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""

KALE PRODUCTION

Presented to the County & AFA (HCD) Staff in charge of the SHEP PLUS Model Farmer Groups during the FT-FaDDE

Prepared by SHEP PLUS

1. Introduction:

1.1 Background

Photo: SHEP PLUS

Kale (Sukuma Wiki)

1. Introduction:

1.1 Background

- Kale is a member of the ***Brassicaceae* family** which includes crops such as **Cabbage**, **Cauliflower**, **Broccoli**, and **Radish**
- A popular **leafy vegetable** in Kenya grown mainly for the domestic market
- Valuable source of **vitamins (A, B, Folate)** and **minerals (Ca, K, Mg)**
- A source of income for most smallholder farmers
- Has **a lower cost of production** compared to other horticultural crops

1.2 Common Varieties

“Collards”

“Thousand Headed”

Photos: SHEP PLUS

1.2 Common Varieties Cont'

"Collards":

- Tolerant to **Soft Rot** and **Black Rot**
- Widely adapted even to warmer areas
- Flowers after **a short period of harvesting**
- **Yield: 15,000kg per acre**

"Thousand Headed":

- A popular variety with succulent leaves
- Extended **production period of up to 3 months**
- **Yield: 15,000kg per acre**

1.3 Other Varieties

Photo: By Goldlocki - Own work, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=3128541

“Marrow Stem”

Photo: National Farmers Information Service
http://www.nafis.go.ke/vegetables/kales/

“Moss Curled Kale”

1.3 Other Varieties

Other varieties grown in Kenya are:

- **"Marrow Stem"**
  - Dark green leaves with sweet taste and little fibre
  - Good digestibility
  - Low dry-matter content
  - **Yield: 15,000kg per acre**
- **"Moss Curled Kale"**
  - Dark curly leaves that are very tasty
  - Not a commonly grown variety
  - **Yield: 15,000kg per acre**

1.3 Other Varieties Cont’

1-6

Photo: AVRDC
https://avrdc.org/ethiopian-kale-brassica-carinata/

“Ethiopian Kale (Kanzira)”

1.3 Other Varieties Cont'

- **"Ethiopian Kale (Kanzira)"**
  - This is a traditional crop of the western and coastal communities though it has gained popularity in major towns
  - Smaller leafed varieties are mainly collected in form of shoots whereas larger leaved varieties one plucks the individual leaves
  - Very perishable unlike other varieties

1.3 Other Varieties Cont'

Photo: © Victor Omai, HCD

"Mfalme F1"

1.3 Other Varieties Cont'

- **"Mfalme F1"**
  - A prolific variety of long harvesting period of more than a year.
  - Harvesting starts 45 days after transplanting.
  - Has uniform dark bluish green leaves.
  - Has soft tender leaves that are easy to cook.
  - Very sweet taste, non-acidic and highly palatable.
  - Yield: **15,000kg** to **20,000kg** per acre depending on level of management.

1.4 Optimal Ecological Requirements

Altitude	**800 – 2,200 metres above sea level**
Rainfall	**750 mm of rainfall**
Growing Temperature	**17 – 30 ^{0}C**
Soils	**• Well drained loam soils** **• High organic matter content** **• pH range 5.5 – 7.0**

2. G20 technologies

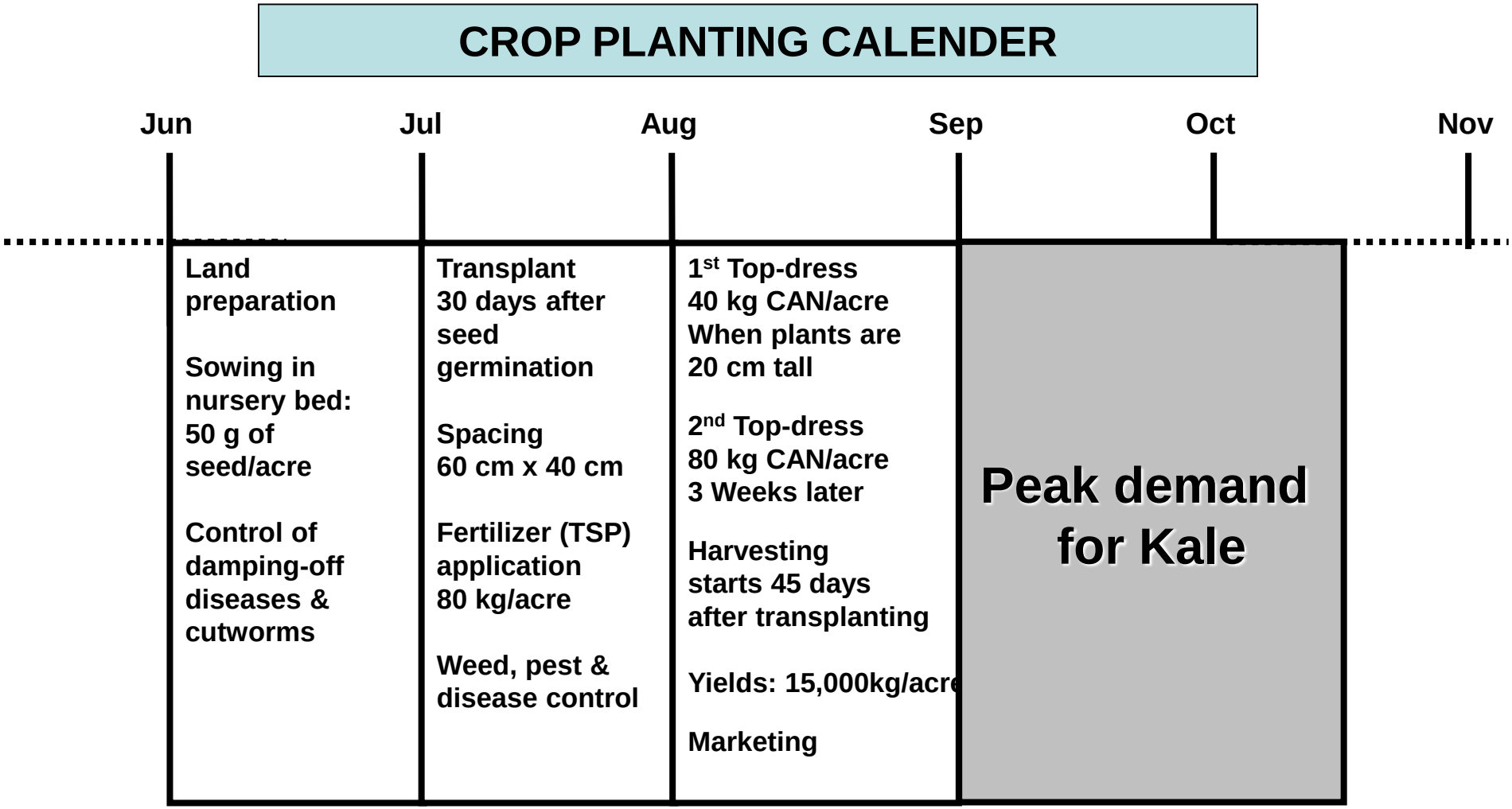
- Make sure to support farmers carry out G20 techniques for any crop

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

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

3.1 Crop Planting Calendar



A Sample of a Kale Planting Calendar

3.2 Basal Application (GHCP&PHHT20: Q8)

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

3.3 Raising Seedlings

A Kale nursery

3.3 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 **50 g per acre**

Nursery Site Selection:

- The nursery should be located in a plot that has not been planted with crops in the ***Brassicaceae* family** for at least three (3) years

3.3 Raising Seedlings Cont'

Nursery Establishment:

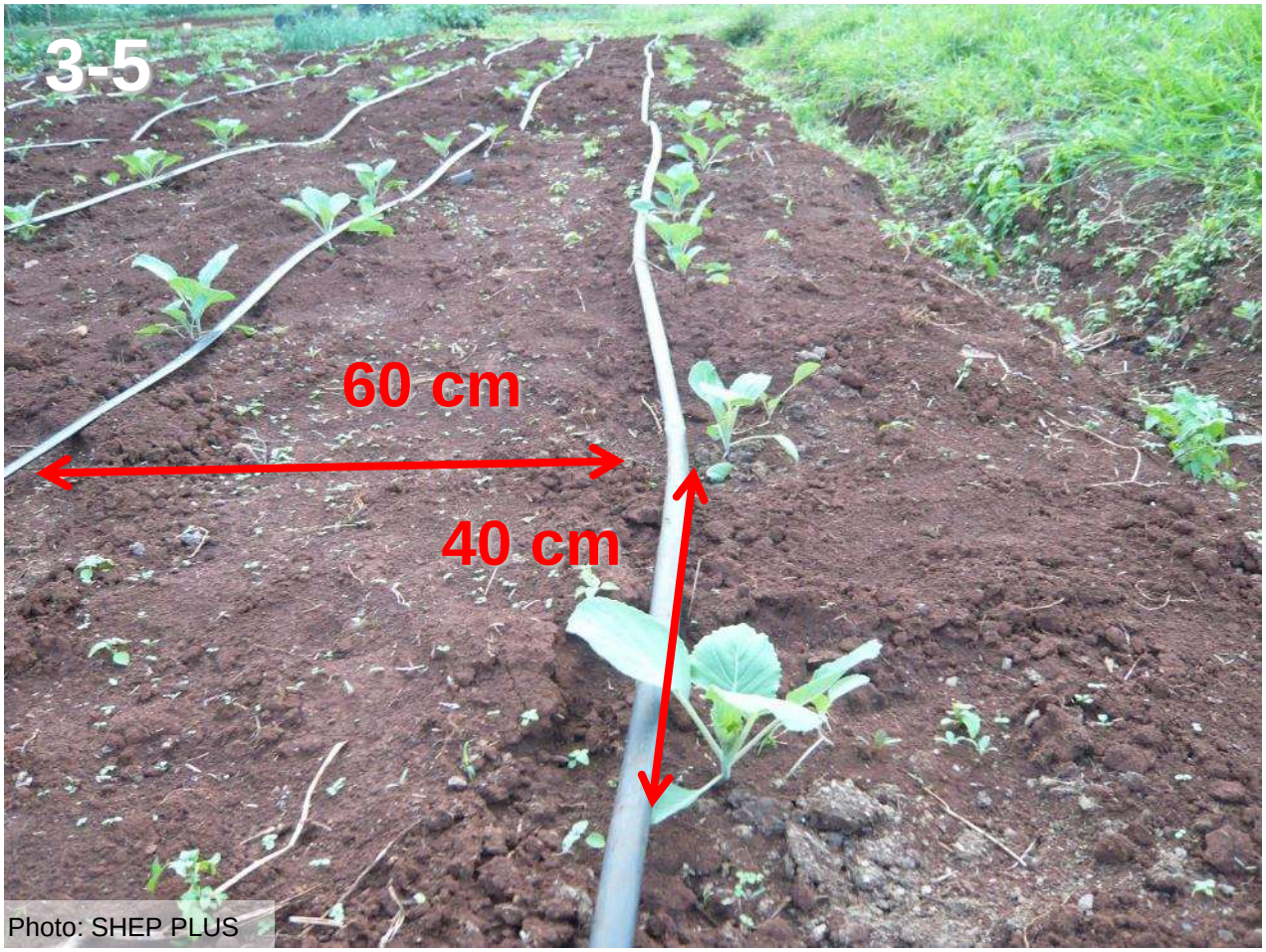
- Prepare a (sunken/ raised) seed bed of **1 m** width and of convenient length
- Make **2 cm deep drills** on the seed bed at a spacing of **10 – 15 cm** apart
- Thinly sow the seeds in the drills and cover lightly with soil
- **Mulch** seedlings in the seedbed, if possible

3.3 Raising Seedlings Cont'

Management of Nursery:

- Water the seedlings regularly
- 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

3.4 Transplanting



Transplanted Kales seedlings

3.4 Transplanting

3.4.1 Appropriate Time:

- Seedling should be transplanted **30 days** after seed germination
- Transplanting should be done either **early in the morning** or **late in the evening**

3.4.2 Recommended Spacing (GHCP&PHHT20: Q10):

- Transplant the seedling at a spacing of **60 cm** between rows and **40 – 60 cm** between plants depending on the variety
- Plant population of 11,111 – 16,666 plants /acre

3.4 Transplanting Cont'

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

- In case manure/compost is to be applied during transplanting, apply **1 – 2 handfuls** per hole (**5 – 8 tons/acre**)
- Apply 80kg per acre of TSP in the planting holes
- **Note:**
  - Soil testing to determine the type and amount of fertilizer
  - Only thoroughly composted manure should be used to avoid possible introduction of pests and diseases in the field
  - The TSP should be mixed thoroughly with the soil to avoid possible scorching of seedlings

3.5 Water Requirement

Photo: SHEP PLUS

Supplementing Kale water requirement through irrigation

3.5 Water Requirement (GHCP&PHHT20: Q12)

- Kale requires an optimal amount of **750 mm** of rainfall during the growing period
- In areas with lower rainfall, water deficit problems should be addressed through irrigation

3.6 Top-dressing

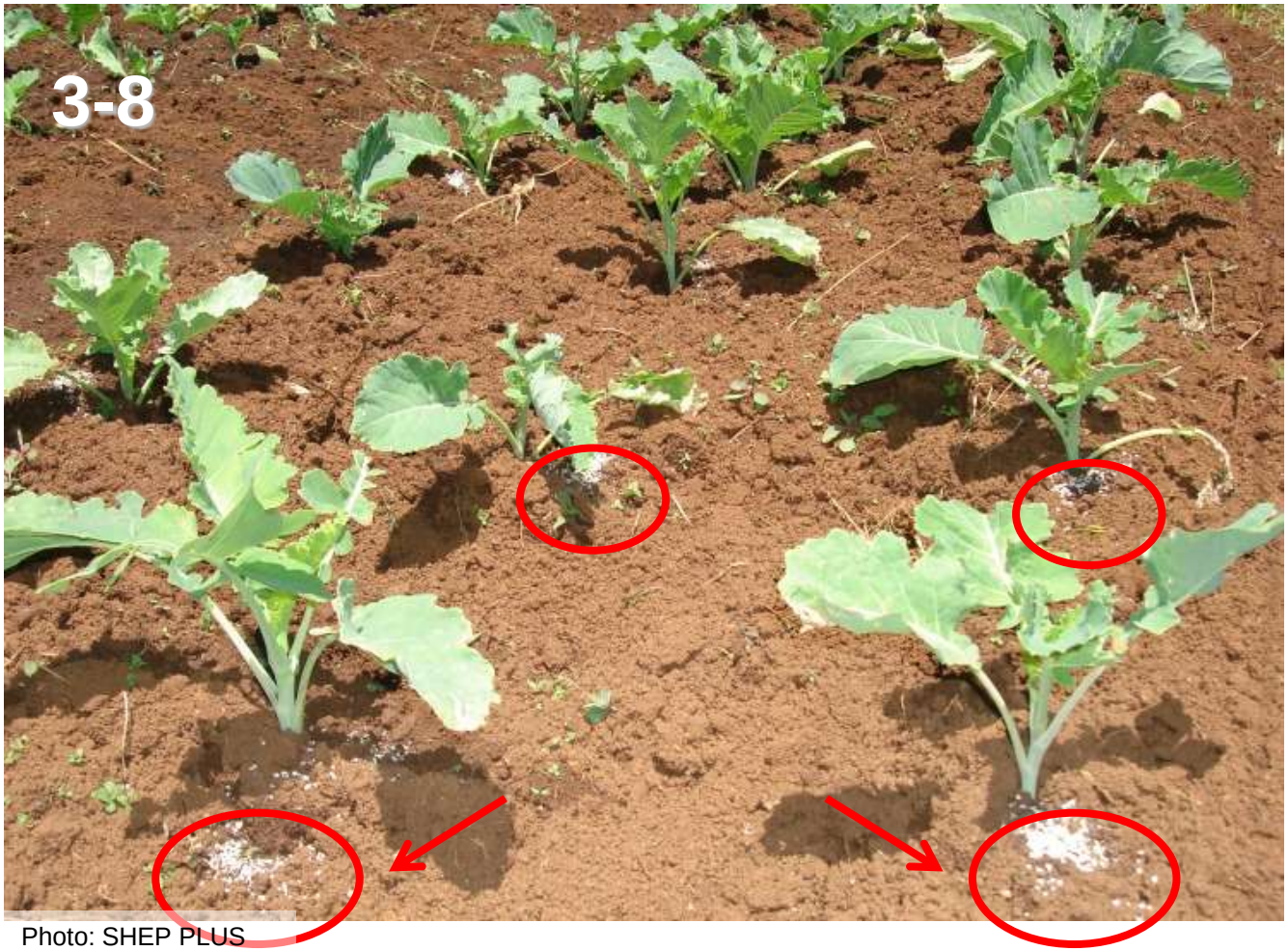


Photo: SHEP PLUS

Top-dressing using the placement method

3.6 Top-dressing (GHCP&PHHT20: Q14)

- Two (2) split applications of CAN are recommended to replenish soil nutrient status
- First split is applied at a rate of **40kg per acre** when plant is 20 cm tall
- Second split application is applied at a rate of **80kg per acre** 3 weeks later
- Placement method is recommended as it is more effective and economical

3.7 Pests & Diseases Control:

(GHCP&PHHT20: Q15 & 16)

3.7.1 Major Pests

- The following are the major pests of Kales in Kenya:

  A. Diamond Back Moth (DBM)

  B. Cabbage Sawfly

  C. Aphids

  D. Cutworms

3.7.1.A: Diamond Back Moth (DBM)

Photo: A. M. Varela, icipe (CC BY-NC-SA 3.0)
http://infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas#simple-table-of-contents-5

“Windows” caused by DBM larvae on a leaf

3.7.1.A: Diamond Back Moth (DBM)

Identification:

- Larvae are **pale yellowish-green** to **green caterpillars** covered with fine, scattered, erect hairs
- When disturbed, the larvae will wriggle backward violently and may drop from the plant, suspended by a silken thread

Symptoms:

- **Windows** on leaves from feeding by larvae
- If larvae are numerous, they may eat **the entire leaf**, leaving only the veins
- Infestations are normally **serious in drier months**

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

Control:

- Use of **Bacillus thuringiensis (Bt)** based bio-insecticides, such as **Delfin 6.4 W.G®**, **Lambda Cyhalothrin** 17.5 g/L (DUDUTHRIN 1.75 EC ®) or **Lufenuron** (**MATCH 50 EC®**)
- **Intercropping with repellants** (e.g. **Tomato**) or **trap crops** (e.g. **Indian Mustard**) reduces DBM destruction on Kale
- **Crop rotation**
- Use of ***Diadegma spp.*** (Parasitic wasp)

3.7.1.B: Cabbage Sawfly

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

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

A “Cabbage Sawfly” larva feeding on a Kale leaf

3.7.1.B: Cabbage Sawfly

Identification:

- The **grayish green larvae** with a black head and more than six pairs of legs
- Windows on leaves from feeding by larvae
- They feed on the blade of the leaves often leaving only the main veins and midrib

Control:

- Destruction of wild plants in the Brassicaceae
- Ploughing in of volunteer plants at the end of the season helps reduce sawfly populations.
- Use of Insecticide: Methoxyfenozide 240g/L (RUNNER 240SC®), Pyrethrins 40g/L (PYAGRO 4EC®)

3.7.1.C: Aphids

Underside of a leaf infested with Aphids

3.7.1.C: Aphids

Identification:

- Aphids are **pale green** and are 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

Symptoms:

- Aphid attack results in **curled** and **distorted leaves**

Control:

- **Field hygiene** through removal and destruction of crop residue
- Use of insecticides, such as **deltamethrin** (e.g. **DECIS®**), **lambdacyhalothrin (KARATE ZEON®)** and **Thiamethoxam (ACTARA 2.5WG®), Imidacloprid 250g/kg (MURCLOPRID 25 WP)**

3.7.1.D: Cutworms

Photo: John C. French Sr., Retired, Universities:Auburn, GA, Clemson and U of MO, Bugwood.org (CC BY 3.0 US)

A Cutworm larva

3.7.1.D: Cutworms

Identification:

- The **grayish black larvae** that curl up tightly when disturbed
- They are often found **hiding in soil** near the cut seedlings

Damage:

- They **girdle** and **cut-off young seedlings at ground level** during the night dragging them into the tunnel in the soil and feed on them during the day

Symptoms:

- Cut stems
- Attacked plant **wilt** and **die**

3.7.1.D: Cutworms Cont'

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
- Flooding of the field for a few days before sowing or transplanting can help kill cutworm caterpillars in the soil
- Use of insecticides **(drench at the base in the evenings)**:
  - Lambda-Cyhalothrin 25g/L (TATA UMEME 2.5EC®(PHI: 3days), Halothrin 2.5EC® (PHI: 3days))
  - Alpha-cypermethrin (ALPHA CYMBA 10EC®(PHI: 3days))

3.7.2 Major Diseases

- The following are the major diseases of Kales in Kenya:
  a. **Black Rot**
  b. **Black Leg (Dry Rot Canker)**
  c. **Ring Spot**
  d. **Downey Mildew**
  e. **Powdery Mildew**

3.7.2.a: Black Rot

Photo: A. M. Varela, icipe (CC BY-NC-SA 3.0)
http://infonet-biovision.org/PlantHealth/Crops/CabbageKale-Brassicas#overlay=node/27240/edit

Symptom of “Black Rot” on a leaf

3.7.2.a: Black Rot

General Descriptions:

- This is a **seed borne bacterial disease**
- Black rot infection and spread is favoured by **wet conditions** and **high temperatures** (**20 – 30 ^{0}C**)
- Crowded plants provide conditions that are ideal for bacterial spread to nearby plants

Symptoms:

- In early stage, **yellowish brown V-shaped lesions** are observed on the leaf margins of affected plants
- On the margins of mature leaves, the veins become distinctly **black**

3.7.2.a: Black Rot Cont'

Symptoms Cont':

- The lesions extend into the leaf, **killing large areas of affected leaves**
- A cross sectional cut of infected stem reveals a characteristic **black ring**
- Seedlings that are infected systemically become **yellow**, **drop lower leaves**, and **may die**

Control:

- Use certified planting material
- Use of tolerant varieties e.g.) **Collards**
- Field sanitation (hygiene)
- Minimum two year crop rotation
- Spray **copper** fungicide **(AMICOP 50WP, COBOX 50WP®)** when the first symptoms appear

3.7.2.b: 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)

Blackleg lesions can girdle the basal part of the stem (Left) and Black leg infected kale wilting (Right)

3.7.2.b: Black Leg (Dry Rot Canker)

General Descriptions:

- This is a **seed borne disease** caused by a **fungus**
- The inoculum is spread by **infected plants**, **garden tools** and **crop debris**

Symptoms:

- Leaves have **light brown spots** which may be circular and later develop **ash grey centres with many black spots**
- Severe stem infection results in **a dark dry rot** above the soil line which extends below and kills the roots

3.7.2.b: Black Leg (Dry Rot Canker) Cont’

Symptoms Cont’:

- Affected plants **wilt abruptly** and **die**

Control:

- Use of certified seed
- Field sanitation (hygiene)
- **3 – 4 year crop rotation**

3.7.2.c: Ring Spot

Symptom of “Ring Spot” on a leaf

3.7.2.c: Ring Spot

General Descriptions:

- This is a **seed borne fungal disease**
- **Infected compost** is the source of the innoculun and it is spread by **wind**

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 **Copper Oxychloride (COBOX 50 WP®)PHI: 3days**

3.7.2.d: Downey Mildew

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

“Downey Mildew” symptom on Kale leaves

3.7.2.d: Downey Mildew

General Descriptions:

- This is **a seed borne fungal disease**
- Spread by **wind**, **rain**, and **overhead irrigation**
- It is severe at **high elevations** where the conditions are **cool and wet**

Symptoms:

- **Fluffy fungal growth** on the underside of leaves which later produce **brown to black spots** on the upper surface

3.7.2.d: Downey Mildew Cont’

Control:

- Follow **recommended spacing** to reduce the risk of incidences
- Nursery and field sanitation
- Crop rotation
- Use of pesticides, such as **propineb 70%** (e.g. **ANTRACOL®**) , Metalaxyl+Mancozeb (**METACOZEB 72 WP)** PHI: 7days

3.7.2.e: Powdery Mildew

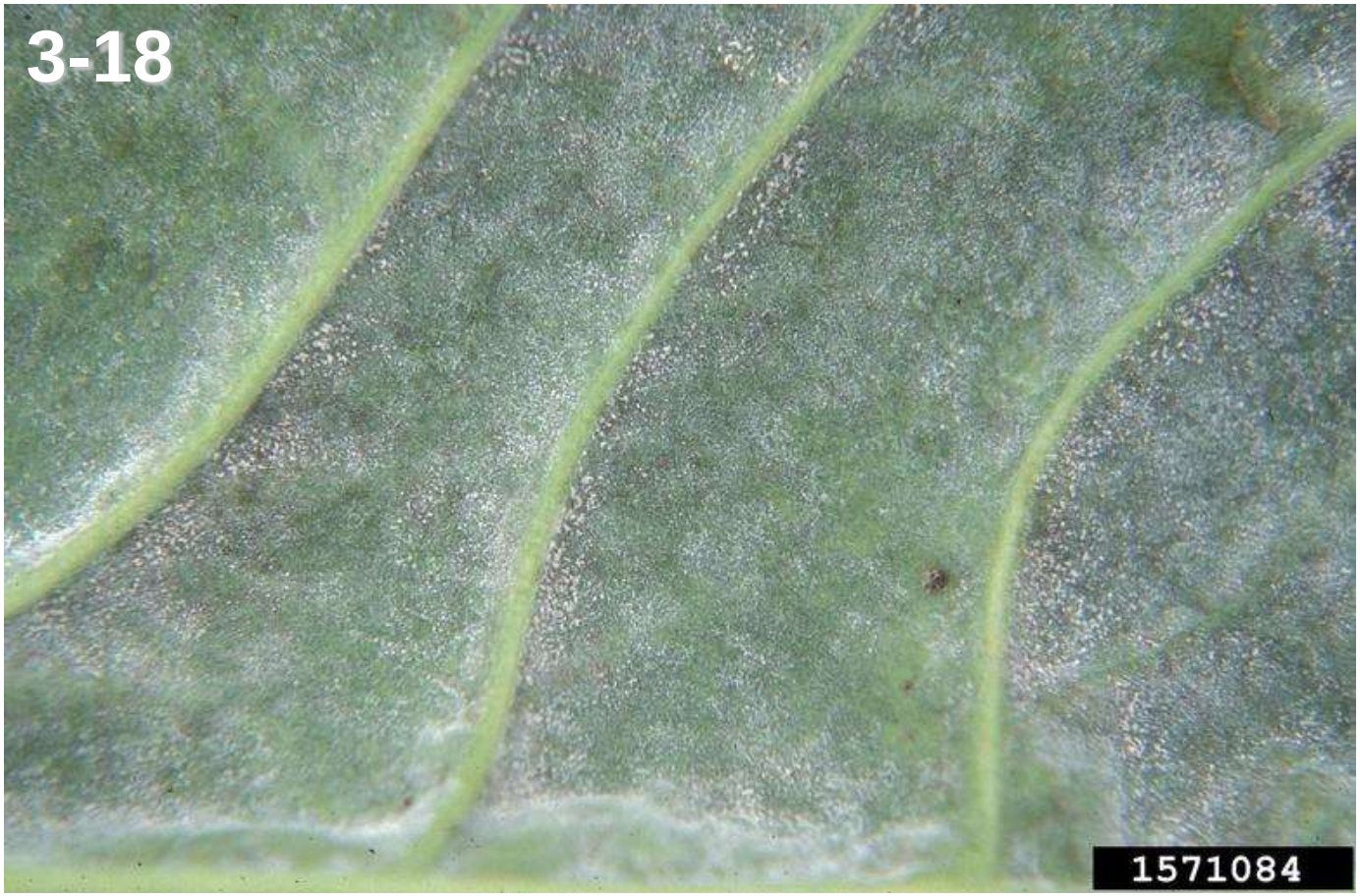


Photo: Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org (CC BY 3.0 US)

“Powdery Mildew” symptom on a leave

3.7.2.e: Powdery Mildew

General Descriptions:

- This is **a fungal disease** that affects a wide range of plants
- Powdery Mildews are severe in **warm**, **dry climates**

Symptoms:

- Appears as **white**, **powdery spots** that may form on both surfaces of leaves
- Leaves infected with Powdery Mildew may gradually turn completely **yellow**, **die**, and **fall off**

3.7.2.e: Powdery Mildew Cont'

Control:

- **Cultural Control:** Correct spacing, remove infected leaves to reduce the spread
- **Chemical Control:** Use of fungicides e.g.) **sulphur 80%** w/w**(COSAVET DF®)** at the onset of disease symptoms

4. Harvest

4.1 Harvesting Indices (GHCP&PHHT20: Q17)

- **Harvesting Period:** Begins **6 weeks** after transplanting and can last for **4 – 6 months**
- **Harvesting Method:**
  - Kale is hand harvested either as a whole plant, shoots or just for its leaves
  - A picker should look for kale with firm, deeply coloured leaves and moist hardy stems
  - Plucking the lower leaves; each time leaving **3 – 4 top leaves**
  - When harvesting the leaves, always leave part of the stalk attached to the stem

4. Harvest Cont’

- **Yields: 15 tons per acre**
- The **frequency** and **total duration of harvesting** depends on management practices; for instance, **irrigation** and additional application of **CAN** shortens the harvesting interval and prolongs the harvesting duration

5. Post-Harvest Handling

5-1

Photo: Even-Amos, Public Domain, https://commons.wikimedia.org/wiki/File:Collard-Greens-Bundle.jpg#/media/File:Collard-Greens-Bundle.jpg

Harvested Kales

5. Post-Harvest Handling

5.1 Containers & Packaging Materials (GHCP&PHHT20: Q18)

- Pack in well ventilated containers
- **Do Not** store/package Kale together with ripening fruits or vegetables (the ripening fruits and vegetables emit ethylene which causes yellowing of leaves)

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

- **Sorting:** Separate the yellow or damaged leaves from the good ones
- **Cleaning:** Wash leaves thoroughly with portable water

5. Post-Harvest Handling Cont’

- **Grading:** Grade the leaves by size, bunching those of the same size and tying in small bundles before packing in well ventilated container for transportation to markets

5.3 Storage

- Kale can be wrapped in a damp paper towel, placed in a plastic bag and stored in the refrigerator for up to 14 – 21 days
- It should not be washed before storing since this may cause it to become limp
- Store in a place with adequate air circulation
- Alternatively, sell the produce immediately while fresh

5. Post-Harvest Handling Cont'

5.4 Preservation through sun drying

- Boil salty water to boiling point (a tea spoon of salt/5 litres water).
- Dip the kales in this water for one minute
- Dip in cold water for one minute
- Drain and dry the spread kales under shade (2-3 days depending on weather)
- Can keep for 6 months

Reference

- The proposed agrochemicals are in accordance with “Products Registered for Use on Crops Version 1_2018”. The registered agrochemicals are subject to change. Please refer to the latest registered agrochemicals by Pest Control Product Board.
- Infonet biovision CD
- CROPS EXTENSION POCKET HANDBOOK, Ministry of Agriculture, 2013, Volume1 Field Crops
- A guide to IPM in Brassicas production, icipe, 2003

THANK YOU

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