and Kuroda types are included. Kuroda varieties originate in Japan and are demanded by the Japanese market.

Varieties are assessed for yield and quality in addition to cavity spot tolerance. In stage 1 trials, they are screened in unreplicated plots. The most promising lines are tested in replicated, stage 2 trials. The best varieties are then grown on growers’ properties for commercial evaluation in stage 3 trials.
The cavity spot susceptible variety Ivor, formerly known as Top-Pak, is grown as a standard in all trials, while the tolerant variety Bolero is included in stage 1 and 2 plantings.

In 1998, 33 carrot varieties were grown in unreplicated stage 1 plots, and a further 36 were grown in replicated stage 2 plots. Twelve varieties were chosen for stage 3 trials at West Gingin and Baldivis.

1998 Variety Trial Results
Stage 1

A wide range of varieties was included in the stage 1 planting. Ivor had the highest yield of these varieties. Several plants showed cavity spot tolerance similar to Bolero, notably the Nantes line Y3010 and the Kuroda line S374i.

As a group, the Kuroda varieties showed high levels of root splitting. A variety with low susceptibility to bolting, root splitting and disease is needed if export of Kuroda varieties to north Asia is to be viable.

Stage 2

All stage 2 varieties were either Nantes or Nantes-cross types apart from Newport, which was an Imperator variety.

The control cavity spot tolerant variety, Bolero, had the lowest incidence of cavity spot. Of the more tolerant varieties, Barbados and Crusader produced the best quality roots.

When assessing the results of both stage 1 and stage 2, cavity spot incidence ranged from 40 per cent in Bolero to 96 per cent in Ivor. Varieties showing promising cavity spot tolerance included Barbados, Crusader, Major, Nandor, Navarre, Nerac, and Red Czar.

Ivor and the recent commercial release Murdoch ranked among the most susceptible.

Stage 3

The 1998 stage 3 sites were sown in January and harvested in May. Site 1 was located at West Gingin, north of Perth and site 2 was located at Baldivis, south of Perth.

Cavity spot incidence was higher at site 1 than site 2. Apart from Ricardo, which had similar cavity spot levels to Ivor, all other varieties had lower levels of cavity spot at both sites. Navarre, Nerac, Crusader, Red Czar, and Nairobi averaged less than 32 per cent of the incidence of cavity spot of Ivor at the two sites (see Table 1).

Crusader produced equivalent marketable yields of similar or better quality to Ivor at the two sites. Most of the varieties included in these plantings proved more cavity spot tolerant than Ivor, though only Crusader showed both cavity spot tolerance and produced root quality comparable to Ivor.

Consequently, Crusader was recommended for export production on sites with known cavity spot problems.

Ricardo’s marketable yield advantage over Ivor at site 2 resulted from a lower rejection rate for misshapen roots. Ricardo has potential to replace Ivor or Murdoch for autumn harvest on sites where cavity spot risk is known to be low.
### Rotation

One of the most successful ways to minimise soil-borne diseases is to practice crop rotation. However, in Western Australia, high infrastructure costs and a lack of suitable rotation crops means that carrots are often repeatedly grown on the same site.

Where rotation is practised, it is important that the *Pythium* that causes cavity spot does not infect the alternate crops. Work on infested land at the Medina Research Station showed that plants in the same botanical family as carrots (Apiaceae), including celery, parsley, parsnip, and blue lace flower, can be hosts of *P. sulcatum*.

The fungus does not infect unrelated plants, such as broccoli, lettuce, onions, tomatoes and spinach. Therefore, rotation crops should not be closely related to carrots.

### Chemical control

Chemical control is a common way of minimising diseases. Two chemicals, the soil fumigant metham sodium, and the fungicide metalaxyl, have the potential to reduce *Pythium* diseases such as cavity spot.

Field trials on growers' properties using metham sodium showed that its use increased the proportion of export quality carrots, but did not reduce cavity spot.

Metalaxyl, sold locally as Ridomil®, Apron® and Rampart®, is recommended overseas for controlling cavity spot. It can also be very effective in reducing the incidence of other *Pythium* diseases of carrots, such as forking and damping off.

However, local trials have shown that metalaxyl gives inconsistent results. As it is an expensive fungicide, it is important that growers know when and where it can be used effectively.
Metalaxyl was found to work well on a site where it had not been used before, but did not work on sites where it had been used on previous crops.

Research found that metalaxyl was breaking down rapidly in soils where it had been used in the past. Once this enhanced biodegradation has developed, there is little growers can do to reverse the process.

Growers appear to have limited options for chemical control of *Pythium* diseases such as cavity spot. Though fungicides may work well initially, they are unlikely to offer a long-term solution.

**Liming**

When the initial crop survey was carried out in 1990/91, it was noted that crops grown on alkaline or neutral soils had a lower incidence of cavity spot than crops grown on acid soils.

Experimental work with hydrated lime and lime sand has shown that if the soil pH is raised to more than 7.2 in calcium chloride, the incidence of cavity spot is reduced in the subsequent three crops. As a result of this finding, liming is widely practised by local carrot growers.

**Future**

The research program conducted by Agriculture Western Australia underpins the Australian carrot export industry. This program has assisted the industry maintain its international competitiveness through improved efficiency and marketable yields.

In southern and eastern Australia where carrot production is mainly for the domestic markets, cavity spot is also causing problems.

A new HRDC funded project, titled 'Integrated management of *Pythium* diseases of carrots', will determine whether local research and development can be applied to carrot production in other States.

Collaborators in Queensland, New South Wales, Victoria, Tasmania and South Australia will send *Pythium* isolates from cavity spot to Agriculture Western Australia to determine whether *P. sulcatum* causes cavity spot in other Australian states. This project will further develop integrated management programs, including chemical control, variety tolerance and use of rotational crops.