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

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

Cabbage (Kabeji)

- 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 Some Common Varieties

Photos: http://thekenyan.co.ke/farming/cabbage-growing-in-kenya/

“Gloria F1”

“Gloria F1”

- A medium-late maturing variety ready for harvesting 90 days after transplanting. Has solid blue green color and thick waxy layer. Tolerant to Black Rot disease. 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**
- **Plant population: 11,111 per an acre**
- **Maturity: 90 days** after transplanting (**medium-late maturing**)
- **Average head weight 3 kg**
- Has solid blue green color and **thick** waxy layer
- Not prone to splitting and keeps well after harvesting
- **Yield: 30-50 t/acre**

1.2 Some Common Varieties

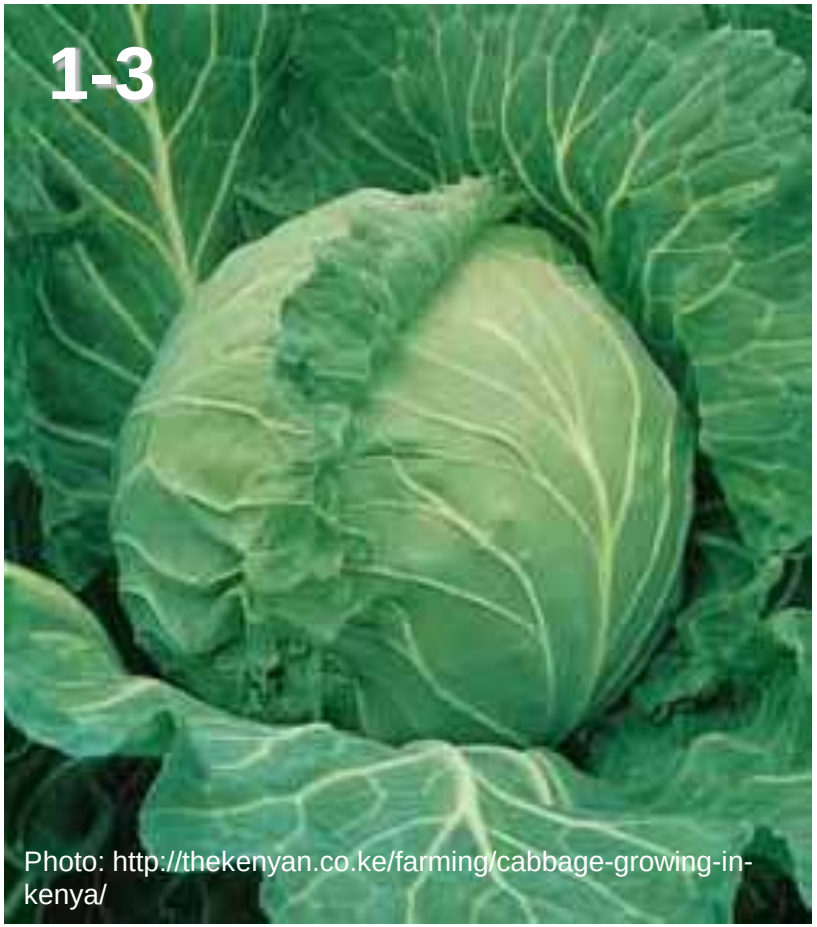


Photo: http://thekenyan.co.ke/farming/cabbage-growing-in-kenya/

“Copenhagen Market”:

- Requires a cool/warm climate
- **Plant Spacing: 60 cm x 45 cm**
- **Plant population: 14,800 per an 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 – 30 t/acre**

“Copenhagen Market”

1.2 Some Common Varieties Cont'

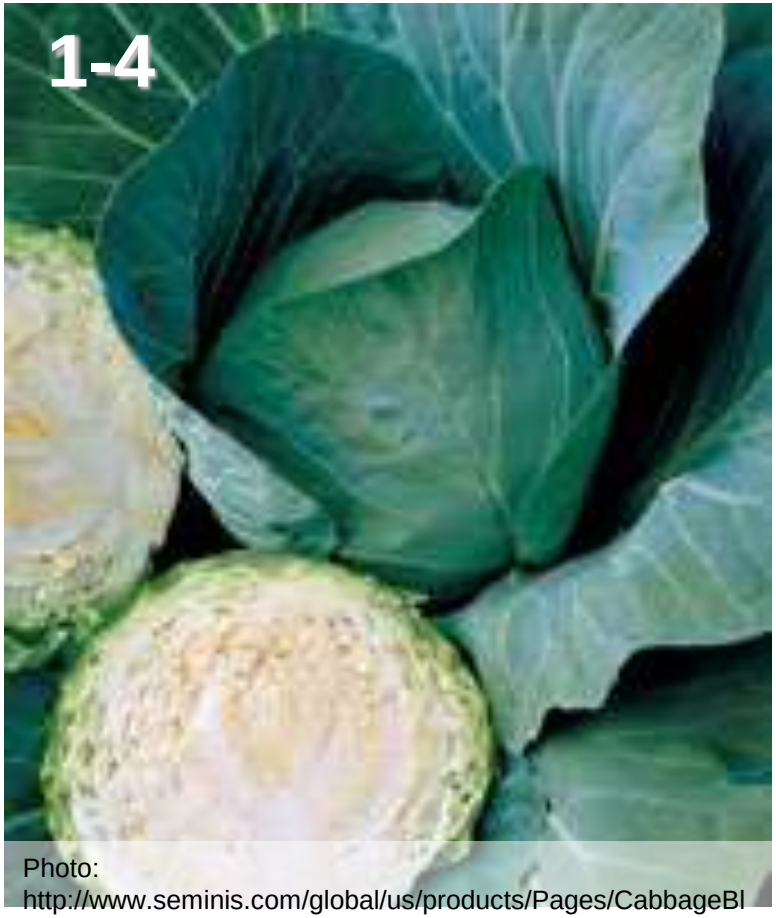


Photo: http://www.seminis.com/global/us/products/Pages/CabbageBlueDynasty.aspx

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

"Blue Dynasty 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 – 68 t/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 – 50 t/acre**

1.2 Some Common Varieties Cont'

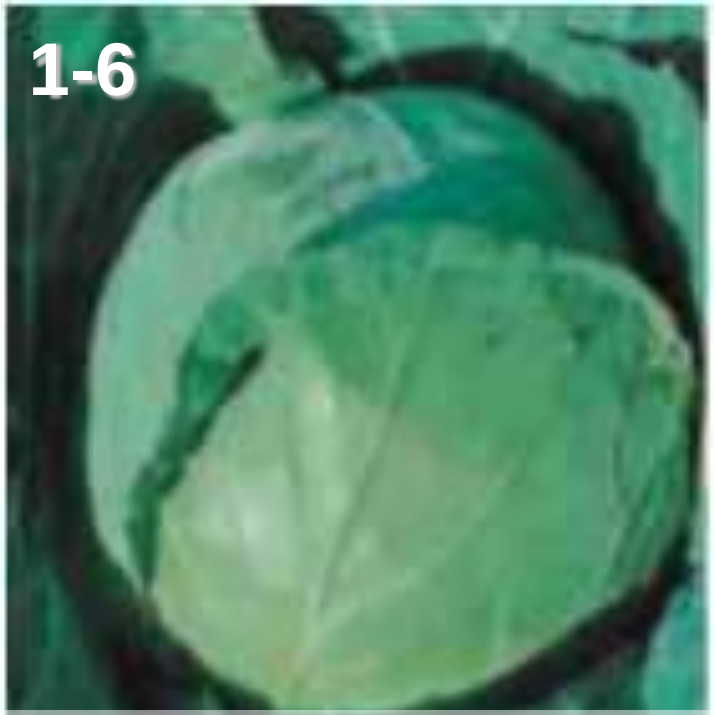


Photo: http://www.seminis.com/global/in/products/Pages/GreenChallenger.aspx

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

"Green Challenger F1"

"Pruktor F1"

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 an acre**
- **Maturity: 60 days** after transplanting (**early maturing**)
- **Head:** round shape with compact size, weighing **2.5 – 3 kg**
- **Yield: 40 – 50 t/acre**

"Pruktor F1":

- **Plant Spacing**: **60 cm x 60 cm**
- 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: 50-60 t/acre**

1.2 Some Common Varieties Cont'

"Riana F1"

- **Plant Spacing: 60 cm x 60 cm**
- **Plant population: 11,111 per an acre**
- 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 – 30 t/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 – 68 t/acre**

1.3 Optimal Ecological Requirements

Altitude	**700 – 2,200 metres above sea level**
Rainfall	**At least 500 mm**
Growing Temperature	**16 – 20 ^{0}C**
Soils	**• Well drained sandy or silty loam soils** **• High organic matter content** **• pH range 6.0 – 6.5**

2. G20 technologies

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

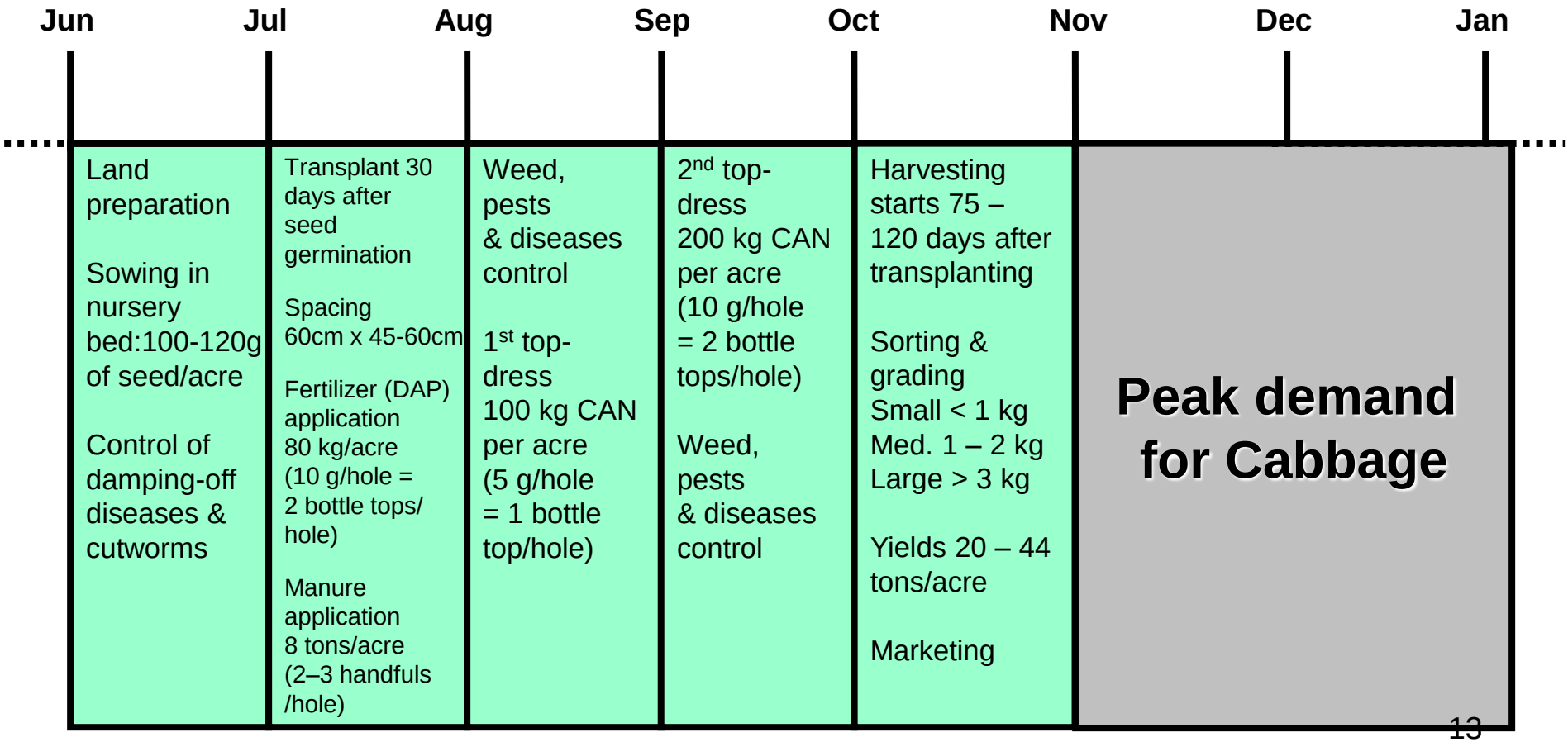
1. Market survey
2. Crop planting calendar
3. Soil testing
4. Composting
5. Use of quality planting materials
6. Recommended land preparation practices
7. Incorporating crop residues
8. Basal application of compost/ manure
9. Recommended practices of seedling preparation/ seedlings from registered nursery

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 Cabbage Planting Calendar



3.2 Raising Seedlings

A Cabbage nursery

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 **100-120g/acre** (Depending on the 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 thereafter
- 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

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 – 44,400 plants/acre depending on variety**

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 (**10g**) of DAP/TSP per planting hole (**80kg/acre**) as a general recommendation but the actual rate will depend on results of soil analysis.

[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

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

(GHCP&PHHT20: Q14)

The application rate will depend on results of soil analysis. But generally application rate can be as follows:

- 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

- 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

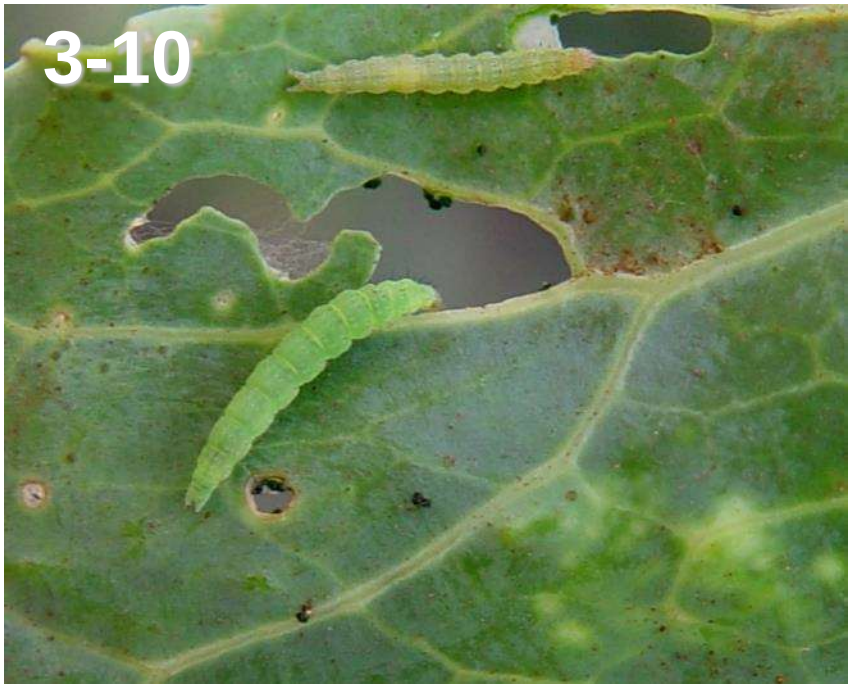


Photo: A. M. Varela, icipe (CC BY-NC-SA 3.0)

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)

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 in 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'

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 repellant, 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 (BELT 480 SC®)**
  - **Methoxyfenozide (RUNNER 240 SC®)**

3.6.1.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 and damage on a Cabbage leaf

3.6.1.B: Cabbage Sawfly

Identification:

- Adult **is a wasp with dark head and thorax** and **bright 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 95SP®)**

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®)**
  – **lambda cyhalothrin (Karate 2.5WG®)**
  – **Thiocyclam 50% w/w of thiocyclam- hydrogenoxalate (EVISECT S®)**

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)

A slug feeding on a leaf

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

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
  - Beauviera bassiana/ biological insecticide (BIOPOWER 1.5®)
  - Lambda Cyhalothrin (TATA UMEME 2.5EC®)
  - Acephate (ASATAF SP®)

  (Drenching should be done in the evenings at the base)

3.6.2 Major Diseases

- Disease infection leads to reduction in quality and quantity of produce
- The following are the major diseases of Cabbage in Kenya:

a. Damping-off
b. Bacterial Black Rot
c. Black Leg (Dry Rot Canker)
d. Ring Spot
***e. Alternaria* Leaf Spot**
f. Bacterial Soft Rot
g. Club Root

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

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 ^{0}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 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)

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

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 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

3.6.2.c: Black Leg (Dry Rot Canker)

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

A Cabbage leaf infected with “Ring Spot”

3.6.2.d: 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**
- Maintain field hygiene
- Crop rotation for at least 2 years
- **Use of fungicides**, such as
  - **Tebuconazole (ORIUS 25EW®, WARRIOR 25EW®)** Crop rotation for at least 2 years

3.6.2.e: Alternaria Leaf Spot

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 a Cabbage stem

3.6.2.f: Bacterial Soft Rot

General Descriptions:

- It is **a soil borne disease**
- **High temperature** (**32 – 33 ^{0}C**) favours 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

3.6.2.f: Bacterial Soft Rot

Control:

- Maintain field hygiene
- **Crop rotation** with legumes, cereals
- Foliar sprays with **copper based fungicides** such as Copper Oxychloride 50% metallic copper (COBOX 50 WP®) and (ISACOP®) at early stage of head formation
- **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**
- **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

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

4-1

Cabbage crops ready for 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

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**)

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

THANK YOU

ASANTE SANA

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