

CARROTS PRODUCTION



SHERP

Training Title: Carrots Production

Objective: To provide a guideline on production of Carrots

Specific Objective:

- To provide basic information on production, post-harvest handling, and marketing of Carrots

Contents:

1. Introduction: Background, Some Common Varieties and Optimal Ecological Requirements
2. Pre-Cultivation Preparation 1 – 5
3. Cultural Practices 1- 9
4. Harvest
5. Post-Harvest Handling
6. Cost & Income Analysis
7. Post-Training Evaluation Exercise

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Disclaimer

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The proposed agrochemicals are in accordance with "Pest Control Product Registered for Use in Edition, 2015". The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Plant variety release, protection and seed quality control directorate .

Preface

- This training material applies the fundamental practices essential for crop production and successful marketing to put into perspective the case of horticultural crop production.
- The fundamental practices are categorized into seven (7) broad topics and twenty (20) sub-topics; the twenty sub-topics are referred to as the General Horticulture Crop Production and Post-Harvest Handling Techniques (GHCP&PHHT20). This categorization is based on the Smallholder Horticulture Empowerment & Promotion (SHEP) experience in mitigating production and marketing challenges facing smallholder horticultural farmers.
- The seven (7) broad topics are: Pre-Cultivation Preparation; Land Preparation; Crop Establishment (Planting/Transplanting); Crop Management; Harvest; Post-Harvest Handling; and Cost and Income Analysis.
- The sub-topics under each topic are as follows: **Pre-Cultivation Preparation** (market survey, crop planting calendar(s), soil sampling & analysis, composting, and quality seed/planting material(s)); **Land Preparation** (land preparation practices, incorporation of crop residues, and basal application); **Crop Establishment** (raising seedlings, planting/transplanting, fertilizer application); **Crop Management** (water requirement, managing of weeds, top-dressing, pests & diseases management practices, and safe & effective use of pesticides); **Harvest** (harvesting indices); **Post-Harvest Handling** (appropriate containers/standard packaging materials, and value addition techniques); and **Cost and Income Analysis** (cost and income analysis).
- The issues outlined in the twenty (20) sub-topics might not necessarily be applicable in all the cases. But where applicable, it is recommended that the instructions issued be given due consideration.

1. Introduction:

1.1 Background

1-1



Source: <https://www.freshfromethiopia.com/ethiopia-carrots/>

Carrots root

1. Introduction:

1.1 Background

1-1



Carrots root

1. Introduction:

1.1 Background

- The carrot first emerged in **Afghanistan about 3000 B.C.**
- Ethiopia carrots belong to the Western species that consist of an orange tap root as opposed to the Asian species of purple roots.
- Major production area is **central-northern areas surrounding Addis Ababa**, especially in the Shewa province
- Carrots **belongs to the family *Apiaceae*** which is related to celery, celeriac, coriander, fennel, parsnip and parsley.
- The plant **is a biennial**, i.e. it grows **vegetatively in the first season** and produces **seed in the second.**
- Carrots are said to be rich in **beta-carotene, dietary fiber, antioxidants and minerals**
- Vitamin A deficiency, which causes night blindness in mothers and children, is a major public health problem in Ethiopia
- Row carrots contain the highest amount (5800-6100µg/100gm) of beta-carotene

1.2 Some Common Varieties



“Nantaise”

1.2 Some Common Varieties



“Nantaise”

1.2 Some Common Varieties

- Nantes is the most common variety in Ethiopia

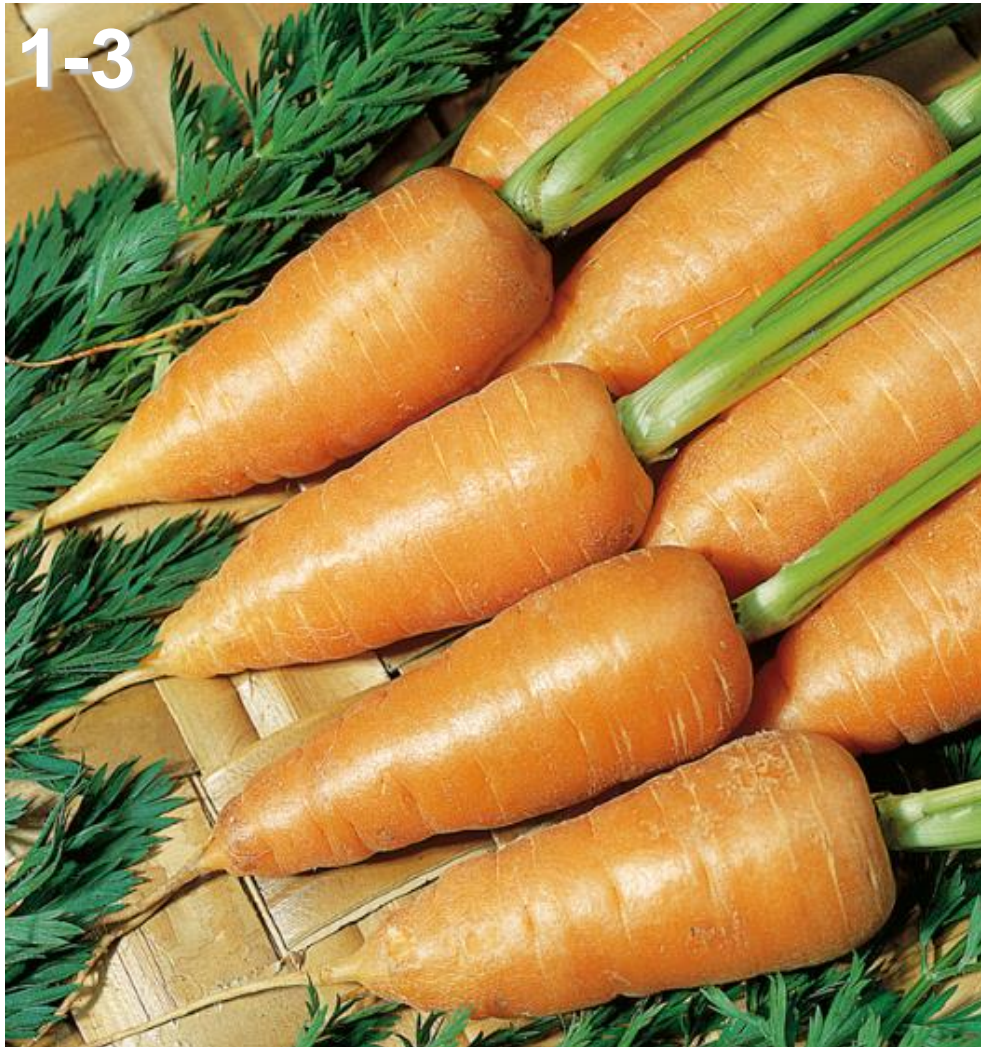
“Nantaise”:

- The root is moderately long with a uniform diameter along **the length** and a **rounded tip** when mature
- The surface is **thinner** and easier to scar
- Nantes is popular for **its high sugar content** but is comparatively low in starch
- Therefore, it does **not store well** compared to “Chantenay”
- High demand among farmers for its good adaptation in highlands and **high market demand** for its **good color, thick and long roots** and **sweet taste**

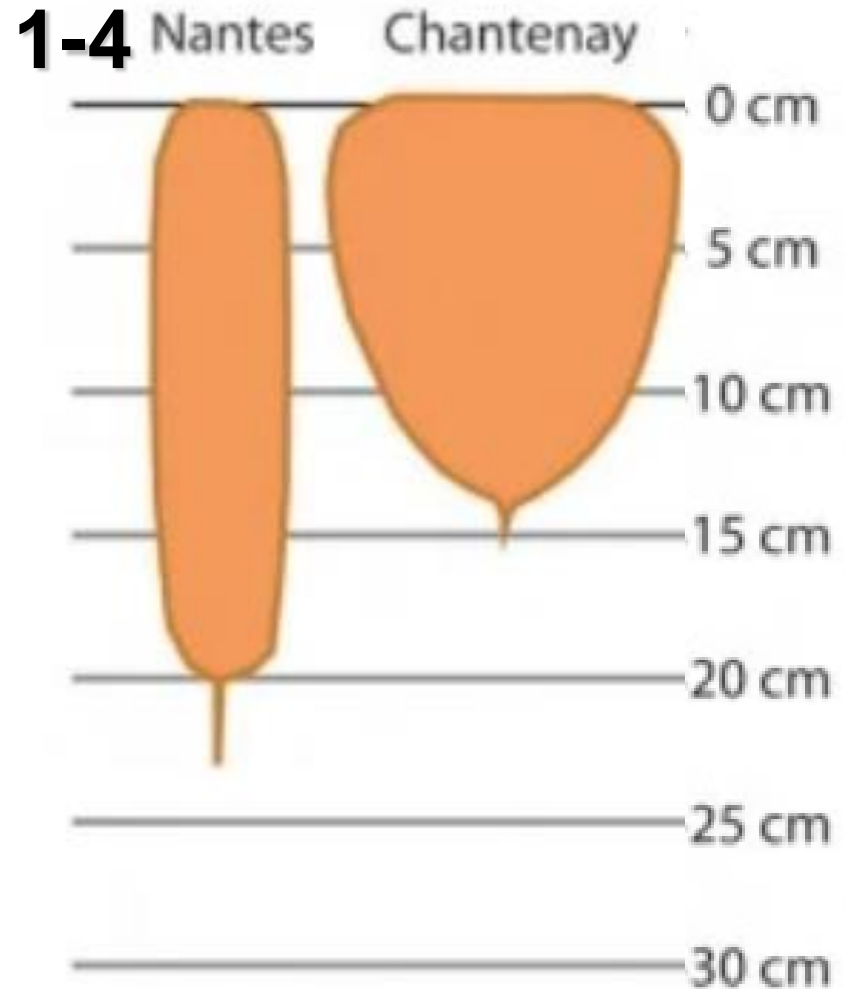
Yield

- Highlands (2,201-3,000 masl): 19.6t/ha
- Mid-altitudes (1,701-2,200 masl): 23.2 t/ha
- Lowlands (500-1,700 masl): 21.2 t/ha

1.3 Other Common Varieties



Source: <https://www.suttons.co.uk/Gardening/Vegetable-Seeds>



Source: <https://www.westcoastseeds.com/blogs/how-to-grow/grow-carrots>

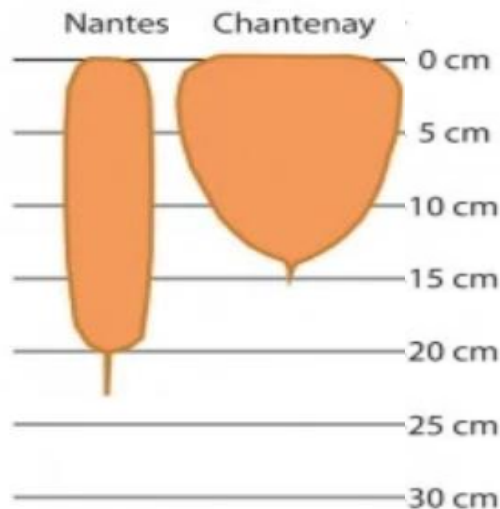
“Chantenay”

“Nantes” and “Chantenay”

1.3 Other Common Varieties



1-4 “Chantenay”



“Nantes” and “Chantenay”

1.3 Other Common Varieties

“Chantenay” is more suited to high altitudes than lowlands and Nantes is more suited to low altitudes

“Chantenay”

- It has very strong foliage and its roots are broad in the shoulder, relatively **short** and **blunt tipped**
- They have a strong pale-coloured core and stores well
- **Shorter roots** than Nantes, deep orange color and a sharp tip
- It has **long shelf life** and is suitable for long distance transport

Yield

- highlands (2,201-3,000masl): 21.7 t/ha
- Mid-altitudes (1,701-2,200masl): 24.1 t/ha
- Lowlands (500-1,700): 19.7 t/ha

“Samson” (a variety of Nantes that is tolerant to powdery mildew) and “**Strong King**” were introduced from the France and Denmark, respectively

- Both varieties were verified under multi-location adaptation trial
- Seeds are produced in the second year.
- Some of the seeds are not true-to-type to the variety which are sold in the local market.
- Seeds that are not true-to-type yield bolting, cracking, splitting and short roots.

1.4 Optimal Ecological Requirements

Altitude	1,800 – 2,500 meter above sea level
Rainfall	500 mm
Growing Temperature	15 – 20 °C
Soils	<ul style="list-style-type: none">• Deep, loose, well-drained sandy to loamy soils• pH range 6.0 – 6.5

1.4 Optimal Ecological Requirements

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1.3 Optimal Ecological Requirements

- **Altitude:** Tropical highland climate is suitable for carrots production. The adaptable altitude is depends on the variety. Ethiopia has high quality carrots production area in **1800-2,500m**.
- **Rainfall:** Carrot requires **well-distributed rainfall** of around **500 mm** during the growing period.
- **Temperature:** The optimum temperature for growth is **15-20 °C**. Temperatures below 10°C cause longer, more slender and paler roots. Shorter, thicker roots are produced at higher temperatures. Temperatures exceeding 20°C lead to poor quality.
- Temperature and soil moisture influence the shape, colour and quality of carrots. The temperature below or above the optimum, poorer colour develops.
- **Soil:** Carrots **require deep, loose, well-drained sandy to loamy soils** with a pH of 6.0-6.5. The crop produced in humus rich soil tends to increase in foliage excessively and **forms forked and hairy carrots**

2. Pre-Cultivation Preparation:

2.1 Market Survey



Conducting a market survey on Carrots

2. Pre-Cultivation Preparation:

2.1 Market Survey



Conducting a market survey on Carrots

2. Pre-Cultivation Preparation: 2.1 Market Survey (GHCP&PHHT20: Q1)

Prepare a sample of questions to enable farmers gather the following information

- Which (month) has the peak demand of carrots
- The price of garlic during the peak demand season
- What is the best variety that has the highest demand
- Supply requirements in the target market (quantities and frequency)
- Market quality requirements (size, quality, and quantity, etc.)
- Potential buyers and terms of payment etc.

2. Pre-Cultivation Preparation:

2.2 Market Survey Questionnaire

Market Survey Questionnaire

Date : ____ / ____ / ____

Region: _____

Zone: _____

Woreda: _____

Name of Group: _____

Name & Contact of the Produce Dealer	Produce & Variety	Produce Quality Market Requirements	Peak Demand (months)	Quantity (kg) & Frequency (daily/weekly etc.) of Supply	Place of Production	Purchasing Unit Price (ETB/kg)	Mode of Payment	Terms of Payment	Marketing Challenges	Dealer's Willingness to Purchase the Produce from the farmers
Mr. Abdela Qasim (0917-xxxxxx)	Carrot (Nantaise)	Medium to large size	October to March	40 qt/week (1qt = 40 kg)	Waliso	10 ETB/kg	Cash	Cash on Delivery	Poor quality (hairy and forked root)	Willing to buy at shop
Mr. Kernal Husen (0911-xxxxxx)	Carrot (local)	Small to Medium size	January to February	1 qt/day (1 qt=100 kg)	Shewarobit	20 ETB/qt	Credit	Within a week	Poor quality (too small and rotten)	Willing to buy at farm gate

2. Pre-Cultivation Preparation:

2.2 Market Survey

Market Survey Questionnaire

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Market Survey Questionnaire

2. Pre-Cultivation Preparation: 2.2 Market Survey Questionnaire

Prepare sample questions to enable you gather the following information

- When (month) is the peak demand for **carrot**
- The price of **carrot** during the peak demand
- The **carrot** variety(s) that has the highest demand
- Supply requirements (quantities and frequency)
- Quality market requirements
- Potential buyers and terms of payment etc.

2.2 Cropping Calendar

A Sample of a Carrots Cropping Calendar under irrigation

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
<p>Apply manure preceding to carrots production</p> <p>Land preparation</p> <p>Seed preparation: 4-5 kg/ha has to be ready before planting</p>	<p>Planting: Spacing 20cmx5cm</p> <p>Plant population 664,000 for double row) plants/ha)</p> <p>Fertilizer rate NPS 78 kg/ha & Urea 140kg/ha split in 2 times</p>	<p>Urea top Dressing; 1st 70kg Of UREA 5 weeks after sowing</p> <p>2nd 70kg/ha 3 weeks after the 1st Application</p>	<p>Cultivation or hoeing (2-3 times)</p> <p>Weed, pests & diseases control</p>	<p>Harvesting after 90-120 days or when reached 2cm diameter</p> <p>Yields 10 - 16 qt/ha</p> <p>Marketing Linking with potential buyers</p>	<p>Peak demand for Carrots during planting</p>		

2.2 Cropping Calendar

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A Sample of a Carrots Cropping Calendar

2.2 Crop Planting Calendar (GHCP&PHHT20: Q2)

- A tool used by farmers to plan for production to ensure that marketing coincides with the period of the year when the market price of a produce is highest

Procedure:

1. Determine from the market survey results (2.1) when there is peak demand for carrots
2. Work backwards from the month when there is peak demand to prepare a monthly farm activities preceding the peak period
3. Use the monthly activities preceding the peak as a procurement plan for farm inputs and a guide for farm operations

Notes:

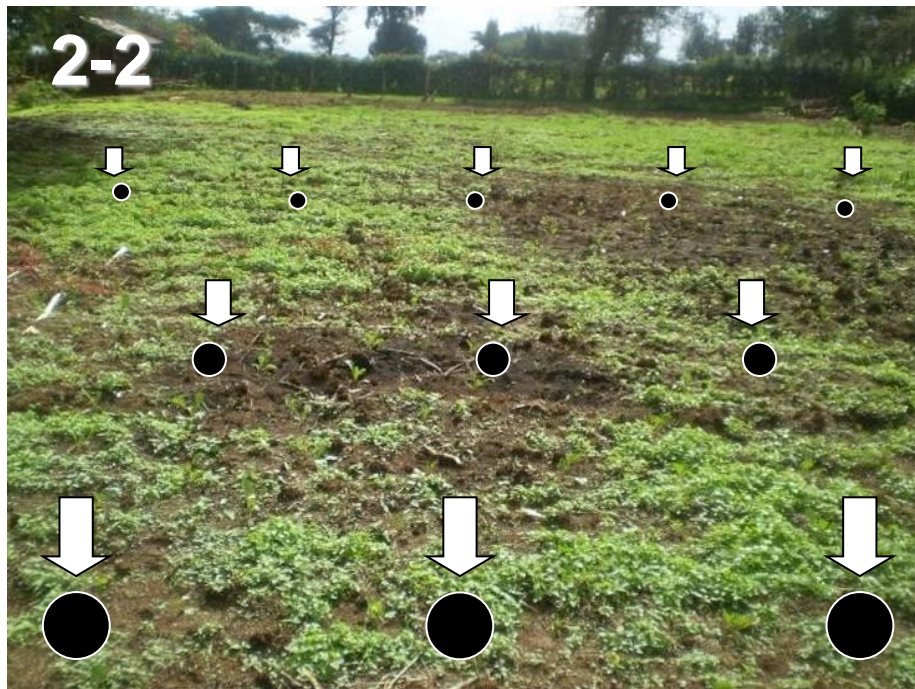
- To meet the peak demand period of the market, there may be need of supplemental irrigation

2.3 Soil Sampling & Analysis



Depending on the farm, sample the soil using the most appropriate method

2.3 Soil Sampling & Analysis



Depending on the farm, sample the soil using the most appropriate method

2.3 Soil Sampling & Analysis (GHCP&PHHT20: Q3)

- It is recommended to have the soils analyzed for nutrient availability and other factors vital to crop production **after every 2 – 3 years**
- The results of the soil analysis can be used to determine fertilizer and manure requirement
- For carrots production, **vertisol** were found to be **NOT suitable** due to limited root growth, posed difficulty during harvesting and washing of roots after harvest



Compost causes hairy roots and forked roots reduces marketable yield

2.4 Composting



2.4 Composting (GHCP&PHHT20: Q4)

- The use of compost or organic manures is **not recommended**, as they often cause **unattractive, hairy roots**, with a **coarser texture** as well as **decrease marketable yield**
- Organic manures or compost should preferably be used on **preceding crops in the rotation**.
- If you have a heavy soil, dig in plenty of manure **several month before planting**.
- Never work fresh manure into the soil as this encourages forking of roots (Fig.3-4)
- It is important to **plan in advance** where to grow carrots since compost should be applied **NOT before planting** carrots but **preceding crops in the rotation**

**Compost causes hairy roots
and reduce marketable yield**

2.5 Quality Seed/Planting Materials



Imported seed from a certified shop

2.5 Quality Seed/Planting Materials



Imported seed from a certified shop

2.5 Quality Seed/Planting Material (GHCP&PHHT20: Q5)

- Carrot seed is **very small** (800,000 to 1,100,000 seeds/kg)
- Seeds are supplied by governmental parastatal companies such as the Ethiopian Fruit and Vegetable Marketing Enterprise (Efruit) and Agricultural Inputs Supply Corporation (AISCO).
- Efruit supplies the Nantes variety from Dutch companies
- Seed should be checked for their **purity percentage, germination percentage and expiry date**
- Use **disease-free or certified seed** (recommended to purchase from a research station and registered store)

3. Cultural Practices:

3.1 Land Preparation



Well prepared Carrots Field

3. Cultural Practices:

3.1 Land Preparation



**Well prepared
Carrots Field**

3. Cultural Practices: 3.1 Land Preparation

Land Preparation Practices: (GHCP&PHHT20: Q6)

- Best grown in **deep well-drained and sandy loam** soils. Heavy clay, compacted and water-logged soils will not give the best shape and carrot sizes
- Carrots need **finely prepared soil** to suit the germination of their small seeds, thus farmers need to plough and prepare land for carrots **5 to 6 times** before planting
- Rake the soil surface to a fine-tilth seedbed before sowing the small carrot seeds
- Deep ploughing or working to loosen the soil to a depth of at **least 30 cm is important to allow good root development**
- Stony soils cause **misshapen roots** and produce **poor quality carrots**
- Carrots are often planted on top of ridges or **raised beds**. This is especially important on heavier soils, shallow soils or these less well-drained, as it gives added soil depth, better drainage and the looser structured soils favored by the carrots

3.2 Incorporation of Crop Residues

3-2



Crop residues to be incorporated in a field

3.2 Incorporation of Crop Residues

3-2



Crop residues to be incorporated in a field

3.2 Incorporation of Crop Residues (GHCP&PHHT20: Q7)

- Incorporating crop residues in the farm land can significantly increase the soil organic content
- It is recommended to incorporate crop residue as early as possible after finishing previous cultivation
- Optimum pH range 6.5 to 7.5; hence lime should be applied at least 30 days before planting, if the pH is less than 6.5
- If agriculture lime is not available, you can apply wood ash since they can also reduce the acidity of the soil (Apply 9kg of wood ashes per 100 m²)
- **However, if the crop residues belongs to the family *Apiaceae* which is related to celery, celeriac, coriander, fennel, parsnip and parsley, remove and burn the residue to avoid possible risk of disease build up**

3.3 Basal Application



Manure should be incorporated preceding crops in the rotation

3.3 Basal Application



Manure should be incorporated preceding crops in the rotation

3.3 Basal Application (GHCP&PHHT20: Q8)

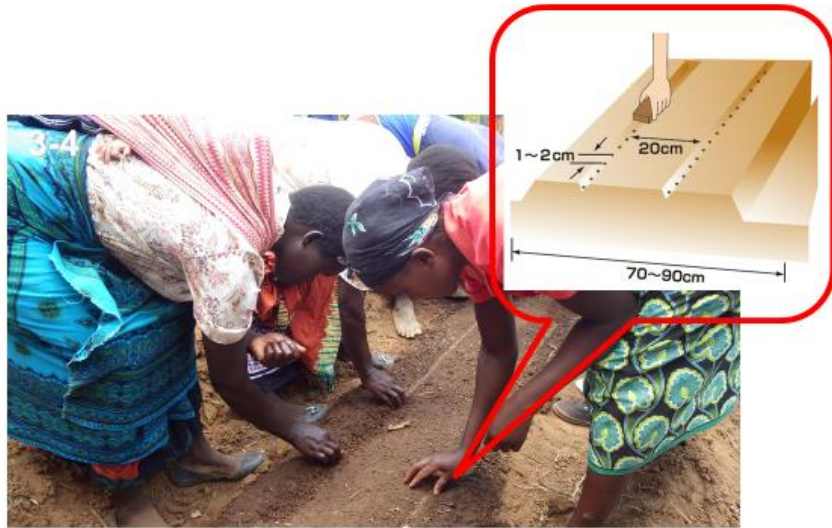
- The use of compost or organic manures **is not recommended**, as they often cause **unattractive, hairy roots**, with a **coarser texture as well as decrease marketable yield**
- Organic manures or compost should preferably be used on **preceding crops in the rotation**.
- However, it's advisable to use 175 kg DAP/ha during sowing for good root yield for fresh market
- It is important to **plan in advance** where to grow carrots since compost should be applied not before planting carrots but **preceding crops in the rotation**

3.4 Seeding rates



Planting carrots seeds in the bed

3.4 Seeding rate



**Planting carrots seeds
in the bed**

3.4 Seeding rates

3.4.1 Appropriate seeding rate:

- Dense plantings could be **thinned out**, but this is costly, time-consuming, therefore following appropriate seed rate is necessary

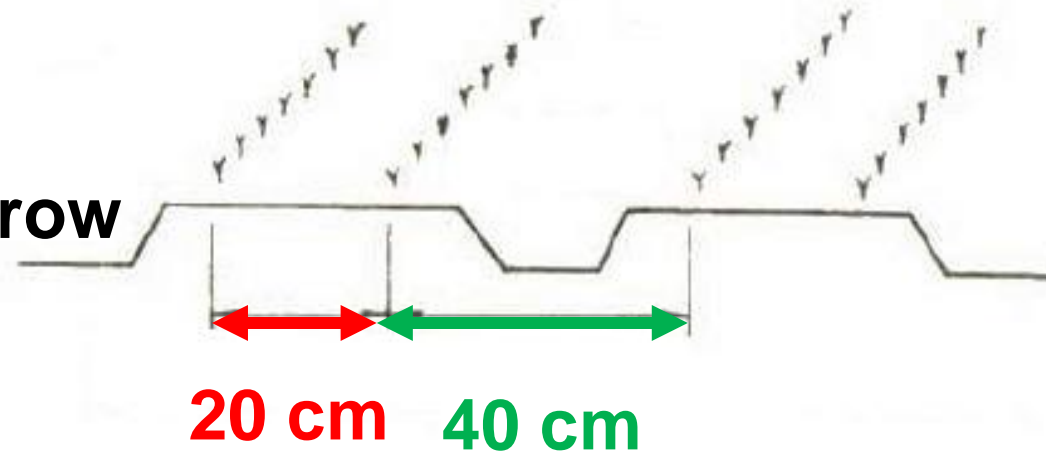
3.4.2 Recommended Spacing (GHCP&PHHT20: Q10):

- The seed should be covered to a uniform depth of 1.0 to 2.5 cm, and should be kept moist until the plants are well established
- **Row planting:** Rows are generally spaced from 20-40cm
- **Double or triple rows:** the width between sets of rows varies from 40 to 60cm
- A mistake that is generally made by new growers is to **plant too densely**
- For the first time of planting, count the number of seeds between **30 to 35 plants per meter** of row to achieve uniform space
- **Mixing seed with sand** in a **ratio of 1:5** helps achieve even distribution. After germination thin the plants to achieve **2.5cm between the plants**
- Farmers usually **reluctant to thinning out** of plants, so attention must be given to ensuring that the correct seeding rate is used at planting

3.5 Planting

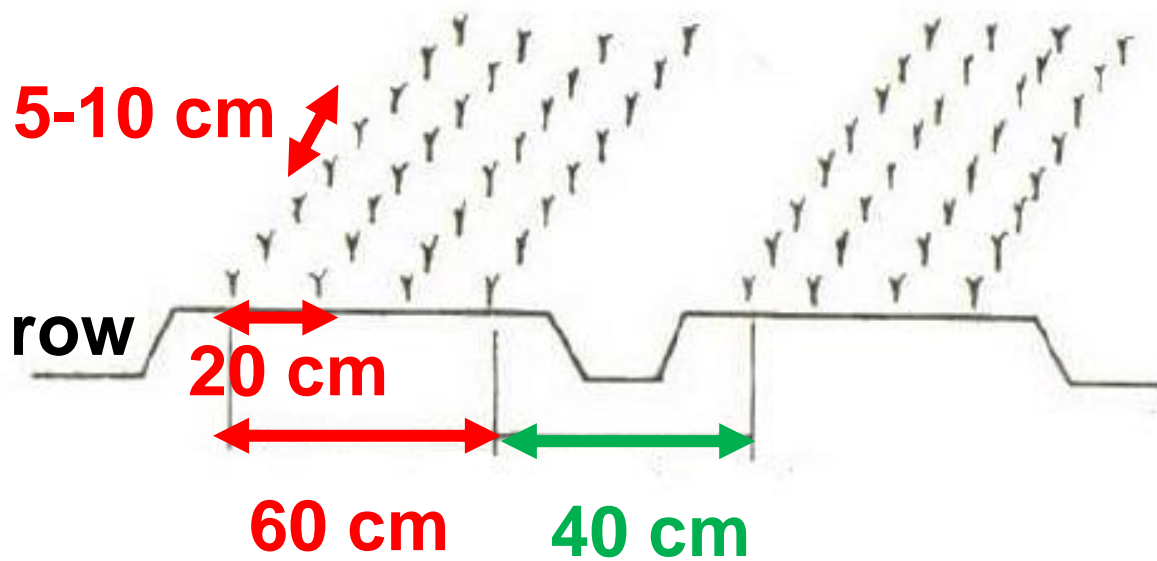
3-5

Double row



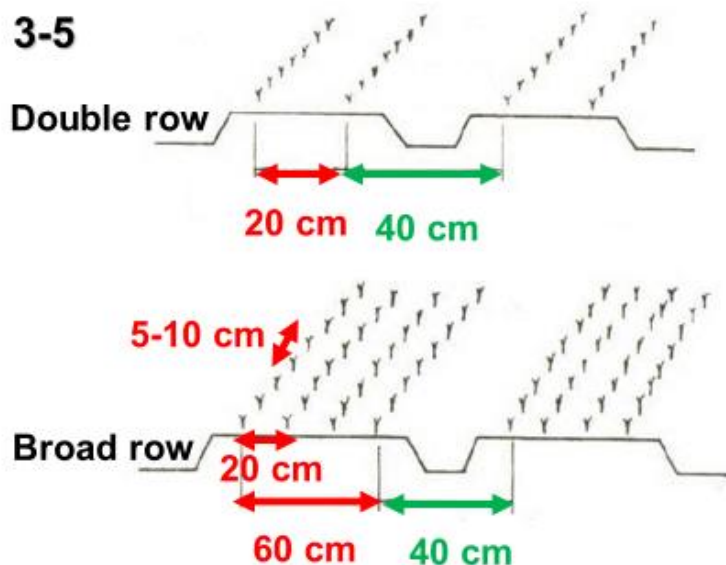
5-10 cm

Broad row



Plant spacing of carrots in the bed

3.5 Planting



Plant spacing of carrots
in the bed

3.5 Planting

3.5.1 Appropriate Time:

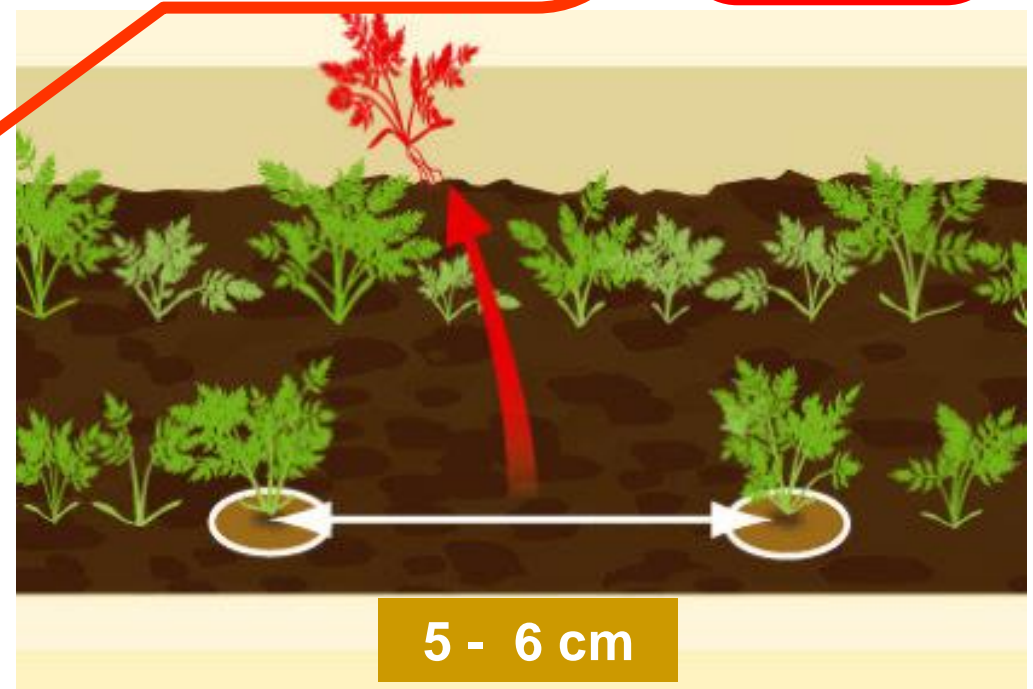
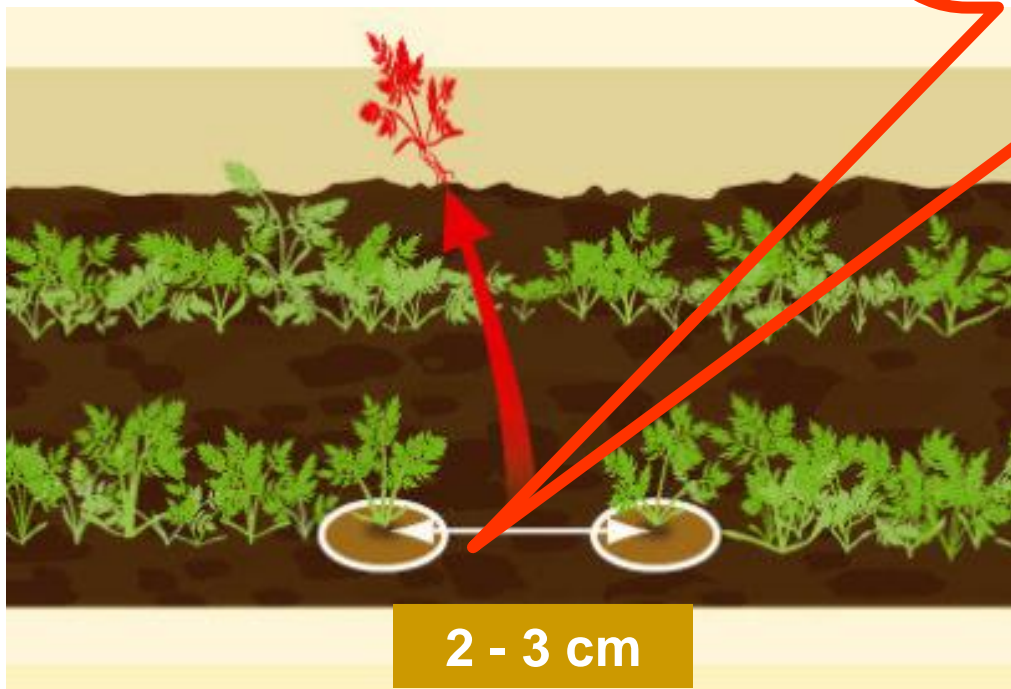
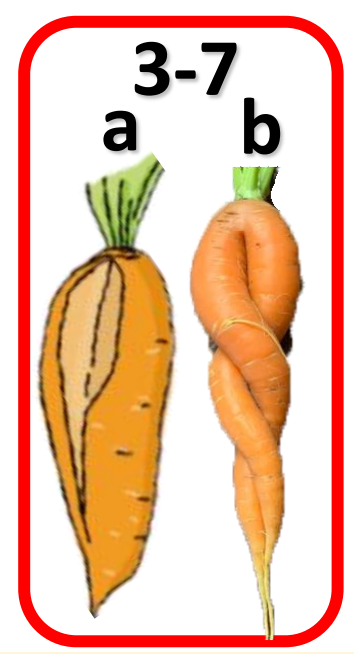
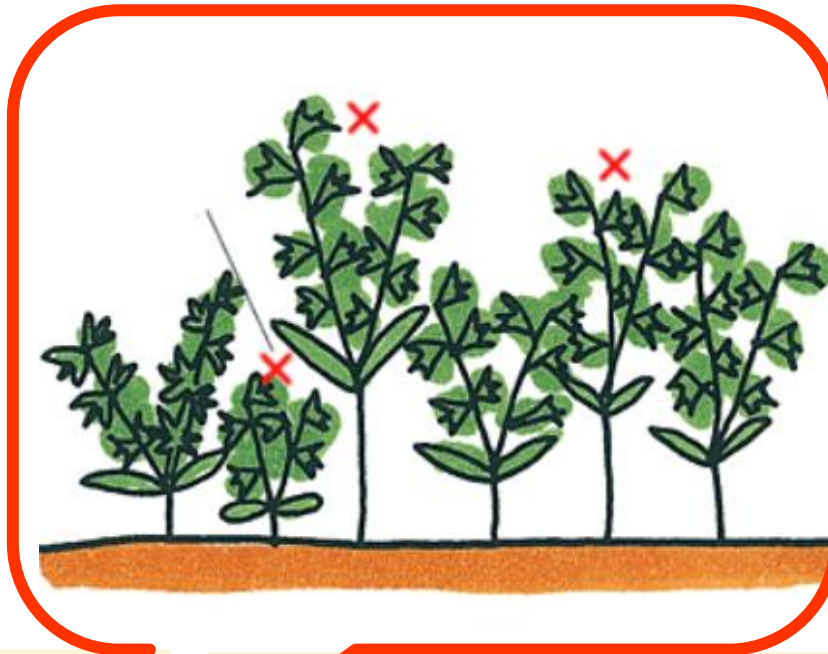
- At horeta research, seeds sown in **March and April produced a high root yield (21.4 to 37.8 t/ha)** but seeds sown in October and November gave a **low yield due to frost attack**
- **Seeding rate: 4-5 kg/ha**

3.5.2 Fertilizer Application Rates (GHCP&PHHT20: Q11):

- Carrots have low nitrogen requirements and good yields can be obtained with **80 kg/ha of nitrogen** and **30kg/ha of phosphorus**
- **Phosphorus** promotes **root development** and thus ensures more vigorous growth; it is a vital element for all root crops
- **Potassium (K):** carrots have a **high potassium requirement**. High potassium ensures a better quality-crisper, better colored roots, and also enhances keeping quality after harvesting.
- In Ethiopia, however, Potassium fertilizer is not available; therefore **applying ash** is highly recommended.
- **Wood ashes** contain soluble potassium which reaches the plant quickly
- **High rates of nitrogen should be avoided**, as this **stimulates leaf growth** at the expense of root development and yield, and also delays harvesting
- It is generally better to under- rather than over-apply nitrogen.
- **NPS 78kg/ha and 140 kg /ha of Urea**

3.6 Thinning

3-6

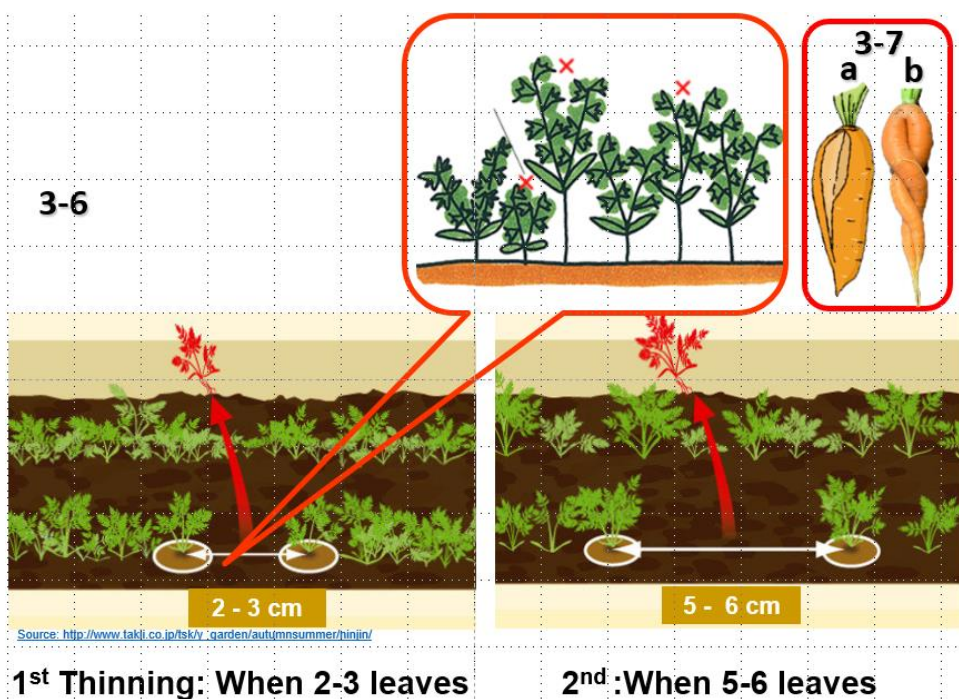


Source: http://www.takii.co.jp/tsk/y_garden/autumnsummer/ninjin/

1st Thinning: When 2-3 leaves

2nd :When 5-6 leaves

3.6 Thinning



3.6 Thinning

3.6.1 Thinning

- ❑ 1st thinning (1 to 2 weeks after emergence): when **2 – 3 leaves** (4cm high): Thin out to 2-3 cm
- ❑ 2nd thinning (2 weeks later), when **5-6 leaves**: Thin out to 5-6 cm
 - Plant density: **80 – 120 roots / m²**
 - If the crop is not thinned out, the carrots will be **small and malformed**
 - Thinning should take place in the afternoon, and when soil is moist
 - Where the population is too low, roots tend to become large, are generally subject to more **splitting/cracking (Fig. 3-7-a)**
 - While where the population is excessive, roots tend to become smaller, are **often twisted around one another (Fig.3-7-b)**, giving a poorer quality root, and marketable yields of good quality may also be lowered

3.7 Water Requirement



Source: <https://www.shutterstock.com/ja/image-photo/irrigated-carrot-field-582183799>

Carrots crop under irrigation

3.7 Water Requirement



Carrots crop under irrigation

3.7 Water Requirement (GHCP&PHHT20: Q12)

- The soil moisture should be maintained at above 50% of available moisture throughout growth
- Generally **25 mm of water** per week should be adequate
- Under dry conditions **long, thin roots** are produced, while excess moisture will result in a **light color** and **larger diameter** but excessively short roots
- Carrots can be grown throughout the year if rain and irrigation water is available.
- Insufficient soil moisture results in a **longer and thinner root**, while very wet conditions have the opposite effect and also give rise to a lighter colour.
- The field should be irrigated lightly immediately after sowing
- Irrigation water should be applied once or twice a day until germinate.
- Watering should gradually be reduced to prevent longitudinal splitting of the roots when the crop approaches maturity
- Water stress during root development also causes **cracking** of the roots

3.8 Managing of Weeds



Source: <http://www.carrotmuseum.co.uk/ohakune1.html>

Weed free carrots fields

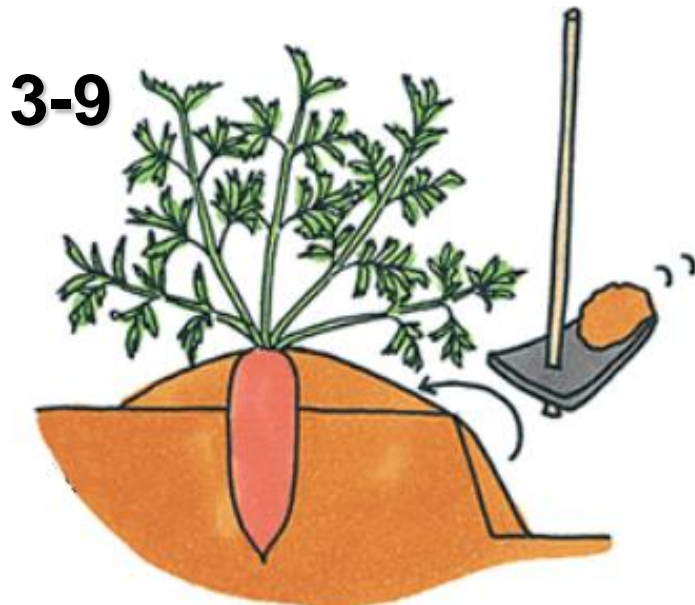


Earthing up roots to protect from sunlight

3.8 Managing of Weeds



Weed free carrots field

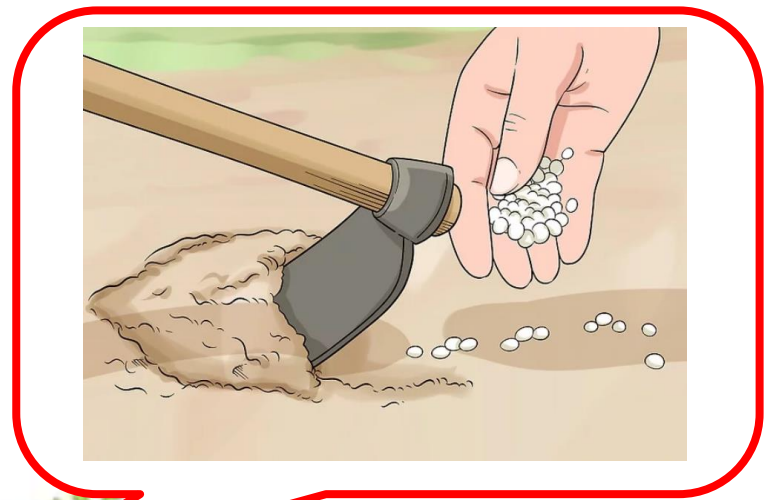


Earthing up roots to protect from sunlight

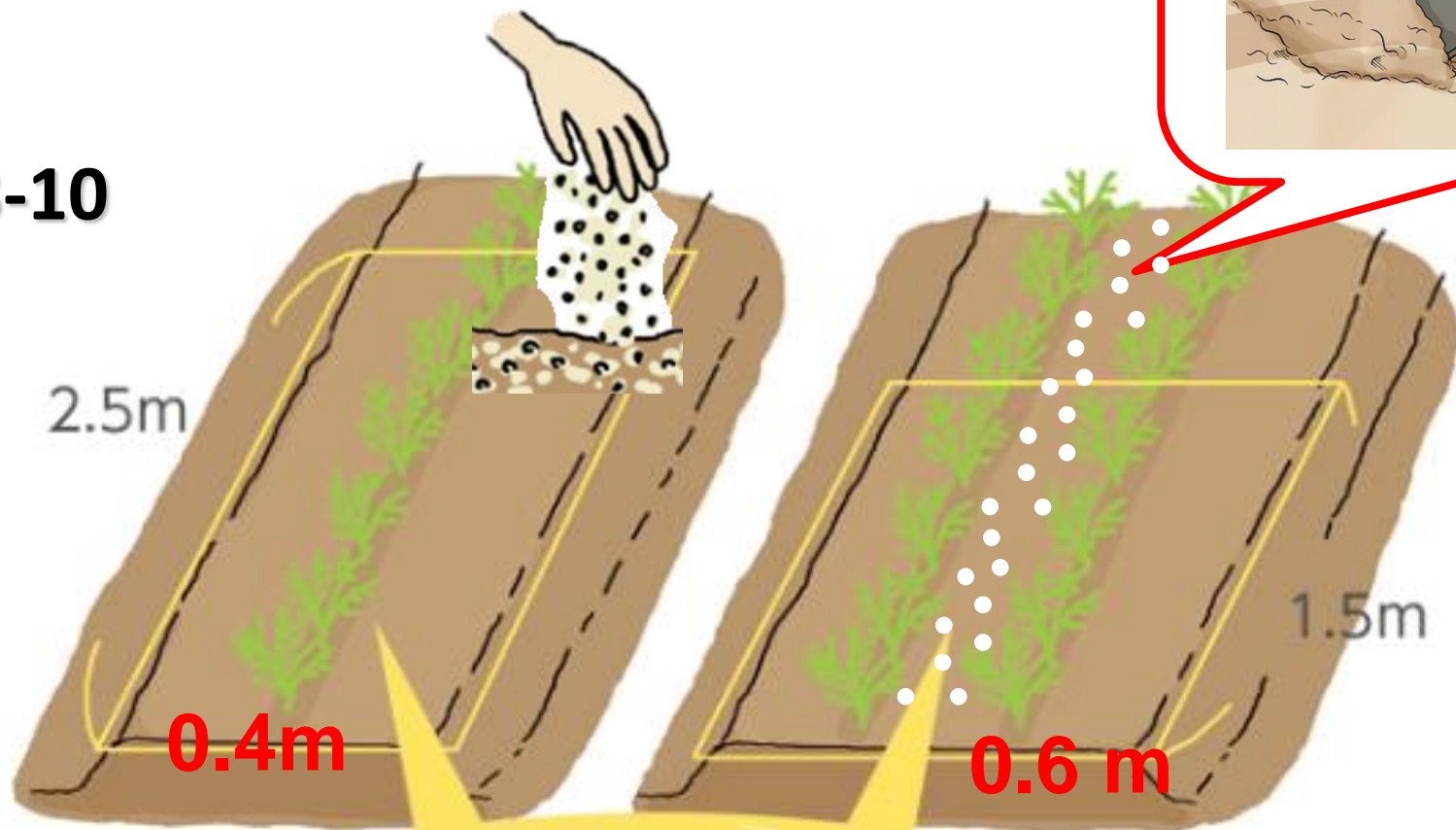
3.8 Managing of Weeds (GHCP&PHHT20: Q13)

- Carrots are small, rather vulnerable plants during the early stages of growth.
- Many weeds grow rapidly and vigorously, and are efficient competitors for available **nutrients, water and sunlight**
- Carrot seedlings are very susceptible to weeds especially at their early stage before they cover the ground
- Weeding and cultivation should be done 2 – 3 times (2 and 4 weeks after sowing) **until the canopy covers the ground** in order to suppress weeds and **earth up roots** to protect them from **direct sunlight which causes them to green (Fig.3-9)**
- When the upper part of the root is exposed to sunlight, chlorophyll is formed, resulting in undesirable green shoulders.
- 1st weeding: 4 weeks after sowing at the same time of the 1st thinning (It preferably done before top-dressing)

3.9 Top-dressing



3-10



Apply UREA **4-9 g/m²**
(One - Two Coca-Cola bottle
top per square meter)

Top-dressing on carrots field

Source https://sakata-tsushin.com/oyakudachi/lesson/vegetable/post_32.html/

3.9 Top-dressing



Source <https://www.wikihow.com/Apply-Urea-Fertilizer>

Top-dressing on carrots field

3.9 Top-dressing (GHCP&PHHT20: Q14)

- Although carrots does not like much Nitrogen, it is good to top-dress to supply additional nutrients during the growth of the crop
- 100 -140kg Urea/ha gives good results and must be applied in splits.
- Apply a top dressing of 100 - 140kg Urea/ha in a split form.
 - ❑ 1st Top-dressing: 5 weeks after sowing, apply 2/3 (9 g of Urea / m²)
 - ❑ 2nd Top-dressing: 3 weeks after 1st application, apply the rest (4g of Urea / m²)
- Sprinkle on both sides of the row, 2 – 10cm from the plants (Do not sprinkle on the plants)
- Remove all the weeds before top-dressing
- Work into the **top 2cm** of the soil

3.10 Pests & Diseases Control

3.10.1. Control/Management Strategies

1.	Cultural Control
2.	Mechanical Control
3.	Biological Control
4.	Chemical Control
5.	Integrated Pest Management (IPM)

3.10 Pests & Diseases Control

3.10.1 Control/Management Strategies

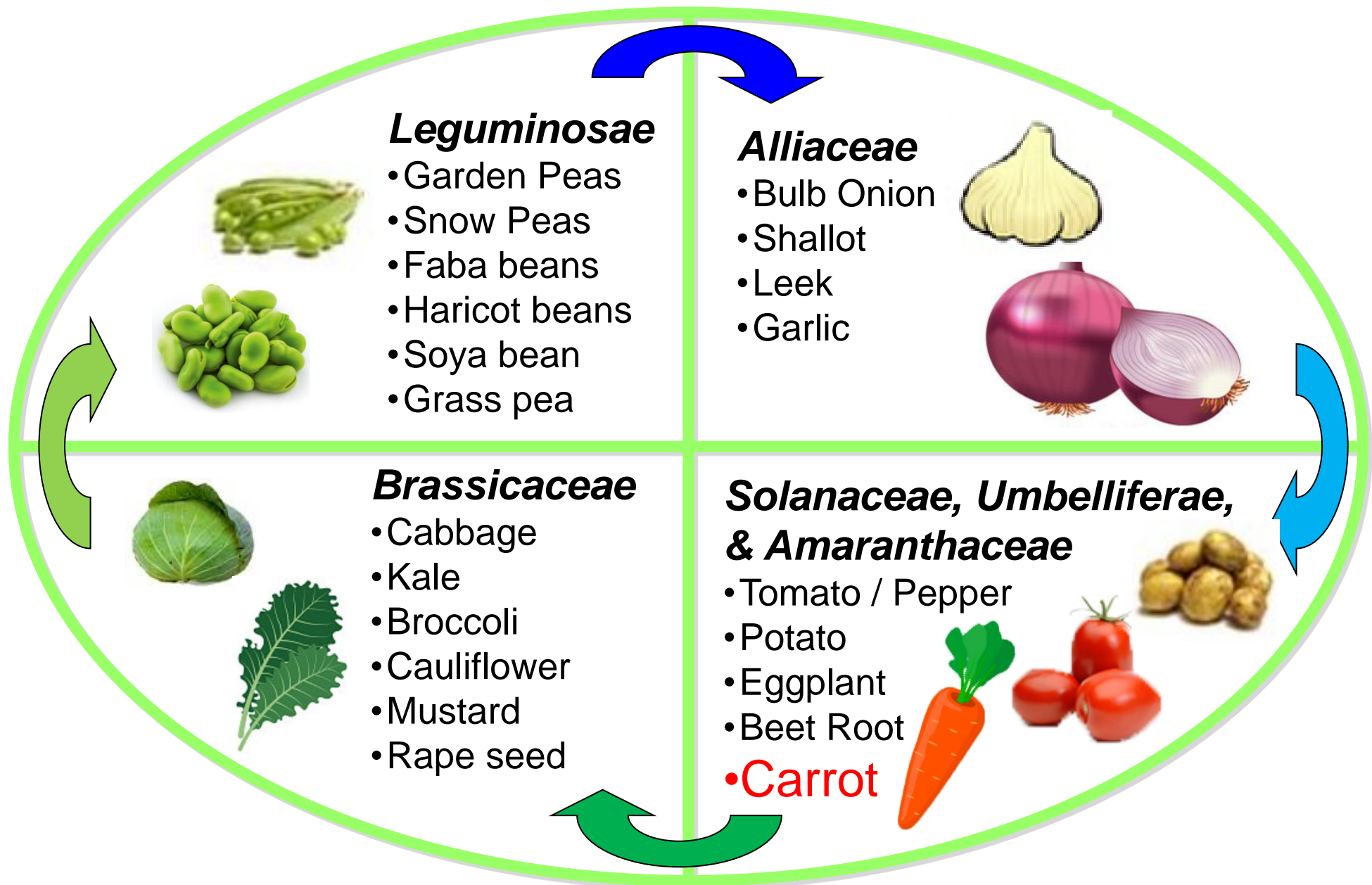
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3.10 Pests & Diseases Control

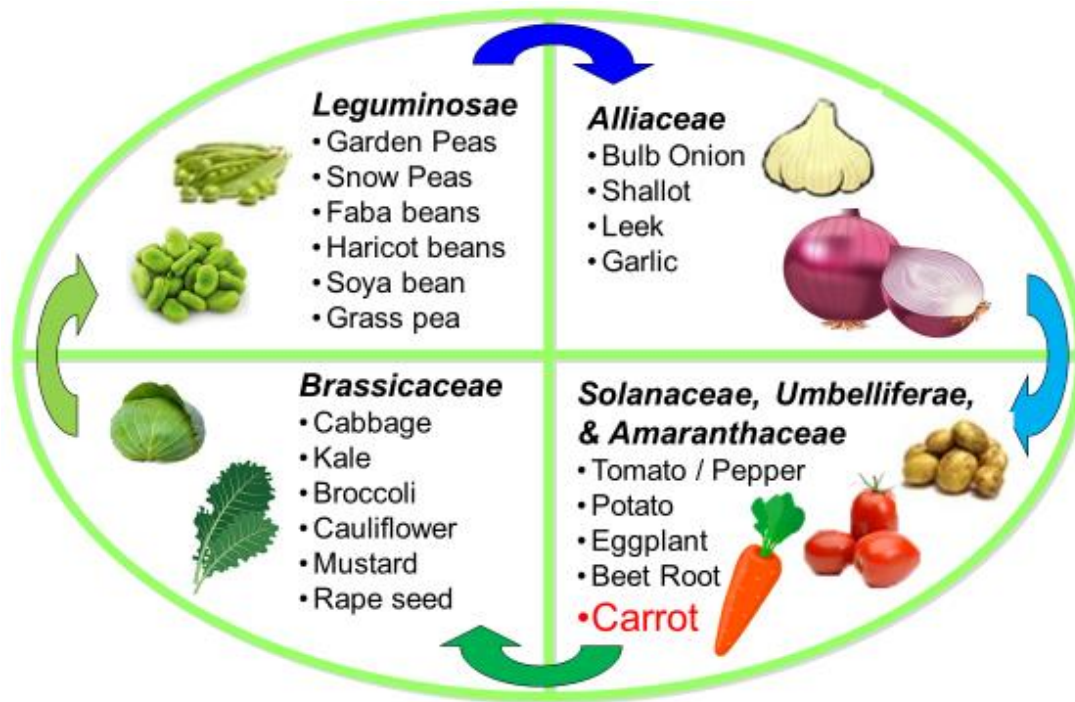
3.10.1 Control/Management Strategies (GHCP&PHHT20: Q15)

- Pests and diseases can be managed through either single control strategies or an integration of two (2) or more methods. The single control strategies are: cultural; physical; biological; and chemical.
- 1. **Cultural Control:** This involves managing the environment in which the crop is growing/grows with a view of maintaining pest and disease below the harmful level. The cultural methods include: field sanitation/hygiene, intercropping, crop rotation, furrowing, flooding, solarization etc.
- 2. **Mechanical Control:** This involves use of insect traps, hand picking, screening house, weeding etc.
- 3. **Biological Control:** This involves use of natural enemies (predators and parasitoids), resistant/tolerant varieties, trap plants, push and pull system, and repellent plants
- 4. **Chemical Control (GHCP&PHHT20: Q16):** This involves use of pesticides. Pesticides are preferred because of the quick knock down effect; they have high efficacy. Pesticide usage has been linked to environmental degradation and should be used as last resort
- 5. **Integrated Pest Management (IPM):** Due to limitation of a single control strategy, use of IPM is a more recommended strategy. IPM integrates cultural, mechanical, biological and as a last resort, chemical control to minimize the crop loss caused by pests and diseases.

3.10.2 Crop Rotation



3.10.2 Crop Rotation

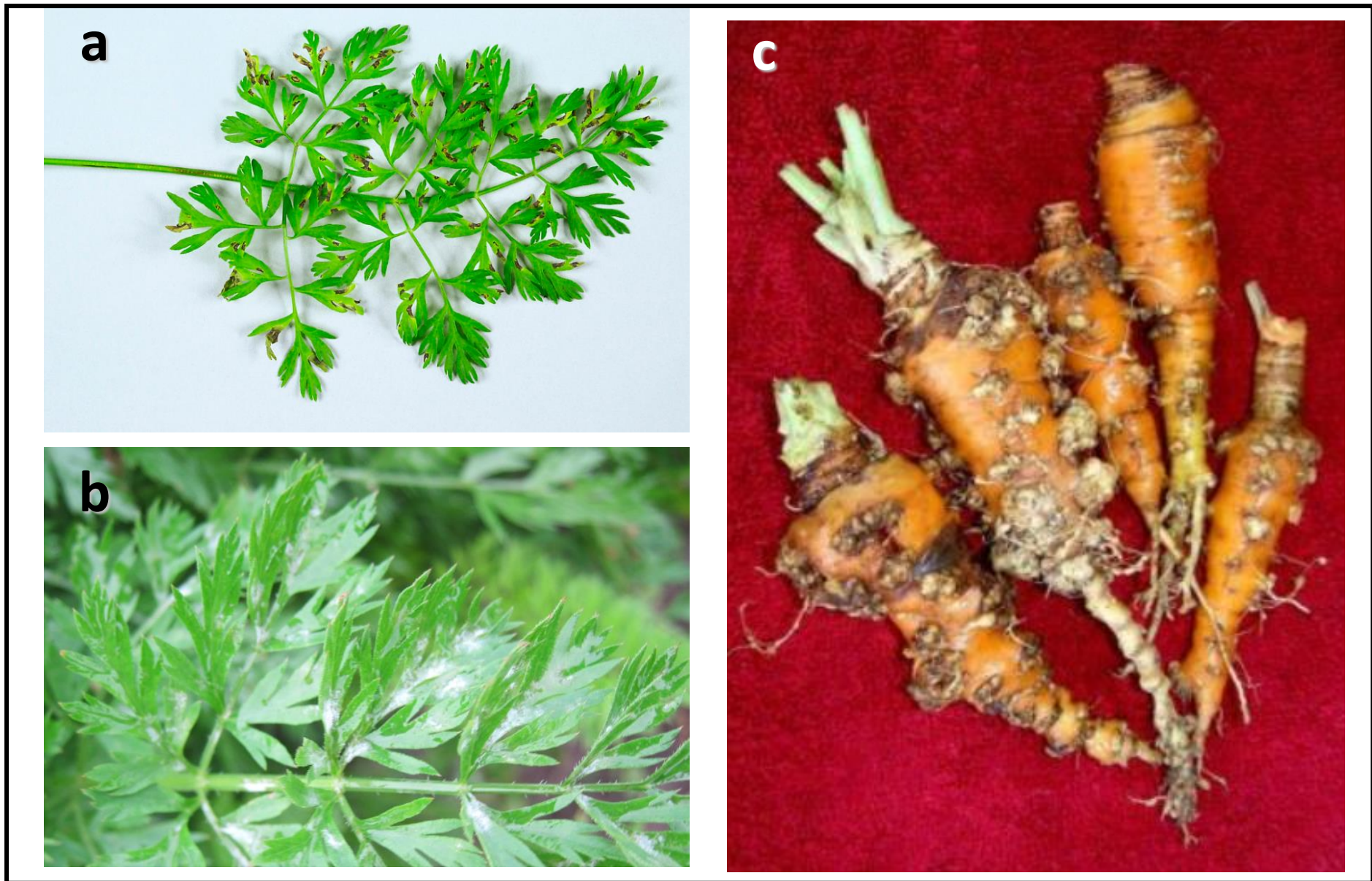


An example of a Crop Rotation

3.10.2 Crop Rotation

- One of the most important strategies of IPM is crop rotation
- Crop rotation prevents pest and disease build-up and in addition, it replenishes soil nutritional status
- A three-year rotation is advisable, mainly to reduce the risk of pest and disease build-up
- By including deeper-rooted crops in rotation with the shallow rooted carrot, nutrients and moisture from the deeper soil layers can be utilized
- Carrots make good crop rotation partners for cabbage, lettuce, pumpkin and tomatoes

3.10.3 Major Pests and diseases



3.10.3 Major Pests and diseases



3.10.3. Major Diseases and Pests

- Disease infestation leads to reduction in quality and quantity of produce
- The proper understanding of each disease symptoms and characters can help to develop integrated disease control methods.
- The following are the major pest and diseases of carrot in Ethiopia:
 - a. **Leaf blight**
 - b. **Powdery mildew**
 - c. **Root-knot nematode**

3.10.3.A: Alternaria Leaf Blight



Source: http://www.pestnet.org/fact_sheets/carrot_leaf_spot_135.htm

**Symptom of leaf blight on
carrots leaves**

3.10.3.A: Alternaria Leaf Blight



**Symptom of leaf blight
on carrots leaves**

3.10.3.A: Alternaria Leaf blight (*Altrnaria dauci*)

General Descriptions:

- It attacks members of the carrot or parsley family
- It will remain in **the soil after harvesting**; it also survives inside seed
- Seed infection can lead to damping-off of seedlings
- Spread over short distances is in wind driven rain

Symptoms:

- Older leaves are attacked first.
- Dark grey to brown spots, angular, with yellow margins, occur on the leaves and petioles
- Under favorable conditions the spots merge and the leaves rapidly blacken, wither and die
- Spores spread from the older leaves to the younger ones, which also become infected

Detection

- Look at the spots: dark-brown to black, with clear yellow halos, and dark venters.

Control:

- **Remove crop debris** after harvest to prevent continued sporulation
- Use **crop rotations of 3 years** or more
- Using **clean, certified seed** (Alternatively, treat in **hot water at 50°C for 25-30 minutes**)
- Do not plant carrots **too densely** in the row; otherwise, the high humidity and prolonged leaf wetness favor the disease

Chemical:

Routine spray (every 7-10 days) fungicides **like**

- **Dithane M45 (Mancozeb)**, at 20g/10 litter of water
- **Copper Oxychloride 85% WP**, at 200g/100 liters of water
- **Bravo 500SC(chlorothalonil)** at 2 liter/ha

3.10.3.B: Powdery mildew



Source: <https://cropscience.bayer.co.uk/threats/diseases/carrot-diseases/powdery-mildew-carrots/>

Outbreaking of powdery mildew on carrots leaves

3.10.3.B: Powdery mildew



Outbreaking of powdery Mildew on carrots leaves

3.10.3.B: Powdery mildew (*Erysiphe heraclei*)

General Descriptions:

- In favorable conditions airborne spores land on leaves and penetrate into the host plant cells
- Leaves of affected carrot plants become white due to being covered with typical growth of a powdery mildew
- Plants are more susceptible when growing in **shady locations** or **stressed by drought**
- Susceptibility also **increases with plant age**, most notably **starting 7 weeks after seeding**
- **Overwinters on crop debris** or other host plants which include wild carrot, celery parsley, parsnip etc.

Symptoms:

- Whitish powdery growth on the undersurface of the leaves
- As the disease progresses, powdery **spots appear on both surfaces** of the leaves and on stems
- Under severe disease pressure the leaves **turn brown, twisted** and brittle before shriveling and dying

Control: (Integrated approach is needed)

- Clean, certified seed
- Crop rotation
- Removal of weeds and discarded plant debris
- Yield often in not impacted because plants become susceptible with age and leaves are not killed as quickly as can occur with other foliar diseases

Chemical

Use of fungicides at first sign of infection every 10-14 days such as:

- **Dithane M45 at 30g/15 liter water**
- **Benomyl at 30ml/15 liter water**
- **Copper Oxychloride**

3.10.3.C: Root-knot nematode



**Symptom of the root-knot
nematode on carrots root**

3.10.3.C: Root-knot nematode



Symptom of the root-knot nematode on carrots root

3.10.3.C: Root-knot nematode

General Description:

- Root knot nematodes are tiny “eelworms” that live in soil and become plant parasites when they use carrot roots as their nurseries
- Nematodes enter carrots **through the root tip**, and this injury causes the root to fork, sometimes in several directions
- Nematodes are often more prevalent on lighter soils

Symptoms:

- Carrot roots are **twisted and deformed**, with much forking and the presence of **knobby galls** on the outside of the roots
- Nodular thickenings on the taproot and particularly on the finer lateral roots
- The attacks are generally more severe with carrots grown over the summer months, when higher soil temperature favor development of the pest

Control

- To avoid infesting new fields with plant-parasitic nematodes, **clean equipment and tools** thoroughly with water, and **prevent movement of infested soil**
- Carrots are more susceptible to root knot nematodes than any other vegetables
- Nematodes are not very active in cool weather (below 17°C), so sometimes winter carrots will be successful even in soils where some nematodes are present
- Pull up affected carrots and dispose them

4. Harvest



Harvesting Carrots

4. Harvest



Harvesting Carrots

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- Carrots are harvested when they have reached a **diameter of 20 mm** and more, still young and tender
- Where carrots have grown poorly, or in very dense stands, the criteria for lifting should not be size, but rather maturity and quality
- Due to the market demand or other factors, carrots can be **harvested earlier**
- Usually when the carrots have reached the mature stage, their base tips appear of the soil surface
- Harvesting is done from **90-120 days after sowing** depending on the agroecology (temperature) of the growing area
- Carrots lifted from wet soils **tend to crack** and are more susceptible to damage
- Therefore, the soil **should be allowed to dry out** to some extent before harvesting
- In dry periods, it is better to use hand tools
- After harvesting, topped, washed and packed
- **Remove the leaves before storing**, to extend shelf life
- Fresh carrots, harvested when mature, will keep for up to five days at room temperature (20°C), and for 7-21 days in a refrigerator

5. Post-Harvest Handling

5.1 Packaging



Packing in the container / a plastic bag

5. Post-Harvest Handling

5.1 Packaging



5. Post-Harvest Handling

5.1 Packaging

- **Small size** and **misshaped** should be removed before packing which is estimated to be between 5-10% depending on the management of the farmers
- After harvesting, if necessary, carrots can be put in cold storage for several months with storage **humidity above 90%** and the temperature is **approximately 0°C**
- In rural conditions, storing carrots is not recommended due to lack of facility.
- Depending on the market carrots can be sold in bunches or in plastic bags.
- Bunched carrots have a **shorter shelf** because they have a higher respiration rate than carrots that have been topped and are in plastic.

**Packing in the container /
a plastic bag**

6. Cost & Income Analysis

Item	Quantity	Unit Price	Total (ETB)
Marketable Yield			
Variable Costs			
Land Preparation			
Manure/Compost			
Seeds			
Fertilizers			
Fungicides			
Insecticides			
Others e.g.) selective Herbicides			
Labour			
Planting			
Spraying/Weeding/Harvesting/Grading			
Transportation/Packaging			

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Spraying/Weeding/Harvesting/Grading			
Transportation/Packaging			

A sample sheet of items and activities to be considered for determining an enterprise's gross margin

6. Cost & Income Analysis

- Farmers are encouraged to keep accurate records of all enterprise activities **(GHCP&PHHT20: Q20)**
- This is vital in determining the enterprise profitability
- Record keeping is very important for farmers practicing commercial agriculture

There are 2 types of records:

•Individual Records:

- Kept by individual farmers and include the cost of production and sales
- Useful in analyzing whether the farmer is making profit or losses in his farming enterprise
- Records are very important for traceability of produce

•Group Records:

- Include activities such as group purchase of inputs, selling of produce etc.

7. Post-Training Evaluation Exercise

QUESTION	TRUE	FALSE
1. Carrots grows well under cool temperature and highland in Ethiopia.		
2. Cold temperature below 10°C cause longer, more slender and paler roots		
3. It is important to apply compost just right before start planting carrots		
4. Carrots will grow heavy clay and water-logged soils		
5. To avoid dense planting, carrots seed should be sown 35 seeds/meter		
6. High rate of nitrogen stimulates root growth, so than it would increasing total yield		
7. If farmers did not thin (high plant population density), roots would splitting/cracking and it decreases the marketable yields		
8. Too much moisture causes short carrots with light colour		
9. The symptom of “ Powdery mildew ” is showing white, powdery fungal		
10. Leaves should NOT remove in order to extend the shelf life		

7. Post-Training Evaluation Exercise

* Please ask the farmers to appropriately indicate answers to each of the following questions.

PAGE NUMBER	QUESTION	TRUE	FALSE
4/28	1. Carrots grows well under cool temperature and highland in Ethiopia.	✓	
4/28	2. Cold temperature below 10°C cause longer, more slender and paler roots	✓	
8/28	3. It is important to apply compost just right before start planting carrots		✓
10/28	4. Carrots will grow heavy clay and water-logged soils		✓
13/28	5. To avoid dense planting, carrots seed should be sown 35 seeds/meter	✓	
14/28	6. High rate of nitrogen stimulates root growth, so than it would increasing total yield		✓
16/28	7. If farmers did not thin (high plant population density), roots would splitting/cracking and it decreases the marketable yields		✓
16/28	8. Too much moisture causes short carrots with light colour	✓	
23/28	9. The symptom of “Powdery mildew” is showing white, powdery fungal	✓	
25/28	10. Leaves should NOT remove in order to extend the shelf life		✓

[Note]

- If there is any question which half of the participants gave the wrong answer, you need to repeat the specific area regarding to question