

JUNE 2018

# OPTIMISING CROP ESTABLISHMENT IN PROCESSING CARROTS

## THE IMPORTANCE OF ESTABLISHING A GOOD CROP

A key factor in maximising the yield of carrots for processing is promoting the establishment of rapid and uniform early crop. Speedy early leaf growth and establishment of a strong root system will help minimise crop variability and maximise carrot yield<sup>1,2</sup>. Getting optimum carrot establishment relies on good pre-sowing planning, followed up with careful post-sowing crop management.

### Carrot seed

Carrot seeds are very small, and while they have the energy required for germination, the embryo inside has not fully formed when the seed is harvested. The embryo is very important as it will develop into the first leaves and root shoots of the carrot plant. As a result, carrot seeds require some time before germination, while the seed prepares its embryo for early plant growth. Seeds can be graded based on the

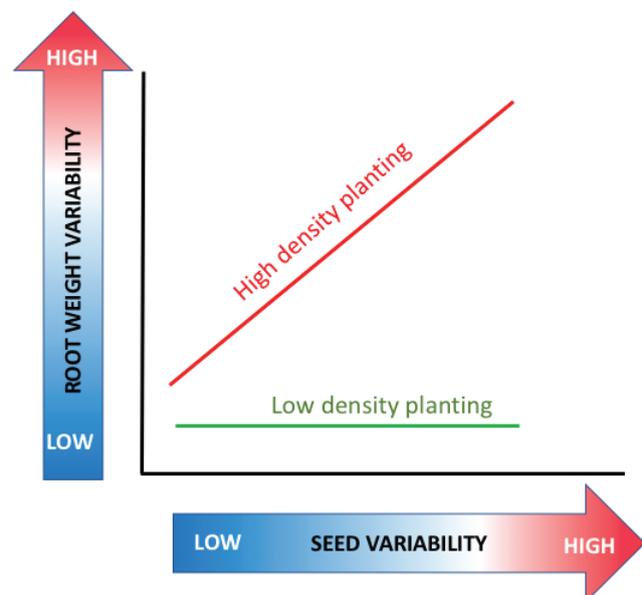


Figure 1. Relationship between variability in seed (embryo size) and final carrot root weight. At low plant density (50-100 plants m<sup>2</sup>), root weight was largely unrelated to seed size but at high density (300-400 plants m<sup>2</sup>) highly uniform seed translated to low variability in root weight<sup>3</sup>.

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embryo size and this will help improve the uniformity of germination. Using graded seed has been shown to significantly influence variability in seedlings at establishment<sup>3,4</sup> – as shown in figure 1. Poor and uneven germination may lead to greater variability in root size and reduce carrot yield<sup>2</sup>. Poor quality seed can also produce weak seedlings that are more vulnerable to competition from weeds and other carrot plants, diseases<sup>2</sup> and herbicide damage. Storing seed for more than three years in suboptimal conditions (i.e. warm and moist) will deplete the seed energy reserves and reduce germination.

### PLANT DENSITY AND CONFIGURATION

Optimising row configuration and density is vital for maximising uniformity of carrots at harvest and yield<sup>4,5</sup>. Row configuration and plant spacing should maximise

access to light, water and nutrients. Plants in the outer rows will have greater access to these elements and may be planted at a higher density to even out growth and taproot size. The optimum planting density will vary between growers and should be set based on planting equipment, block configuration and the market they are supplying. The planting density will dictate the size and quality of the final taproot (see figure 2).

Seeding rates should be calculated based on the final plant-stand target and needs to take into account seed germination percentage and the possibility of field losses (e.g. insect or wind damage) during establishment. Seed grading may help improve accuracy of seed placement as size and uniformity of the seed will determine how efficiently it moves through the seeding equipment and how it is placed in the soil<sup>1</sup>.

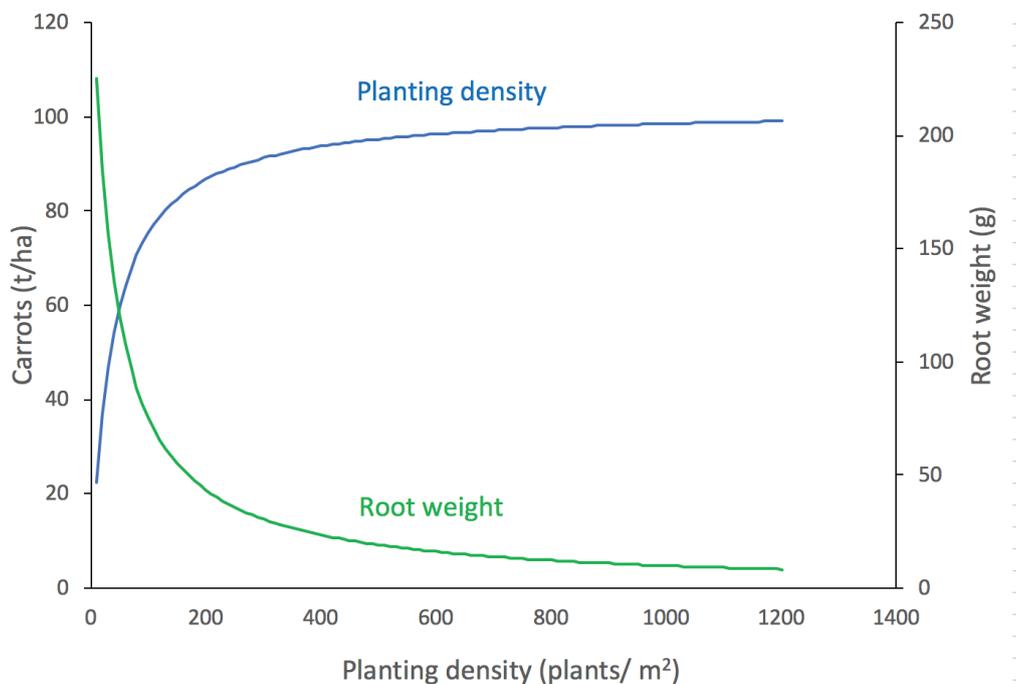


Figure 2. Relationship between planting density, root weight and total yield in carrots cv. Chantenay<sup>6</sup>

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### WHAT IS MY SEEDING RATE?

As an example, a grower is targeting a final plant stand of 80 plants per m<sup>2</sup>. The seed germination is 95% and the establishment rate, taking into account post-sowing field losses, is 70% (i.e. 30% of the seed planted is lost due to insect or wind damage).

What rate (kg per ha) should the carrot seed be sown at?

$$1. \text{ TARGET PLANT STAND (per m}^2\text{)} \times 10\,000 = \frac{\text{TARGET PLANT STAND (per ha)} \ 80 \times 10\,000}{= 80\,000 \text{ plants per hectare}}$$

$$2. \text{ SEEDING RATE (seeds per hectare)} = \frac{\text{TARGET PLANT STAND (per ha)} \div \text{GERMINATION \%} \times 100\,000}{\text{ESTABLISHMENT \%}}$$

$$\text{SEEDING RATE (seeds per hectare)} = \frac{(80\,000 \div 95) \times 100\,000}{70}$$

$$\text{SEEDING RATE (seeds per hectare)} = 1,203,007$$

To convert seeds per hectare to kg per hectare you need to know the number of carrot seeds in a gram which will vary between varieties.

$$1. \text{ SEEDING RATE (kg per hectare)} = \frac{\text{SEEDING RATE (seeds per hectare)} \div \text{SEEDS PER GRAM}}{1000}$$

Using the above example if the variety contained 400 seeds per gram, the planting rate in kg/hectare would be:

$$\text{SEEDING RATE (kg per hectare)} = \frac{1,203,007 \div 400}{1000}$$

$$= 3 \text{ KG PER HECTARE}$$



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### Optimising the seed bed

Due to the small energy reserves contained in carrot seed, germination, emergence and early growth of seedlings are particularly sensitive to poor seedbed conditions<sup>7,8</sup>. During the first 40–60 days, carrots are sending their main taproot down. At the end of this period, when secondary growth begins, taproot length

is set. It is especially important to have the soil worked deep, as compact areas (including stones) will either cause the taproot to stop growing down, or result in bent or forked carrots.

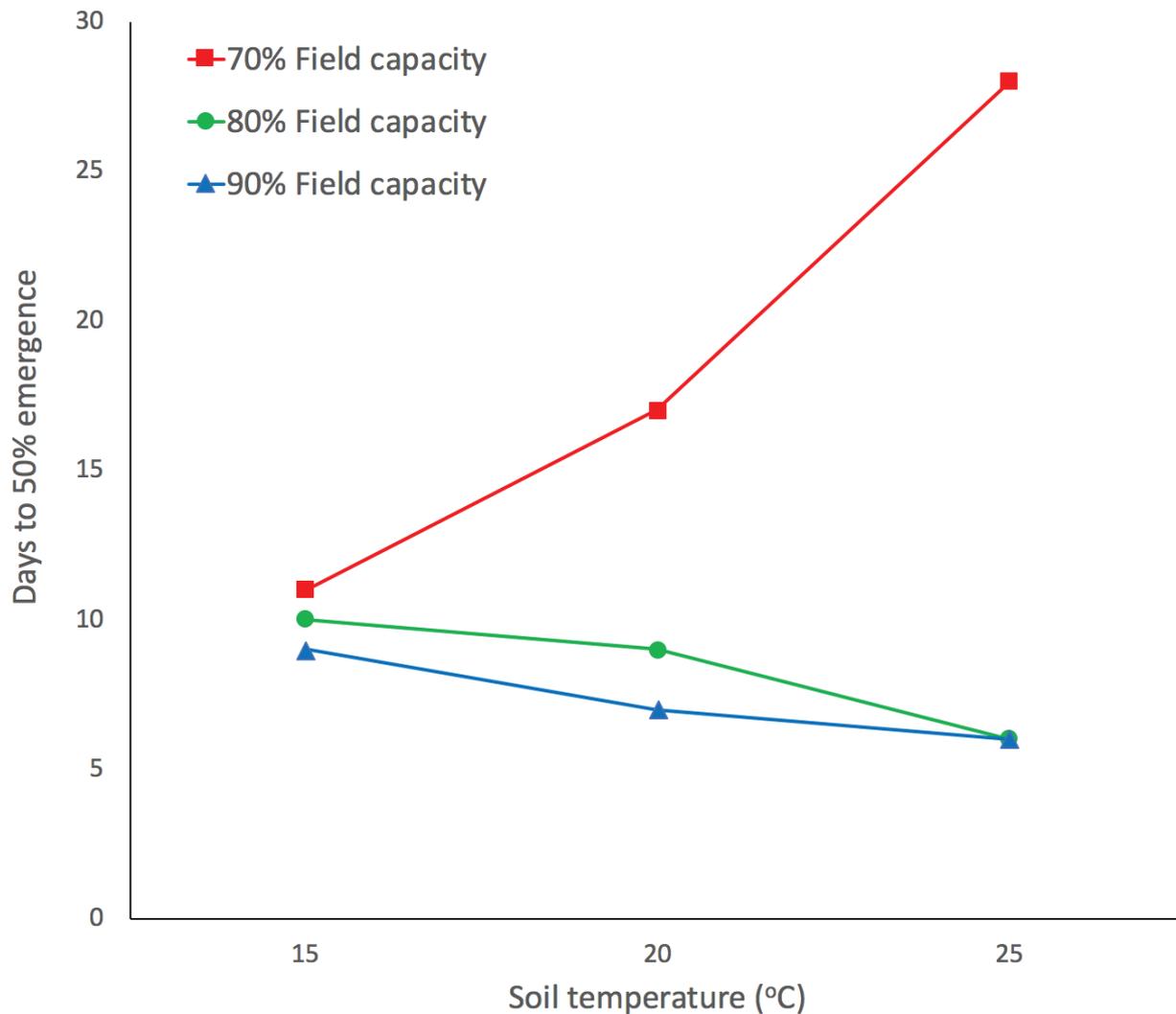
To ensure that seed germination and establishment are maximised, consideration should be given to the factors outlined below.

## FACTOR

## MANAGEMENT

Soil type	Select paddocks with suitable soil, i.e. well-drained clay loams with greater than 40cm profile depth <sup>7</sup> . Soil with large stones (>200mm diameter) can make seed bed preparation difficult and damage carrots <sup>8</sup> .
Seed bed structure	Soil should be friable (easily crumbled) for unrestricted and good water infiltration. Compacted soils will restrict root growth. Consider controlled traffic to minimise compaction. Deep rooted cover crops sown before carrots, such as Tilage Radish <sup>®</sup> , can also help break up compacted soils.
Seed placement	Depth should enable good seed soil contact and generally ranges from 5 to 15mm. Depth may be adjusted to maximise soil moisture while avoiding planting too deep as this will deplete seed energy reserves and delay emergence, particularly in crusted soils.
Soil moisture	If possible, pre-irrigate to ensure adequate soil moisture available to the seed for germination (see figure 3). Early irrigation should be carefully managed to avoid moisture stress in seedlings. In contrast, overwatering will shorten taproot length and can also lead to hairy carrots with excess root scars. Use of soil-moisture monitoring sensors can help apply the right amount of water at the right time.
Soil temperature	Sow seed at a time when soil temperature is a minimum of 7°C but preferably 10°C or more, which will encourage rapid germination and emergence (see figure 3).
Soil chemistry and fertility	Carrots can be grown in acid or alkaline soils, with an optimal range of pH 5.5–7. Soil tests should be conducted to determine if any soil amendments are necessary. Carrots are good scavengers of nutrients however synthetic fertilisers or composts may be considered to address any major deficiencies. Recommended fertilisers application methods include pre-plant incorporation into the soil or post-plant application via fertigation or topdressing. Excess nitrogen or excessive wetting and drying cycles should be avoided as it promotes both growth and harvest splitting of carrots.

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**Figure 3.** Effect of soil temperature and soil moisture (expressed as % of field capacity\*) on carrot emergence. Seedlings emerged slightly faster with an increase in soil temperature, as long as field capacity was maintained at more than 80%<sup>2</sup>.

\*At 100% field capacity the soil contains the maximum amount of water it can hold against gravity, following wetting by a rainfall or irrigation event. Excess free water has drained leaving large pores filled with air and small pores filled with water.

**AVOIDING EXTREMES**

Carrot seedlings are very vulnerable to extreme environmental conditions, such as high wind, frost or extreme rainfall events. Where feasible, steps should be taken to minimise such risks, for instance planting in paddocks that are less exposed or have wind breaks. Also, select planting dates with minimal risk of frost events during early crop establishment.

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### TAKE HOME MESSAGES

- Uniform crop emergence and rapidly growing seedlings set the foundation for a uniform high-yielding carrot crop.
- Using high-quality, uniform carrot seed improves germination and seedling establishment.
- Grading seed can help reduce variability in seedlings.
- Carrot seeds have small energy reserves, so a well-prepared seed bed and adequate soil moisture immediately post-sowing is vital for good crop establishment.

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