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The export carrot industry

By Angie Galati and Allan McKay
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South Perth

Carrots are the single most important horticultural export commodity from Western Australia.

In 1991-92, over 23,000 tonnes of carrots worth more than $12 million (fob) were exported. The State now exports about 70 per cent of its carrot production to Singapore, Malaysia, Hong Kong and the Middle East (see Table 1). These exports account for more than 90 per cent of Australian carrot exports.

The State's carrot exports started in the mid-1970s. In 1977-78, only 2170 t of carrots were exported, but exports have increased steadily since then (see Figure 1).

Carrots, one of the major horticultural crops produced on the Swan Coastal Plain, are grown from Gingin in the north to Myalup in the south. About 780 ha were planted in 1991-92. The sandy soils, reserves of good quality groundwater for irrigation, and mild Mediterranean climate mean the area is ideally suited to the year-round production of premium quality carrots.

The small domestic market provided the impetus for export development in Western Australia. The State has several advantages in supplying export markets with carrots apart from the ability to supply high quality produce year-round. Its closeness to south-east Asian markets and regular shipping services have been important in the establishment of vegetable export industries based on sea freight.

Table 1. Major markets for carrots exported from Western Australia in 1991-92

<table>
<thead>
<tr>
<th>Destination</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>10,950</td>
</tr>
<tr>
<td>Malaysia</td>
<td>9,044</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>1,883</td>
</tr>
<tr>
<td>Bahrain</td>
<td>473</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>438</td>
</tr>
<tr>
<td>Brunei</td>
<td>225</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>168</td>
</tr>
<tr>
<td>Seychelles</td>
<td>167</td>
</tr>
<tr>
<td>Muara</td>
<td>75</td>
</tr>
<tr>
<td>Kuwait</td>
<td>41</td>
</tr>
<tr>
<td>Other</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>23,492</td>
</tr>
</tbody>
</table>

Figure 1. Export of carrots from Western Australia, 1980-1992 (Source: Western Australian Quarantine and Inspection Service.)

About carrots

Carrots (Daucus carota L.) belong to the Apiaceae or Umbelliferae family, which includes the vegetables celery and parsnips and many herbs including parsley, coriander and dill.

Cultivated carrots are normally biennials. They produce leaves and an edible taproot in the first year, then an elongated flower stalk and subsequently seed in the second year.

Carrots with purple roots were domesticated in Afghanistan. They spread to the eastern Mediterranean under Arab influence in the 10th to 12th centuries, and then to Western Europe in the next 200 years. It is likely that today's orange carrot was selected in the Netherlands in the 17th century. It was probably a mutant of a yellow root that spread with the purple form.

A wide range of varieties including many F1 hybrids is now produced by seed companies in France, Holland, America and Australia.
Despite high labour, transport, port and shipping costs, the local industry has developed an internationally competitive export industry. Four major and several small vegetable exporting companies operate in the State.

The industry has responded to high labour costs by becoming highly mechanised. Precision air-seeders, mechanical harvesters and production line washing and size grading facilities are common. Grading carrots for quality and packing is labour-intensive. Only smaller producers who grow for the domestic market harvest by hand.

**Production of export carrots**

Carrots are commonly grown in rotation with other vegetable crops including lettuce, onions, potatoes, cauliflowers and Chinese cabbage. Carrots are also often followed by another carrot crop. Some producers have attempted to continuously crop carrots, which has led to major disease problems.

Once the preceding crop is harvested, the remaining residue is mulched into the soil and allowed to break down before planting. Carrots are susceptible to root knot nematode damage, particularly during summer; so nematicides are usually applied before planting.

The Swan Coastal Plain's mild climate means that carrots can be produced throughout the year. Carrots require between three and five months from planting to harvesting, depending on planting date, density and varieties. The growing period largely depends on temperature. In the hottest months the crop can be ready for harvest 14 weeks after sowing while it can take up to 22 weeks when the crop grows through winter.

**Sowing**

Carrots are sown with precision seeders to achieve uniform plant spacing at the required density. Marketable yield and root length are affected by plant density (see Figure 2).

The grower aims to produce between 60 and 90 plants per square metre. The higher density is used in summer for crops of higher yield potential, while the lower density is used for winter harvest when root length tends to be shorter. Lower plant density produces longer roots (see Figure 2). Carrots for export must be longer than 150 mm.

The optimum density depends on the time of year, how long the crop is growing and its yield potential.

Precision air-seeders can sow raw, pelleted or film-coated carrot seed. Pelleted seed is coated with an inert material to produce a round pellet that is easier to sow than the smaller, oblong, raw seed. With film-coated seed, the seed is covered with a thin polymer coating to smooth rough edges. This makes the seed flow more easily through precision seeders.

**Soils and fertilisers**

Carrots are grown successfully on the orange alkaline Spearwood sands close to the coast, the slightly acidic yellow to grey Karrakatta sands and the coarse grey acidic Bassendean sands further inland.

Most phosphorus fertiliser and trace elements are applied before planting. On the Bassendean sands (from which phosphorus can be leached) split applications of phosphorus are the most efficient. Nitrogen, potassium, magnesium and some additional boron are applied at regular intervals.

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Improving efficiency of the industry
Exporting vegetables is a highly competitive business; growers in other states are eager to expand production. maximising production efficiency and quality are objectives of Western Australia’s export carrot industry.

After arrival and clearance at the importing port, carrots are either taken directly to wet markets, supermarkets, hotels or cool-stored for later distribution. The cartons are then cool-stored before being packed into 20 kg capacity cartons lined with plastic to prevent dehydration.

A recent field experiment comparing blight control strategies demonstrated the importance of controlling blight. Alternating sprays of the fungicides chlorothalonil and mancozeb applied at regular intervals gave an export yield of 63 t/ha, while in the same crop where blight was not controlled the yield was 24 t/ha.

Calibration of leaf tissue analysis for nitrogen is being developed. This test, together with improved irrigation techniques, will help growers to maximise crop water use efficiency and minimise nitrate leaching. A specialist extension officer has been working with vegetable growers on the Swan Coastal Plain to encourage adoption of soil and plant analysis, and more efficient fertiliser use.

Varieties
Export carrot production is almost exclusively based on hybrid Nantes carrot varieties bred by European seed companies. The sweet-flavoured, blunt-ended Nantes varieties have replaced the long tapered Western Red variety in the past three years. Nantes carrots are popular with overseas consumers and varieties such as Nandor and Top Pak are higher yielding and have smaller leaves than Western Red. The smaller leaves improve harvesting efficiency.

Weeds, pests and diseases
Pre- and post-emergent herbicides are used to control weeds. Few insects damage carrots, though leaf hoppers (jassids), aphids and Rutherglen bugs occasionally cause leaf damage.

Leaf diseases, particularly leaf blight caused by the fungus Alternaria dauci, are controlled by foliar sprays in autumn and winter. If leaf blight is allowed to develop, crop yield can be seriously reduced and mechanical harvesting becomes difficult because tops are weakened.

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Harvesting and marketing
Export carrots are harvested by specialised machines that lift the crop, cut off the leaves and drop the roots into bulk bins for transport to the washers. The washers remove all soil, leaving the carrots ready for grading and packing. If not packed immediately, they are cool-stored close to 0°C to maintain freshness. The carrots are graded for export, only roots larger than 150 mm without blemishes being retained for export. Then they are packed into 20 kg capacity cartons lined with plastic to prevent dehydration.

The cartons are then cool-stored before being stacked into refrigerated sea containers that are loaded onto ships at Fremantle, ready for the six to seven day sea voyage to Singapore and Malaysia, or the 12 to 14 days to Hong Kong. A six-metre-long container holds about 650 cartons or 13 t of carrots.

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Improving efficiency of the industry
Exporting vegetables is a highly competitive business; growers in other states and countries are eager to expand production. Improvement in production efficiency and quality are major objectives of Western Australia’s export carrot industry.
The Department of Agriculture surveyed commercial carrot producers in 1990-91, at the start of a cooperative research project with the Sumich Group Ltd, Australia's leading vegetable producing and exporting company. Matching funds were provided by the Horticultural Research and Development Corporation. The aim of the project was to identify how marketable yields of carrots could be improved within a sustainable production system.

The survey of 202 crops grown by 60 growers revealed that the average total yield was close to 65 t/ha, while yield of export grade carrots was about 40 t/ha. Many causes of carrots being downgraded to unmarketable were found in the survey (see Table 2).

Substantial gains in yield of export grade carrots have resulted from growers paying closer attention to agronomic practices including rotation, crop establishment, wind protection, plant density and nutrition.

During the survey soil, leaf and root samples were collected from carrot crops close to harvest. Roots were graded and disorders and diseases identified. Results of soil and plant analysis, together with a yield profile from the crop, were sent to the grower, along with suggestions on ways to improve yield.

Cavity spot disease, found in 48 per cent of crops surveyed, caused a marketable yield loss of more than 10 per cent in 16 per cent of the crops surveyed. Cavity spot is caused by soil-borne Pythium fungi and is likely to become more widespread the longer carrots are grown on the same land. One aim of present research is to develop an integrated control strategy for cavity spot that includes crop rotation, planting tolerant varieties and use of soil amendments and fungicides.

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The carrot industry is eager for research to continue and in 1992 it formed the Carrot Association for Research and Development.

# Table 2. The incidence of disorders and the proportion of crops with more than 10 per cent yield loss from the disorder (severity); data from 202 crops in the 1990-91 carrot crop survey

<table>
<thead>
<tr>
<th>Disease or disorder</th>
<th>Incidence</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cavity spot</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>Forked</td>
<td>86</td>
<td>13</td>
</tr>
<tr>
<td>Nodes enlarged</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>Undersize</td>
<td>98</td>
<td>10</td>
</tr>
<tr>
<td>Misshapen</td>
<td>89</td>
<td>10</td>
</tr>
<tr>
<td>Scab</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Oversize</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>Nematodes</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Bolted</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Split</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Rots</td>
<td>24</td>
<td>0.5</td>
</tr>
<tr>
<td>Hairy roots</td>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>Boron deficiency</td>
<td>6</td>
<td>0.5</td>
</tr>
</tbody>
</table>