Factsheet

Organic Carrot Production

Soil type and fertility requirements
Carrots thrive in deep, loose, well-drained soils, although they can be grown on most soil types. Soils with a large amount of stones are not suitable, though the use of destoners, can be helpful in some situations. For best results a pH of 6.0-6.8 is preferable. Lime, if required, should be applied a month before the crop is drilled.

Rotation
Carrots do not require a high fertility so can come later in the rotation than leafy crops or potatoes. Planting after an application of farmyard manure should be avoided as this increases the likelihood of forked and misshaped roots. As with any crop grown from seed, weeding will be a major expense so the rotation should be used to ensure a clean site is available.

Crops of early carrots can be followed by green manures or winter cover crops. Due to the late harvesting time, though, it is rare for any cover crop to be sown after a main carrot crop. In addition, the wet conditions typical of many autumns means the heavy harvesting machinery can do considerable damage to the soil structure, making cultivations for any following late autumn crop virtually impossible.

Sowing dates

Type	Sowing dates	Harvesting dates
First Early[1]	end of October / November, under polythene (floating or tunnels)	May/June
Second early	January / February, under polythen (floating or tunnels)	June / July
Early main crop	April / May, open ground or under polythene (floating) / fleece	August / September
Main crop	end May / early June, open ground	October / November onwards

Growing systems
Cultivation machinery such as power harrows should be set at approximately 25cm deep.

[1] It is essential that bolt resistant varieties are used; steps must be taken to ensure no disease and pest carry over occurs from the main crop.

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Carrot seeds are small, so a seed bed with a fine, even tilth is needed for good germination. Attention to detail, however, is important as the tilth must not be so fine that the soil slumps and caps after rain, or so loose that it dries out too fast. Finishing the seed bed preparation with a light rolling, evenly firming the soil, seems to be the ideal.

Many growers prepare the seed bed a few weeks ahead of sowing to allow a stale seed bed to form, encouraging a flush of germinating weeds which can be dealt with, by flame weeding or further cultivations, before the sowing.

- **Bed system**
  A true bed system ensures there is no soil compaction in the crop growing area. However, soil preparation for a bed system is more time consuming and you need the right machinery to cope with the deep wheeling that may occur between beds and problems that occur with the harvest machinery. Better for smaller units, where yields are maximised and early crops are probably harvested by hand.

- **Ridges**
  Carrots work well on ridges, but this system should only be used for producing large carrots as it is hard to get the high populations needed for smaller carrots. Suitable on heavy soils and in areas of high rainfall as the lifting is made easier. Weeding is particularly difficult with this system, and as with the bed system, specialised mechanical weeders are necessary. The use of a share lifter for harvesting is an advantage.

Sowing

Size of the harvested carrots is vital so make sure you know, before sowing, the market for each crop. For instance, if a crop is specifically grown for a pre-pack outlet too many large carrots can significantly reduce the value of the crop – even if the larger ones can be sold elsewhere the grading costs can be high. This is particularly important for organic growers as pack sizes are more limited, which means there is even less flexibility within the system.

Sowing density is as important as variety for carrot size, with lower densities producing larger carrots and vice versa. Other factors, such as fertility and soil moisture, further influence the final size. Thus, if fertility is low it is advisable to lower the sowing density so that fewer carrots are produced. This will allow the majority to reach marketable size, while preventing the development of many, poor quality carrots that fail to reach the required proportions. Carrots will grow to a smaller size in dry conditions, so where irrigation is not available densities should be kept lower giving the roots a greater chance of reaching the desired proportions.

Early carrot crops should be sown at a lower density than maincrops. This encourages the fast development of the roots, leading to an early harvest of the crop.

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- **Between Row Spacing**
  Typical row widths range from 35 to 55cm, or 75cm if grown on ridges. When deciding on a row width it is important that it is compatible with the weeding and harvesting machinery. In addition, where covers, such as fleece or polythene, are to be employed the spacing must correspond to their widths.

- **Within Row Spacing**
  Since spacing between rows is, to some extent, predetermined by the weeding and harvesting system employed on the holding, the final plant density has to be controlled by within row spacing. Typical average sowing rates are:

Single line drilling: 50-65 seeds/metre
Multi-line drilling: three lines (2.5cm apart) / bed: 80-100 seeds / metre e.g. each line has 27-33 seeds/metre

Examples – Tractor Width (wheel centre measurement) 1.7m (68 inch)

Row width - s line	Seeds / metre with each row	Result – seeds per hectare	Suitable for
50cm	50	1,000,000	Early Crops
50cm	60	1,200,000	Wholesale market
50cm	100	2,000,000	Prepack market

- **Sowing Depth**
  Carrots must not be drilled too deeply, and the recommended depth is 1cm.

- **Germination / Irrigation**
  If conditions are good carrot seeds will germinate within ten days from sowing. In hot, dry conditions, irrigation may be needed. Regular applications ensure the soil does not dry out. For example, typical applications could be 12-18mm of water every 4-7 days until emergence. If conditions continue to be dry a further irrigation, 4 weeks later, will increase yields.

  Carrots are very vulnerable to capping, so with susceptible soils irrigate little and often at the pre-emergence stage to prevent a problem.

Weed control

- **Flame weeding**
  Flame weeding is a very useful procedure at the pre-emergence stage, and correctly carried out, can significantly reduce weeding costs. Weed seedlings germinate faster than the sown carrots. Flame weeding takes place some time between sowing and emergence of the crop. Flame weeders work best on weed seedlings at the early cotyledon stage, and in some situations it may be necessary to flame twice before emergence. The timing of this operation is critical.

For the best effect, delay sowing for four to seven days after the last stale seedbed cultivation. This allows the weeds to emerge ahead of the crop.

There are several types of tractor mounted flame weeders available. However, for smaller areas hand held burners, with the liquid propane canister carried in a back-pack can be used.

- **Inter row cultivations**
  Steerage hoes are useful when the crop is very small, for instance, just after the development of the first true leaves, as they can be set deep enough to dislodge weeds without disturbing the crop. Some brush weeders can be too vigorous at this early stage, but are very effective when the crop is larger, particularly in wet seasons.

- **Hand weeding**
  Even where regular inter row cultivations are carried out hand weeding within the rows is usually necessary and very expensive. It is best that the procedure is carried out when the plants are still young as the removal of large weeds can cause considerable damage to a crop. In addition, mature plants of weeds such as fat hen can create problems with weeders and harvesters if their stalks are pulled up and left on the surface between the rows.

Diseases

Cavity Spot: Cavity spot is caused by the soil borne fungus *Pythium violae*. Another species, *Pythium sulcatum*, may also cause cavity spot in some fields. The symptoms consist of small elliptical lesions on the root, which gradually enlarge, and become blackened. Eventually, quite large rotten areas can be formed. These are caused by secondary bacterial infections of the original cavity. There is no plant-to-plant spread of the disease, and infection takes place relatively early in the life of the crop directly from the soil, though cavities are not seen until roots are more mature. Control methods include:

- Indexing of soil – diagnostic procedures are available which will indicate the risk of infection on the land intended for cropping.
- Selection of resistant varieties
- Rotational separation between carrot crops – at least a three-year break is advisable but does not guarantee that the disease will decline significantly.
- Earlier lifting to avoid extensive symptom development.

NB Cavity spot is harboured by lucerne, a fact that should be taken into consideration when planning the rotation.

Violet root rot: Violet root rot is caused by the fungus *Rhizoctonia crocorum*, previously known as *Helicobasidium purpureum*. It is a very persistent soil-borne fungus, with a wide host range. Affected roots initially become covered in numerous purple brown specks, which eventually merge to give large purple blotches on the root from about October onwards. Complete rotting of the roots

often follows, and saleability of the other roots is greatly reduced. Any known infected area should be avoided. Parsnips, red beet, and potatoes can all suffer from violet root rot, and many weeds can act as reservoirs of the disease. Infected crops should not be ploughed in as this will create even higher levels of infection in the soil. Very long rotations (more than ten years) between host crops are probably necessary to achieve any useful decline. If infection is detected early in a crop, it should be lifted to prevent further disease build up.

Scab: Scab is caused by the organism *Streptomyces scabies*. Though infrequent in carrots, it can occasionally cause severe losses. Raised scab-like lesions are formed transversely around the carrot, and saleability is greatly reduced. It is most common on light alkaline soils with low organic matter content. Cultural methods offer the best means of control, and include:

- Increase soil organic matter
- Irrigate dry sandy soils
- Avoid liming

Alternaria blight: Two species of Alternaria may infect carrots, *A. dauci* and *A. radicina*. The latter is usually associated with a seedling disease, but *A. dauci* can cause widespread foliage blight in wet years towards the end of the growing season. Both species are seed-borne, and can survive on debris, but do not usually persist for long periods in the soil. Control measures should concentrate on:

- The use of disease free seed
- Good hygiene practice to remove infected debris from growing areas
- A rotational break of two or three years

Crown rot: The symptoms are a brownish green discolouration at the crown of the root, which penetrates into the core of the carrot. It is thought that the symptom is caused by a fungus, and species of *Itersonilia* have been suspected as the pathogenic agent. However, this has not been confirmed. It is possible that crown rot will be a problem on organic carrots. Removal of debris and good rotational practices are likely to reduce risk, but crops may still become infected.

Pests

Carrot Fly: Carrot fly *(Psila rosae)* is a major pest of carrots. The larvae of the fly burrows into the roots. This then becomes blackened as secondary rots of the damaged tissue occur. The understanding of the fly's lifecycle is critical when cultural control options are considered. Flies emerge from pupae during May and early June, and lay eggs around young carrot plants. The eggs hatch after about seven days, and the larvae burrow into the soil and feed on young roots. There are three larval stages, and it is the second and third ones that produce the characteristic mines in the main root. The mature larvae then pupate close to the soil surface, so that a second generation of flies emerge about the end of July. A partial third generation of flies can sometimes be produced.

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Carrot fly problems are largely a product of intensive carrot growing, in areas where a number of other hosts (e.g. parsnip, celery, parsley) are also grown. Small isolated fields, where long breaks between host crops have been maintained, may escape damage altogether. Crops sited on exposed sites may be less prone to damage, as will be those well away from hedgerows and ditches (particularly where nettles are present) since these areas shelter the flies.

- Time of drilling – autumn drilled or January / February sown crops can escape attack provided they are harvested before July. Main crop carrots sown between February and mid-May are most prone to attack. Crops sown between mid-May and mid-June tend to escape first generation fly attack, but may be affected by the second generation. Later sowings will also escape the problem, but roots may not reach their full size potential.
- Variety choice – some varieties (e.g. Sytan) appear to have a type of resistance to carrot fly damage, they can contribute towards an integrated approach with cultural methods.
- Crop covers – a number of crop covers (which should be non-woven) are available. They must be in place after drilling or later, but before the first flies start to become active.
- Growing system – carrots grown on the flat more susceptible than ridge-grown.

Cutworms: Cutworms can occasionally damage young carrot plants by feeding on the areas of the stem at and just above the ground level. The foliage may wilt very quickly, and the plants can be severed. Cutworms are the caterpillar stage of several moth species, the most common being the turnip moth. They may be active from about mid-June onwards until the autumn. They tend to be a more serious problem on weedy land, which gives good cover for the moth stage, and on light to medium soils. However, the moths and young larvae die in wet soil, and irrigation of crops at risk usually prevents serious damage. Pheromone traps can be used to monitor turnip moth activity, and cutworm prediction systems are available, which can be used to trigger irrigation applications.

Aphids: The willow carrot aphid *(Carvariella aegopodii)* can reduce yields of carrots by direct feeding damage. The aphid also attacks other umbelliferous crops such as parsnip. Eggs are laid on willow, which hatch in the spring. The winged aphid appears in May, migrating to carrots over a period of about 8-10 weeks. As well as direct feeding damage the aphids can also transmit a virus infection called Carrot Motley Dwarf, and more recently a further virus problem, Parsnip Yellow Fleck, has been identified. This causes wilting and yellowing of the foliage and a brown stain in the crown of the carrot, or complete root death.

Umbelliferous weeds in the field margins can harbour aphids and must be controlled if the populations become significant. Early and mid-season crops should be sited away from overwintering fields (including those covered over) which could harbour the viruses and aphids, and debris should not be left on the surface. Organic farming areas may have a high population of aphid predators which will help to reduce problems.

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Wireworms: Wireworms are the larvae of click beetles. They are particularly common in fields which have just been ploughed out from grassland, and they can persist in the soil for several years. Several horticultural crops, including carrots, are attacked by the pest. Consolidation of the planting or seed beds can reduce wireworm activity, and fast growing, vigorous plants will usually escape severe damage.

Slugs: Slugs can be a serious problem in carrot crops, particularly at emergence. They feed on dead and decaying plant matter, and are most abundant in soils with a high organic matter such as those that have had a green manure or grass/clover ley ploughed in. To reduce the risk of damage the carrot crop should be grown towards the end of a rotation when the slug population should be lower.

Harvesting

Early carrot crops should be monitored closely and harvested when they are the correct size for the market they are intended. This statement is obvious but not always adhered to.

Harvesting of the main crop takes place in October and November. If the carrots are to keep in good condition when in store they must be fully mature at harvest. A sign of this maturity is the yellowing of leaves in the field. Another useful test is to pull several plants, which should be inspected a few days later. If they show signs of wilting it means that the crop is not mature and will not keep if harvested.

The handling of carrots during harvest and the environment in which they are stored is critical. They must be handled gently to avoid breakage and damage, and stored in a cool, very humid environment if they are to retain their quality. If the carrots are harvested in warm conditions they should be cooled immediately, preferably using hydro-cooling. Harvesting with some mud on the roots aids storage, but excessive mud may cause rots.

- **Harvesters**
  Many small producers simply hand harvest with a fork. Slightly larger growers use an undercutting blade which simply loosens the crop making hand harvesting easier.

  For larger producers using mechanical harvesters there are two categories of machine.
  - Top lifters: lift the crop by the foliage. They are ideal for heavier soils as less soil separation is necessary. They also operate well in wet conditions and are good for crops going into cold stores. However, they do require carrots with strong tops.
  - Share lifters: run in the soil can be less trouble, and are ideal for lighter soils.

  Lifted carrots going into store need to be topped, and if this process is not carried out by the lifter then a topper will be necessary. If the crop is to be stored

in the soil topping is not necessary as the tops will naturally die off during the winter.

- **Yields**
  Harvested yields can range between 40-100 tonnes/hectare, depending on the specification of the crop and, of course, how well they grow. With main crop carrots, a typical crop would have 60% pre-pack size and 40% large wholesale size.

Storage

The carrot season is extended into the winter period by storage of the main crop. The methods of storage are:

- Leaving the crop in the soil
- Lifting the crop and placing in a cold store

Leaving the crop in the soil is the most common method of storing carrots in the UK, and its low cost is a significant factor in opting for this system. To ensure that frost does not damage the carrots the rows must be moulded with soil and in severe weather covered with straw or some other insulator such as fleece or plastic sheets. This method of storage should only take place where carrots can be lifted in wet conditions as there will be times during the winter when the grower will have no option but to harvest in poor conditions. Some damage may occur from rots and carrot fly as the storage season progresses.

Keeping carrots in a cold store is also a successful and viable method of storage, and means that supplies can be more reliable. In addition, crops grown on heavier soils can be harvested before soil conditions become too wet. After lifting, the crop needs to be cooled as fast as possible to just above freezing. Research has shown that fast cooling extends the storage period significantly, however it does cause a loss of "bloom" in the carrots appearance. The crop should not be washed before storage, but should be kept in high humidity conditions.