



Japan International Cooperation Agency



Agriculture and Food Authority
Horticultural Crops Directorate



Ministry of Agriculture, Livestock and Fisheries
State Department for Crop Development & Agricultural Research

Smallholder Horticulture Empowerment & Promotion Project for Local and Up-Scaling (SHEP PLUS)

*“Changing Farmers’ Mindset from **“Grow and Sell”** to **“Grow to Sell”**”*

CABBAGE PRODUCTION



Prepared by SHEP PLUS

Training Title: Cabbage Production

Objective: To provide a guideline on production of Cabbage

Specific Objective:

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

Contents:

1. Introduction: Background, 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 cited agrochemicals are in accordance with "Pest Control Product Registered for Use in Kenya 11th Edition, 2018". The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.

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 Unit Project (SHEP UP) 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 cases. But where applicable, it is recommended that the instructions issued be given due consideration.

1. Introduction:

1.1 Background



Cabbage (Kabeji)

1. Introduction:

1.1 Background



Cabbage (Kabeji)

1. Introduction:

1.1 Background

- Cabbage is a member of the ***Brassicaceae* (*Cruciferae*)** family which includes crops such as **Kale, Cauliflower, Broccoli** and **Radish**
- Three main types: **Green, Red** and **Savoy**
- One of the most **widely grown, popular** and **nutritious vegetables** in Kenya mainly for the domestic market
- Grown by both small and medium scale farmers
- Contains **Calcium, Iron, Vitamin A, C & E, Minerals, Riboflavin, Nicotinamine** and **Ascorbic Acid**
- Cabbage has cleansing effect of stomach and intestinal tract if consumed raw without salt due to high sulphur and chlorine content

1.2 Common Varieties



“Gloria F1”



“Copenhagen Market”

1.2 Common Varieties



“Gloria F1”



“Copenhagen Market”

1.2 Some Common Varieties

- The following are the common varieties grown in Kenya

“Gloria F1”

- A medium-late maturing variety ready for harvesting 90 days after transplanting. Has solid blue green color and thick waxy layer. It is not prone to splitting and keeps well after harvesting.
- Tolerant to **Black Rot** and resistant to **Fusarium yellows**
- **Plant Spacing: 60 cm x 60 cm**
- **Maturity: 90 days** after transplanting (**medium-late maturing**)
- Plant population: **11,111 per acre**
- **Average head weight 3-5 kg**
- **Yield: 30,000-50,000kg per acre**

“Copenhagen Market”:

- Requires a cool/warm climate
- **Plant Spacing: 60 cm x 45 cm**
- Plant population: **14,800 per acre**
- **Maturity: 65 – 70 days** after transplanting (**early maturing**)
- **Head: small to medium round shape with uniform size, weighing 2 – 2.5 kg**
- **Yield: 20,000 – 30,000kg per acre**

1.2 Common Varieties Cont'



Photo:
<http://www.seminis.com/global/us/products/Pages/CabbageBlueDynasty.aspx>

“Blue Dynasty F1”



Photo: <http://www.easeed.com/index.php/2015-07-16-12-56-29/vegetables/cabbage-baraka-f1>

“Baraka F1”

1.2 Common Varieties Cont'



Photo: <http://www.sarim.com/global/en/products/pages/Cabbage/BlueDynasty.aspx>

“Blue Dynasty F1”



Photo: <http://www.comend.com/index.php/2015-11-15-12-46-20/vegetables/cabbage-baraka-f1>

“Baraka F1”

1.2 Some Common Varieties Cont'

“Blue Dynasty F1”

- Good tolerance to **Black Rot, Cabbage Ring Spot, Diamond Back Moth (DBM) & Fusarium Yellows**
- Can do well in warm areas
- **Plant Spacing: 60 cm x 60 cm**
- Plant population: **11,111 heads per an acre**
- **Maturity: 80 – 85 days** after transplanting (medium-late maturing)
- **Head:** round compact shape, weighing **4 – 5 kg**
- **Yield: 45,000 – 68,000kg per acre**

“Baraka F1”:

- High yielding bluish green round heads weighing **4 – 6 kg**
- **Maturity:** 75 days
- Good field holding capacity
- High tolerance to **Black Rot, Ring Spot & Cabbage Yellows**
- Good ground clearance
- **Yield: 40,000 – 50,000kg per acre**

1.2 Common Varieties Cont'



Photo:
[http://www.seminis.com/global/in/products/Pages/Green Challenger.aspx](http://www.seminis.com/global/in/products/Pages/Green_Challenger.aspx)

“Green Challenger F1”



Photo: http://profyseeds.com/products/cabbage-pruktor-f1-hybrid-80-seeds_130.html

“Pruktor F1”

1.2 Common Varieties Cont'



1.2 Some Common Varieties Cont'

“Green Challenger F1”

- Blue green colour with rich creamy internal colour
- Tolerance to **Diamond Back Moth (DBM)**, **Black Rot** & **Fusarium Yellows**
- **Plant Spacing:** 30 x 30 cm/60 x 60 cm
- **Plant Population:** 11,111-44,444 per acre
- **Maturity:** 60 days after transplanting (early maturing)
- **Head:** round shape with compact size, weighing 2.5 – 3 kg
- **Yield:** 40,000 – 50,000kg per acre

Photo: <http://www.seminis.com/global/in/products/Pages/GreenChallenger.aspx>

“Green Challenger F1”



“Pruktor F1”:

- **Plant Spacing:** 60 cm x 60 cm
- **Population:** 11,111 per acre
- Sweet flavor
- Tolerant to **Black Rot** and **Diamond Back Moth (DBM)**
- Tolerant to **low night temperatures**
- **Maturity:** 80 days after transplanting
- **Head:** uniform size, weighing 5 – 6 kg
- **Yield:** 50,000 – 60,000kg per acre

Photo: http://profyseeds.com/products/cabbage-pruktor-f1-hybrid-80-seeds_130.html

“Pruktor F1”

1.2 Common Varieties Cont'



Information Source: <http://egv.aparte.dk>

“Riana F1”

1.2 Common Varieties Cont'



“Riana F1”

1.2 Some Common Varieties Cont'

“Riana F1”

- **Plant Spacing:** 60 cm x 60 cm
- Both heat and cold tolerant, blue green, white internal color
- Resistant to splitting when irrigated or rain fed
- **Maturity:** 90 – 100 days after transplanting
- **Head:** Round and compact, weighing 1.5 – 2.5 kg
- Tolerant to **Black Rot** and **Tip Burn**
- **Yield:** 15,000 – 30,000kg per acre

“Amigo F1”:

- Tolerant to **Black Rot** and **Diamond Back Moth (DBM)**
- Green and semi round heads 4 – 6 kg
- Requires warm/cool areas, **Maturity:** 90 – 100 days
- **Yield:** 45,000 – 68,000kg per acre

Other varieties grown in Kenya are:

- | | | |
|----------------------|--------------------------|-------------|
| • Prize Drumhead | • Super Master F1 | • Queen F1 |
| • Glory of Enkhuizen | • Oxylys | • Fanaka F1 |
| • Golden Acre | • Star 3308 F1 | • Tristar |
| • Sugar Loaf | • Santa F1 | |
| • Fortuna | • Rotan F1 | |
| • K-Y Cross | • Field Winner F1 | |
| • Early Market F1 | • Globe Master Hybrid F1 | |

1.3 Other types of Cabbages



Photo: <http://www.condorseed.com/vegetables/cabbage/cabbage-red-acre/C>

“Red Acre”

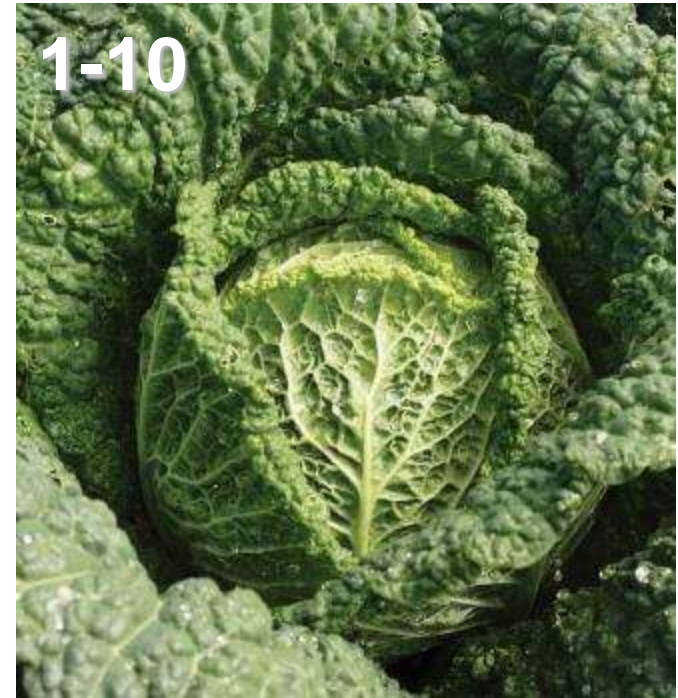


Photo: <https://www.westcoastseeds.com/shop/vegetable-seeds/cabbage-seeds/savoy-capriccio/>

“Savoy Cabbage”

1.3 Other types of Cabbages



“Red Acre”



“Savoy Cabbage”

1.3 Other types of Cabbages

1. Red Type

- Red Cabbage (*Brassica oleracea* var, *capitata fruticosa rubra*) is just another form within same species and has much in common with Green Cabbage
- Red Cabbage has **twice** as much **Vitamin C** as Green Cabbage
- Grown varieties in Kenya are “**Mammoth Red Rock** (1.2-2.0kg/ head)”, “**Red Acre** (1.2-2.0kg/ head)”, “**Red Dynasty** (4-5kg/ head, 45-56t/ acre)” “**Ruby Ball**” etc.

2. Savoy Type

“Savoy Cabbage”:

- Savoy Cabbage (*Brassica oleracea* var. *sabauda*.) has **deeply crinkled and ruffled textured leaves**
- Savoy Cabbage is milder and tastier than Red and Green Cabbages and has **beta-carotene**

1.3 Optimal Ecological Requirements

Altitude	700 – 2,200 metres above sea level
Rainfall	At least 500 mm
Growing Temperature	16 – 20 °C
Soils	<ul style="list-style-type: none">• Well drained sandy or silty loam soils• High organic matter content• pH range 6.0 – 6.5

1.3 Optimal Ecological Requirements

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Rainfall	At least 500 mm
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Soils	<ul style="list-style-type: none"> • Well drained sandy or silty loam soils • High organic matter content • pH range 6.0 – 6.5

1.3 Optimal Ecological Requirements

- **Altitude:** Cabbage can be grown in altitudes ranging from **700 – 2,200 m** above sea level. At low altitude the crop should be grown during the cool months of the year.
- **Rainfall:** Cabbage has a **high water requirement** and at least **500 mm** of rainfall well distributed throughout the growing period is required.
- **Temperature:** Cabbage performs better under **cool temperatures** and the **optimum temperature** range for production is **16 – 20 °C**. Temperatures above **25 °C** hamper head formation.
- **Soil:** Cabbage requires **well drained sandy or silty loams** with high organic matter content and high water holding capacity. The optimal soil pH range is **6.0 – 6.5**.

2. G20 technologies

1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/ manure
9. Recommended practices of seedling preparation/ seedlings from registered nursery

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[G20 Technologies]

Make sure to support farmers carry out G20 techniques for any crop

2. G20 technologies

10. Recommended spacing

11. Recommended fertilizer application rate

12. Supplementing water

13. Timely weeding

14. Top-dressing

15. IPM practices

16. Safe and effective use of pesticides

17. Use of harvesting indices

18. Appropriate post harvest handling containers

19. Value addition techniques

20. Keeping farm records

2. G20 technologies

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- | | |
|---------------------------------------------|--------------------------------------------------|
| 10. Recommended spacing | 16. Safe and effective use of pesticides |
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| 15. IPM practices | |

[G20 Technologies]

Make sure to support farmers carry out G20 techniques for any crop

2.1 Crop Planting Calendar

A Sample of a Cabbage Planting Calendar

Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Land preparation	Transplant 30 days after seed germination	Weed, pests & diseases control	2 nd top-dress 200 kg CAN per acre (20 g/hole = 4 bottle tops/hole)	Harvesting starts 75 – 120 days after transplanting	Peak demand for Cabbage		
Sowing in nursery bed:100-120g of seed/acre	Spacing 60cm x 45-60cm	1 st top-dress 100 kg CAN per acre (10 g/hole = 2 bottle tops/hole)	Weed, pests & diseases control	Sorting & grading Small 1-2 kg Med. 3-4 kg Large > 5 kg			
Control of damping-off diseases & cutworms	Fertilizer (DAP) application 80 kg/acre (10 g/hole = 2 bottle tops/hole)			Yields 16 – 68 tons/acre			
	Manure application 8 tons/acre (2 – 3 handfuls /hole)			Marketing			

2.1 Crop Planting Calendar

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	Manure application 8 tons/acre (2 – 3 handfuls /hole)			Marketing			

A Sample of a Cabbage Planting Calendar:
Targeting a peak market demand beginning just after November

2.1 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:

- Determine from the market survey results (2.1) when there is peak demand for Cabbage
- Work backwards from the month when there is peak demand to prepare a monthly farm activities preceding the peak period
- 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

2.2 Composting



Manure preparation through composting

2.2 Composting



**Manure preparation
through composting**

2.2 Composting (GHCP&PHHT20: Q4)

- Cabbage, like most leafy vegetables, is a heavy feeder and does well in soils with high organic content
- Based on the results of the soil analysis, prepare adequate compost for application
- During compost making, the organic matter need to be covered to prevent leaching of nutrients
- The recommended rate of application ranges from **5 – 8 tons/acre**

3.1 Basal Application

3-3



Manure prepared for basal application

3.1 Basal Application

3-3



Photo: SHEP PLUS

3.1 Basal Application (GHCP&PHHT20: Q8)

- The manure/compost should be broadcasted (**5 – 8 tones/acre**) then worked into the soil (incorporated) preferably using a hoe
- Manure/compost should be applied **1 – 2 weeks** before transplanting

Manure prepared for basal application

3.2 Raising Seedlings



A Cabbage nursery

3.2 Raising Seedlings



**A Cabbage nursery: seedlings
2 weeks after germination at
an interrow spacing of 15 cm**

3.2 Raising Seedlings (GHCP&PHHT20: Q9)

- Use certified seed with special attributes, such as tolerance/resistance to pest and diseases and high yielding
- The seed rate is about **100-120 g/acre (depending on variety (F1/OP) and spacing)**

Nursery Site Selection:

- Avoid setting up the nursery in fields previously having a Cabbage crop

Nursery Establishment:

- Prepare a seedbed of **1 m width** and of a convenient length
- Make drills on the seedbed at a spacing of **10 – 20 cm apart**
- Thinly sow the seeds in the drills and cover lightly with soil

Management of Nursery:

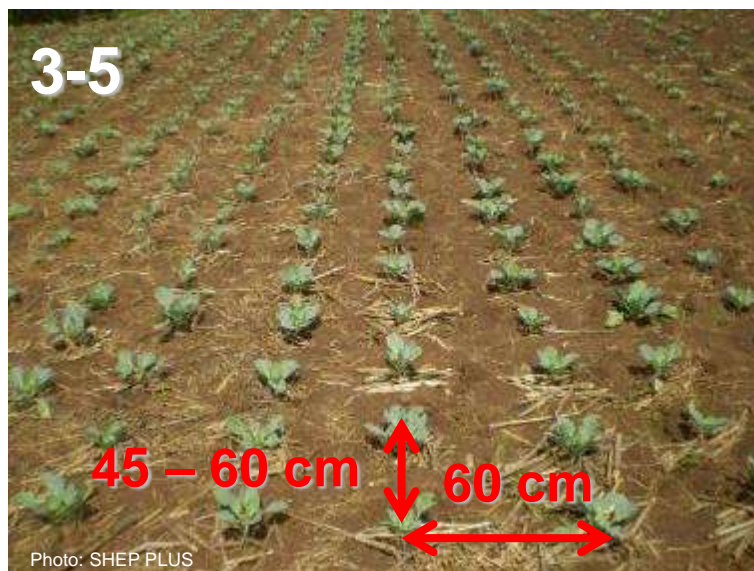
- Water thoroughly after transplanting and regularly
- However, avoid **over-watering** which can lead to **“Damping-off”** disease
- Start hardening the seedlings **1 – 2 weeks** before transplanting by reducing the frequency of watering and the shade over the nursery
- Mulching is important to provide favourable environment for seedlings

3.3 Transplanting



Cabbage crop 2 weeks after transplanting

3.3 Transplanting



Cabbage crop 2 weeks after transplanting

3.3 Transplanting

3.3.1 Appropriate Time

- Seedlings are transplanted **30 days** after seed germination
- It is recommended that transplanting should be done either early in the morning or late in the evening

3.3.2 Recommended Spacing (**GHCP&PHHT20: Q10**)

- The recommended spacing is **60 cm between rows** and **45 – 60 cm between plants** depending on the variety
- Plant population: **11,000 – 14,800 plants/acre**

3.3.3 Fertilizer Application Rates (**GHCP&PHHT2: Q11**)

- Apply **2 – 3 handfuls** of manure per planting hole (**8 tons/acre**) and 2 half-litre water bottle tops (**10 g**) of DAP per planting hole (**80 kg/acre**)

[Note]

- **DAP** should not be applied on acid soils, use **DSP**, **TSP** or **NPK**
- Only thoroughly decomposed manure should be used to avoid possible introduction of cutworms in the field
- The **DAP** fertilizer should be mixed thoroughly with the soil to avoid possible scorching of the seedlings

3.4 Water Requirement



Photo: © Victor Omari HCD 2019

Cabbage under drip irrigation

3.4 Water Requirement



Cabbage under drip irrigation

3.4 Water Requirement (GHCP&PHHT20: Q12)

- The optimal amount of rainfall required for Cabbage during the growing period is **500 mm**
- Regular watering ensures uniform head formation, prevents **head splitting** and increases the size of the head
- Watering should be reduced as crop matures
- Excessive watering increases water logging hence deficiencies of **Magnesium** and **Phosphorus**
- Use potable water for irrigation for food hygiene

Irrigation Methods:

- Irrigation can be **overhead, drip** or **furrow**

3.5 Top-dressing

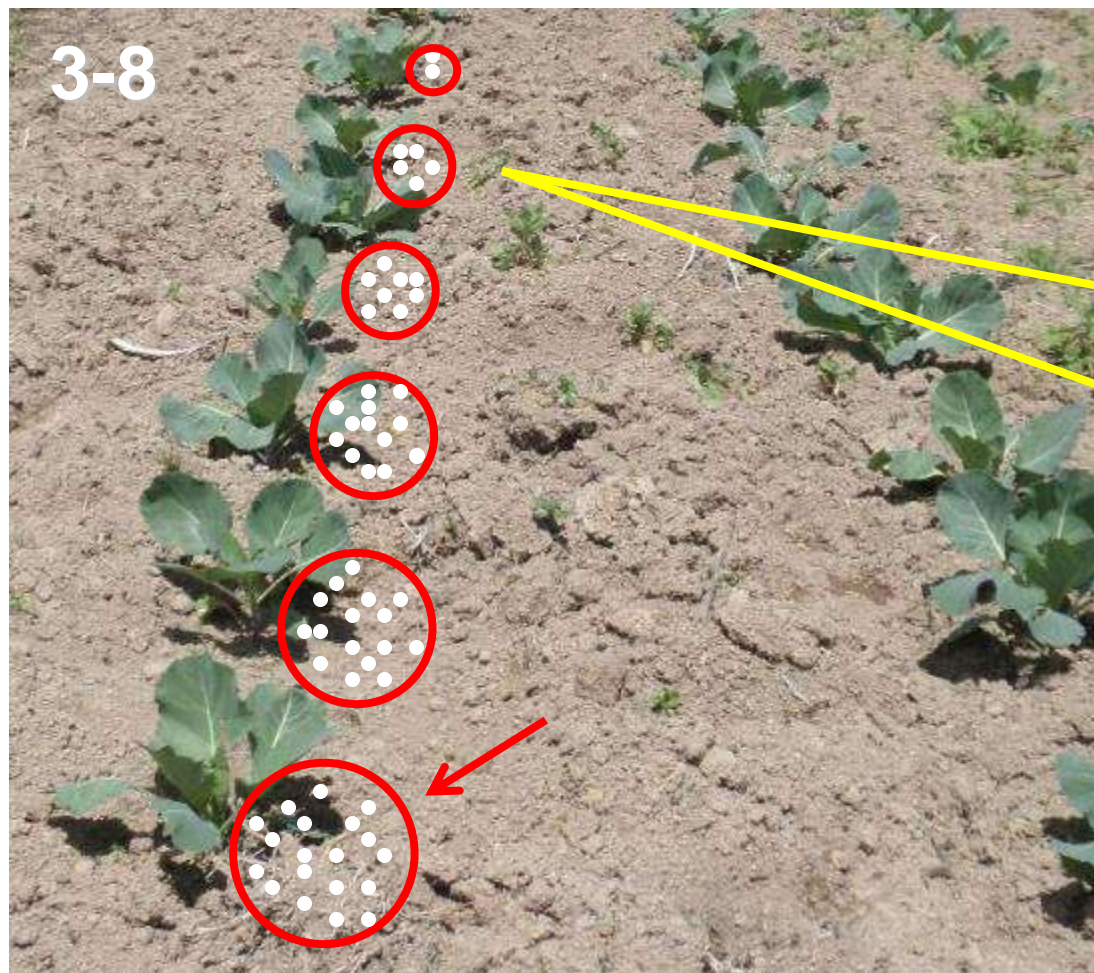
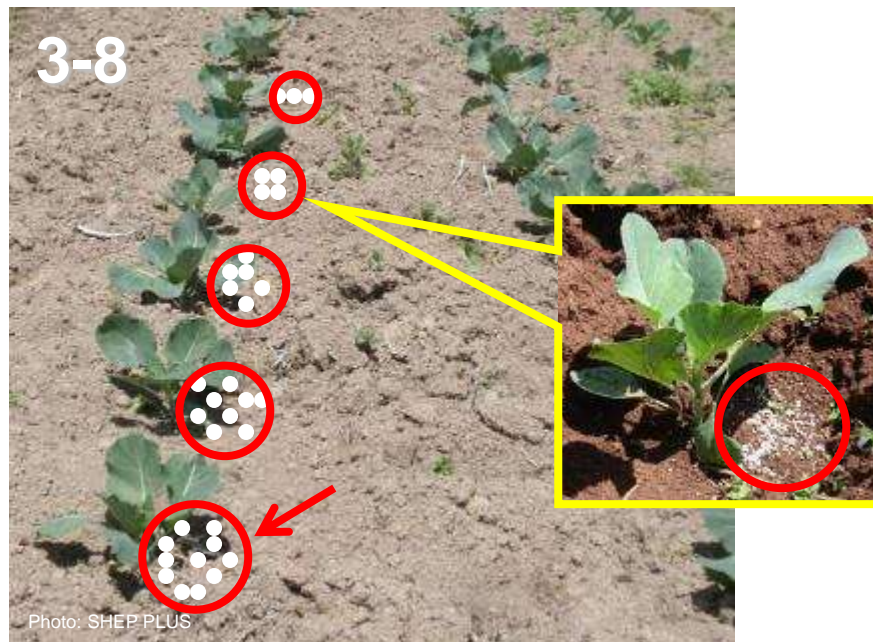


Photo: SHEP PLUS



Top-dressing using the placement method

3.5 Top-dressing



Cabbage top-dressed with CAN using the placement method

3.5 Top-dressing (**GHCP&PHHT20: Q14**)

- The crop should be top dressed with **CAN fertilizer** in **2 splits** to avoid nutrient loss through leaching as well as excessive soil salinity
- The first split is applied at a rate of **10 g/plant (100 kg/acre) 2 – 3 weeks** after transplanting
- The second split is applied at a rate of **20 gm/plant (200 kg/acre)** at the onset of head formation (*KARI & The Rockefeller Foundation, 2005*)
- **Placement method** is preferred over broadcasting as it is **more effective** and **economical**

3.6.1 Major Pests



3.6.1 Major Pests



3.6.1 Major Pests

- Pest damage causes a reduction in quality and quantity of produce
- The following are the major pests of Cabbage in Kenya:

- A. Diamond Back Moth (DBM)**
- B. Cabbage Sawfly**
- C. Aphids**
- D. Slugs**
- E. Cutworms**

3.6.1.A: Diamond Back Moth (DBM)



Photo: SHEP PLUS

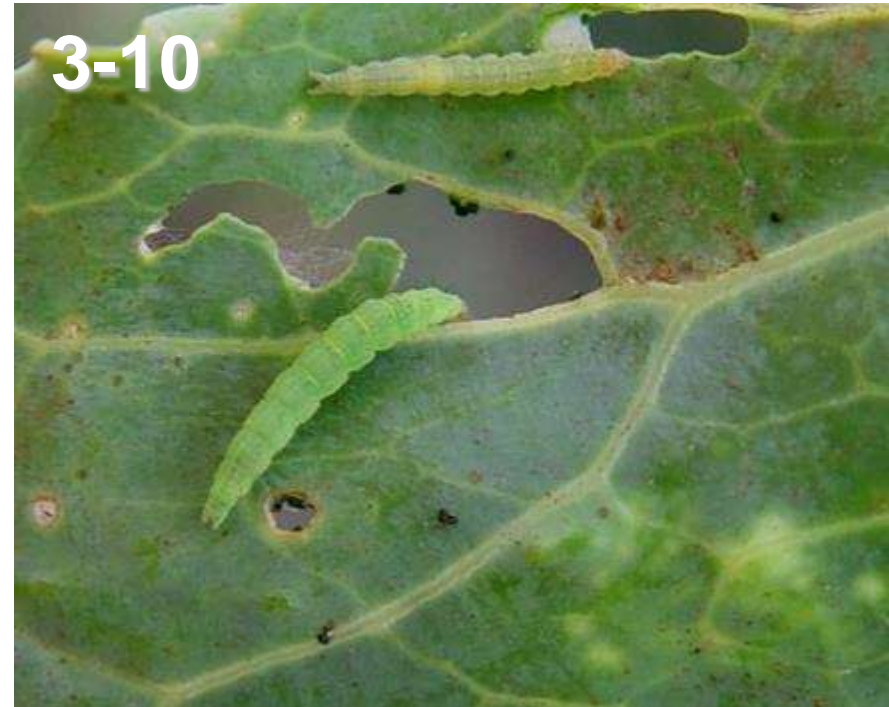


Photo: A. M. Varela, icipe (CC BY-NC-SA 3.0)

<http://infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas#simple-table-of-contents-5>

Cabbage plant damaged by the DBM larvae

3.6.1.A: Diamond Back Moth (DBM)



Photo: SHEP PLUS



Photo: Am. M. Varela, iCrop (CC BY-NC-SA 3.0)

<http://infonet.biovision.org/PlantHealth/Crops/Cabbage/Kale-Brassicastimple-table-of-contents-5>

Cabbage plant damaged by the DBM larvae (inset)

3.6.1.A: Diamond Back Moth (DBM)

Identification:

- Male adult is **small grayish moth** with **diamond pattern on its back** when wings are closed
- **Eggs** laid on upper surface of leaves (one female can lay 400 eggs)

Damages:

- The **pale green larvae** feed on the underside of leaves making **“windows”**
- Pupation takes place into a silken gauze-like cocoon at underside of leaf
- Infestations are normally serious **in drier months**
- **Failure to form heads** if infested early

Control:

- Use of bio-insecticides such as ***Bacillus thuringiensis* (Bt)** (**DELFIN 6.4W.G®** and **HALT 50WP®**)

3.6.1.A: Diamond Back Moth (DBM) Cont'



Photo: By Indiaphotoblog at en.wikipedia, CC BY 3.0, <https://commons.wikimedia.org/w/index.php?curid=17047173>

“Indian Mustard”: Trap Crop to reduce DBM destruction on Cabbage

3.6.1.A: Diamond Back Moth (DBM) Cont'



Photo: By Indiaphotoblog at en.wikipedia, CC BY 3.0,
<https://commons.wikimedia.org/w/index.php?curid=17047173>

**“Indian Mustard”: Trap Crop
to reduce DBM destruction
on Cabbage**

3.6.1.A: Diamond Back Moth (DBM) Cont'

Control Cont':

- **Intercropping with other crops** which act as **repellants** (e.g. **Tomato**) or **trap crops** (e.g. **Indian Mustard**) reduces DBM destruction on Cabbage
- When Tomato is used as a repellent, Cabbage is planted **30 days after Tomato**
- **Use of parasitic wasp (*Diadegma spp.*)**
- Use of neem products, such as **azadirachtin (Neemraj Super 3000®)** etc.
- **Use of pesticides**, such as
 - **Chlorantraniprole 200g/L (CORAGEN 20 SC®)**
 - **Indoxcarb (AVAUNT 150 EC®)**
 - **Malathion (FEDOTHION 50 EC®)**
 - **Flubendiamide 480g/L (BELT 480 SC®)**
 - **Methoxyfenoxide (RUNNER 240 SC)**

3.6.1.B: Cabbage Sawfly



Photo: © A. M. Valera, icipe

<http://infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas#simple-table-of-contents-5>

**A “Cabbage Sawfly” larva and damage
on a Cabbage leaf**

3.6.1.B: Cabbage Sawfly



A “Cabbage Sawfly” larva and damage on a Cabbage leaf

3.6.1.B: Cabbage Sawfly

Identification:

- Adult is a wasp with dark thorax and blight yellow abdomen
- Adults fly slowly above the crop
- Eggs laid singly inside the leaf
- The **grayish green larvae** with fleshy warts along the body feed on the blade of the leaves: often leaving **only the main veins** and **midrib**
- Larvae drop to the ground if there is slight disturbance
- Pupation takes place **inside the soil**
- Spin tough silken cocoons

Control

- **Destruction of wild plants** of the ***Brassicaceae*** family
- **Use of pesticides**, such as
 - Methoxyfenozide (RUNNER 240SC®)
 - Imidacloprid (MURCLOPRID 25 WP®)
 - Trichlorfon (DIPTEREX 95 SP®)

3.6.1.C: Aphids



**Underside of a Cabbage leaf infested
with Aphids**

3.6.1.C: Aphids



**Underside of a Cabbage leaf
infested with Aphids**

3.6.1.C: Aphids

Important Types:

- Mealy Cabbage Aphid
- False Cabbage Aphid
- Green Peach Aphid

Identification of Mealy Cabbage Aphid:

- They are **pale green** and usually covered with a **light dust of mealy powder**
- They suck plant sap from the central part of the plant and near the base of leaves

Damage:

- Aphid attack results in curled and distorted leaves which in turn leads to **poor head formation**

Control:

- **Field hygiene** through removal and destruction of crop residue
- Natural enemies (**Parasitic Wasps**)
- **Use of Biopesticide products**, such as
 - **Azadiractin (NEEMRAJ SUPER®, ACHOOK 0.15% EC®)**
- **Use of insecticides**, such as
 - **Imidacloprid (EMERALD Gold®)**
 - **Lambdacyhalothrin (KARATE 2.5WG®)**
 - **Thiocyclam 50% w/w of thiocyclam-hydrogenoxalate (EVISECTS®)**

3.6.1.D: Slugs



Photo: R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org (CC BY 3.0 US)

Cabbage plant damaged by slug

3.6.1.D: Slugs



Photo: R.J. Reynolds Tobacco Company Slide Set, R.J. Reynolds Tobacco Company, Bugwood.org (CC BY 3.0 US)

Cabbage plant damaged by slug

3.6.1.D: Slugs

Identification:

- Found under the leaves

Damage:

- Reduced **quality** and **marketability**

Control:

- Cultural control by drowning the slugs in water (bury tins at ground level and fill with water) and **add yeast** to attract the slugs
- **Use slug pellets**

3.6.1.E: Cutworms



Photo: © A. M. Valera, icipe (CC BY-NC-SA 3.0) <http://infonet-biovision.org/PlantHealth/Pests/Cutworms#>

A Cutworm larva

3.6.1.E: Cutworms



Photo: © A. M. Valera, icipe (CC BY-NC-SA 3.0) <http://infonet-biovision.org/PlantHealth/Pests/Cutworms#>

A Cutworm larva

3.6.1.E: Cutworms

Identification:

- They are **grayish black larvae** that partially or completely bite the stem at ground level **causing the plant to fall over**
- They are often found hiding in soil near the cut seedlings

Control:

- **Hand removal** since the pest is easily found near the damaged plant, especially at the beginning of infestation
- **Early weeding** destroys sites for egg laying
- **Ploughing** exposes the pest to its predators and desiccation
- **Use of appropriate insecticides**, such as
 - Beauveria bassiana/ biological insecticide (BIOPOWER 1.5®)
 - Lambda Cyhalothrin (TATA UMEME 2.5EC®)
 - Acephate (ASATAF SP®)**(Drenching should be done in the evenings)**

3.6.2 Major Diseases



Photo: SHEP PLUS



Photo: SHEP PLUS



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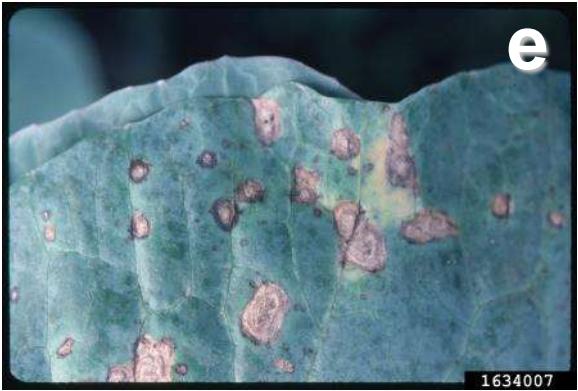


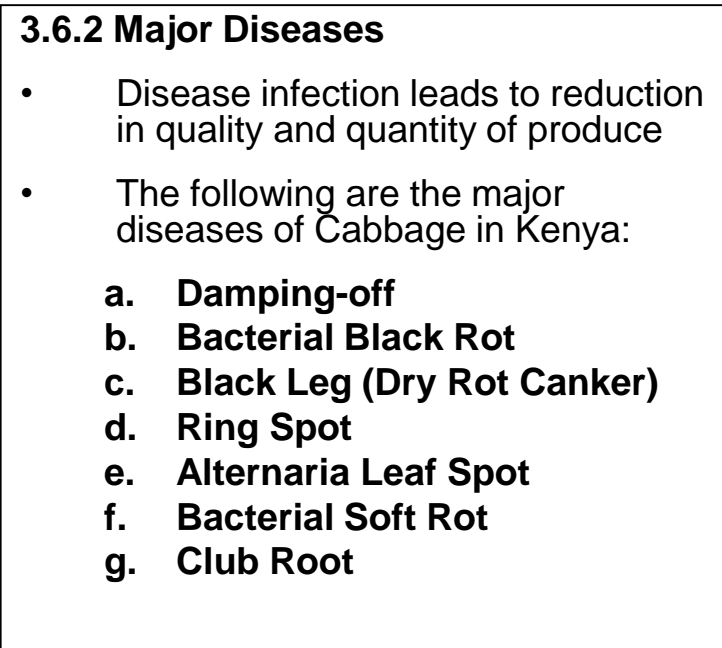
Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org (CC BY-NC 3.0 US)



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)



3.6.2.a: Damping-off



Photo: SHEP PLUS

Symptom of “Damping-off”

3.6.2.a: Damping-off



Photo: SHEP PLUS

Symptom of “Damping-off”

3.6.2.a: Damping-off

General Descriptions:

- The disease is caused by the **fungi**
- Common problem at the **nursery stage**
- More likely prevalent during **rainy season**
- **Too much moisture** will dispose the crop to the disease

Symptoms:

- **Seedlings rot** at the base of the stem thus falling over to the ground

Control:

- Avoid **dense sowing** which cause damp conditions
- Avoid **excessive watering** and **fertilization**, particularly with nitrates
- Avoid fields with a history of the disease
- Practice **crop rotation**
- Use **certified disease-free seed**
- **Solarization of seedbed** where feasible
- Use of appropriate fungicide such as Metalaxyl-M+Mancozeb (AMIDIL 68WG®)

3.6.2.b: Black Rot



Early symptom of “Black Rot” on the edge of a Cabbage leaf

3.6.2.b: Black Rot



Early symptom of “Black Rot” on the edge of a Cabbage leaf

3.6.2.b: Black Rot

General Descriptions:

- This is a **seed-borne bacterial disease**, spread through **soil + Infected debris**
- Black rot infection and spread is favored by **wet conditions** and **high temperatures (26 – 30 °C)**
- Crowded plants provide conditions that are ideal for bacterial spread to nearby plants

Symptoms:

- Yellow **V-shaped lesions** on the leaf margins which later turn **brown** as the leaf veins in the affected area become **black**
- A cross sectional cut of infected stem reveal a characteristic **black ring**
- In later stages, affected heads turn **black** and soft
- The rotten heads give a characteristic **offensive odour**

Control:

- Use certified seeds
- Field sanitation (burn crop residues)
- Use of resistant/tolerant varieties, e.g.) **Green Challenger, Amigo F1**
- Crop rotation (at least 3 years)
- Use of copper based fungicide such as AMICOP 50WP® (should be sprayed at early stage of disease infestation)

3.6.2.c: Black Leg (Dry Rot Canker)



Photo: © Jack Kelly Clark, courtesy
University of California Statewide IPM
Program



Photo: © Infonet-Biovision <http://www.infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas> (CC BY-NC-SA 3.0)

**A stem infected with “Black Leg” (Left) and
Blackleg infected kale wilting (Right)**

3.6.2.c: Black Leg (Dry Rot Canker)

3-18



Photo: © Jack Kelly Clark, courtesy University of California Statewide IPM Program

Blackleg lesions can girdle the basal part of the stem

3-19



Photo: © Infonet-Biovision <http://www.infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas> (CC BY-NC-SA 3.0)

Blackleg infected kale wilting

3.6.2.c: Black Leg (Dry Rot Canker)

General Descriptions:

- This is a **seed borne fungal disease**
- Spread through **movement of infected seedlings, garden tools and crop debris**
- It is destructive in **wet soil**

Symptoms:

- Leaves have **light brown spots** which may be circular and which later develop ash **grey centres with many black spots**
- Stem has **dark cankers** extending below the soil level that kills the roots
- Destroys the **fibrous root system**
- Affected plants **wilt abruptly** and **die or topple** over as heads enlarge

Control:

- Use of **certified seed**
- **Field sanitation** (hygiene)
- **Crop rotation** for 1-2 years
- **Good drainage**
- Diseased plant parts should not be fed to animals if manure is to be used on fields
- Ploughing
- Application of Iprodione (ROVRAL 250 FLO ®) (spray on the base of the plants. Do not apply more than twice)

3.6.2.d: Ring Spot



Photo: © Malcolm Storey CC BY-NC-SA 2.0 UK

A Cabbage leaf infected with “Ring Spot”

3.6.2.d: Ring Spot



Photo: © Malcolm Storey CC BY-NC-SA 2.0 UK

**A Cabbage leaf infected with
“Ring Spot”**

3.9.4d: Ring Spot

General Descriptions:

- This is a **seed borne fungal disease**
- Spread by **wind** or **use of compost** made from infected crop residues

Symptoms:

- **Circular brown grey spots** on the leaves which are often bordered by a **green margin** and with **black – specked concentric zones**

Control:

- Use of **certified seeds**
- Crop rotation for at least 2 years
- **Use of fungicides**, such as
 - **Tebuconazole (ORIUS 25EW, WARRIOR 25EW)**
- Maintain field hygiene

3.6.2.e: *Alternaria* Leaf Spot

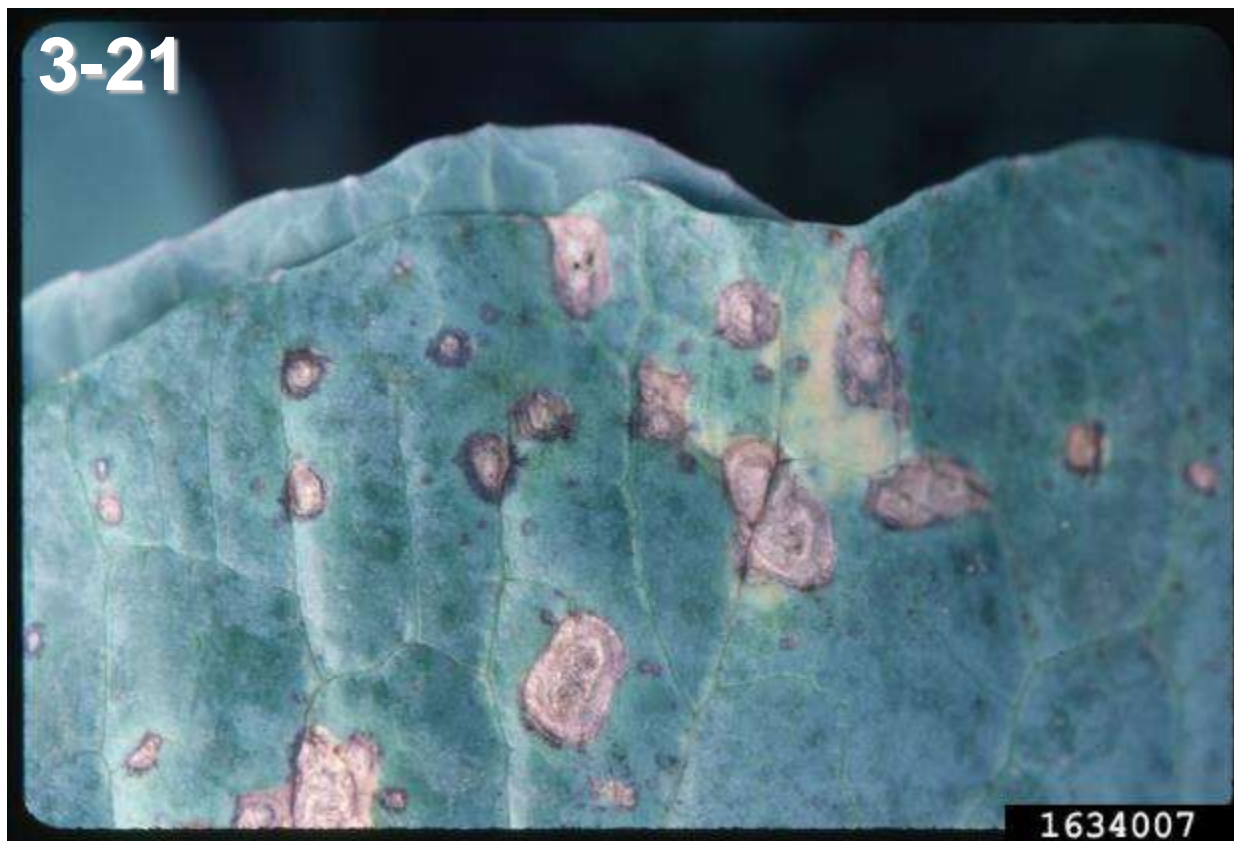


Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org (CC BY-NC 3.0 US)

Symptom of *Alternaria* Leaf Spot

3.6.2.e: Alternaria Leaf Spot

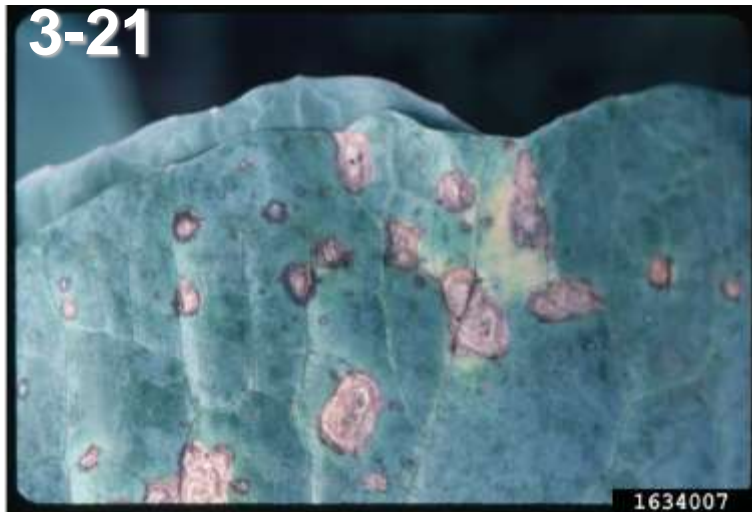


Photo: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University. Bugwood.org (CC BY-NC 3.0 US)

Symptom of
“*Alternaria* Leaf Spot”

3.6.2.e: Alternaria Leaf Spot

General Descriptions:

- A **fungal disease** that can severely damage cabbage if uncontrolled

Symptoms:

- Initial symptoms are **small, circular dark spots** on older leaf surfaces
- As the spots enlarge, **concentric rings** develop within lesions surrounded by a **yellow halo**
- The lesions eventually fall out, producing a hole or under wet conditions, may be covered with masses of black spores
- In storage, **spots enlarge** and soft rot bacteria may enter lesions

Control:

- Use **disease free transplants**
- Remove infected plant debris or destroy it after the season
- **Crop rotation**

3.6.2.f: Bacterial Soft Rot



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)



Photo: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org (CC BY 3.0 US)

Symptom of the “Bacterial Soft Rot” on Cabbages

3.6.2.f: Bacterial Soft Rot



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)



Photo: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org (CC BY 3.0 US)

Symptom of the “Bacterial Soft Rot” on a Cabbage stem

3.6.2.f: Bacterial Soft Rot

General Descriptions:

- It is a **soil borne disease**
- **High temperature (32 – 33 °C)** favour disease development
- The disease is spread rapidly by **rain splash** on lower leaves
- It is mainly a **post-harvest problem**

Symptoms:

- The head becomes **soft** and has **watery rot** which develops an **offensive smell**
- When the stem of the affected plant is cut, a **very bad smell** is generated

Control:

- Maintain field hygiene
- **Crop rotation** with legumes, cereals
- **Avoid harvesting when it is wet**
- Remove from the field or plough crops deeply immediately after harvesting so that the residues decompose as quickly as possible
- Handle produce carefully and store in a **cool, well-ventilated area**
- Foliar sprays with **copper based fungicides** such as Copper Oxychloride 50% metallic copper (COBOX 50 WP®) and (ISACOP®) at early stage of head formation
- **Use of bactericide** such as Bronopol 27% w/w (ENRICH BM)

3.6.2.g: Club Root



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)

**Galls on root of Cabbage affected
by the fungus**

3.6.2.g: Club Root



Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)

**Galls on root of Cabbage
affected by the fungus**

3.6.2.g: Club Root

General Descriptions:

- Extensive **galling, swelling** and **distortion of roots**

Symptoms:

- Galled roots often invaded by secondary rot organisms, such as soft rot bacteria resulting in rapid decay of roots
- Fungus persists as thick walled viable spores for **over 10 years**
- Fungus dispersed by surface water, movement of infected plant or soil

Control:

- **Crop rotation**
- **Field hygiene**
- Lime application creates soil condition **unfavorable** for spore formation

4. Harvest



Cabbage crops ready for harvest

4. Harvest



Cabbage crops ready for harvest

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- **Maturity Period:** 2.5 – 4 months after transplanting depending on variety and location
- **Maturity:** When the **head becomes firm**
- Harvest the heads **before** they **pass the prime stage** to avoid **cracking** or **splitting**
- Cut heads at the base and leave **the outer leaves** to protect the head and keeping it fresh
- Avoid bruising the head as it encourages rotting
- **Yields:** 15 – 68 tons per acre (depending on the variety and crop husbandry)
- **Varieties with firm solid heads** have good storability

5. Post-Harvest Handling



Use of appropriate crates in post-harvest handling

5. Post-Harvest Handling



Photo: <https://pxhere.com/en/photo/652820> CC0 Public Domain

Use of appropriate crates in post-harvest handling

5. Post-Harvest Handling

5.1 Containers & Packaging Materials

(GHCP&PHHT20: Q18)

- Packed in **clean well ventilated containers/crates** and transported in covered vehicles

5.2 Value Addition Techniques: Sorting, Cleaning & Grading **(GHCP&PHHT20: Q19)**

- **Sorting:** Damaged and diseased heads are discarded
- **Grading:** Cabbages are graded depending on the head size: **small (1 – 2 kg)**, **medium (3 – 4 kg)**, **large (over 5 kg)**