Cabbage Cultivation Manual

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Volume 1
HOW TO GROW CABBAGES IN KENYA

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Acknowledgement

We wish to express our sincere gratitude to RDA KOREA for funding the project, Technical advice and various stakeholders involved in one way or another in this noble effort.

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Introduction:

How to use this field guide

This manual is designed to let you grow cabbage as easy as possible. It provides you with the appropriate suggested management practices on how to grow cabbage as a result of a three-year project in five counties.

In the pest pages, there is a brief description of each pest, its life cycle, damage it causes, and its control measures. It is very important to know how the insect/mite pest develops because the adult does not always cause the damage and sometimes it is not even found where the damage occurred. Included in the control measures are cultural practices, physical control, plant extracts, other homemade solutions, and other practical methods.

This manual also provides farmers with practical guides and alternatives to eliminate the use and dependence on synthetic pesticides for the management of cabbage pests. The recommended practices are safer, more affordable, and easy to follow. Most of the farm practices the farmers can apply by themselves and the materials that are needed are easily available in their backyards or in their kitchens or can be purchased in the handpicking; plant extract (e.g. Ginger spray); other homemade solution (e.g. Soap spray); other method (use of baits).

However, with every effort made to provide you with complete information on the pest control in cabbage growing, the recommendations may vary from every location. It is highly suggested that you have to try the various control practices in small scale especially for the plant extracts and other homemade solutions, in order to make adjustments that are adaptable to your farm conditions before going into large scale application.
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CHAPTER 1

Forward and Executive Summary

The word Cabbage is derived from the French word caboche, which means ‘Head’. Its scientific name is Brassica oleraceae. Cabbage is a vegetable variety that is common in Kenya and forms an essential part of the diet and income in Kenyan families. Cabbage is mainly used for cooking, in vegetable salad and as plant matter for livestock feed. Cabbage contains mustard oil that give them distinctive odor and taste. It is an excellent source of minerals such as potassium and high in calcium vitamins A and C. Crucifers (cabbage, broccoli, cauliflower, etc) are particularly effective against colon cancer and also protect against cancers of the skin, breast, stomach, bladder, liver and lung; provided there are not much pesticide residues. The major market outlet is the local fresh market in rural and urban areas. There are many varieties in Kenya but the most popular are Gloria F1, Prucktor, Fanaka, Haraka, Fiona F1 Copenhagen market, Fiona F1 and Golden Acre.

Cabbage grows in altitude ranging from 800 to over 2,000 metres. Soils should be well drained, high in organic matter, with high water holding capacity with optimum ph of 6-6.5. The optimum temperature for cabbage growing is between 16 to 20°C. The vegetable has high water requirement during growth period with 500mm rainfall considered optimal. Cabbage is propagated from seed which are widely available in seed stores across Kenya. The growing of these vegetables should be started by raising seedlings on nursery beds. The nursery beds are raised for wet areas or sunken for hot areas.

The plant should be top dressed with a nitrogen fertilizer when seedlings are established and second topdressing when the leaves start folding. Have the soil tested for nutrient status where possible before planting. The field should be kept free of weeds during the vegetable’s growing season and mulched to conserves moisture. Cabbage plants are prone to pests and diseases. High incidences of pest and diseases infestation, lack of high quality seeds as well as inadequate knowledge and skills on Good Agricultural Practices are among the major pointers to low yields in cabbage production. By and large, many emerging cabbage farmers in Kenya are not able to obtain immediate, sufficient agronomic information to enhance their farming practices. Some of the common pests include cabbage maggots, Diamond-
back moth, Thrips, Slag, Ants, Cutworm, Aphids, moths, Flea beetles, Whiteflies. Common diseases are Black Rot, Bacterial Soft rot, Downy mildew, Club root. The best practices to avoid pests and diseases would be to practice crop rotation while also using seeds and seedlings that are resistant.

Harvesting starts 75-120 days after transplanting and lasts 4-6 weeks depending on the variety. The vegetable is ready when heads are firm. 3-4 wrapper leaves should be left to cover the head and keep it fresh. Depending on variety, soil nutrient status, water availability and environmental conditions the vegetable yields range from 40-100 tons/ha. The cost of producing a cabbage head is 6 shs under good crop husbandry Grade and pack cabbage vegetable heads in crates arrange with stem end facing the outer wall of the crates for transportation. The fresh cabbage has the best taste and you should ensure that you consume it or have your harvest/produce reach the market the fastest possible. Many emerging cabbage farmers in Kenya are not able to obtain immediate, sufficient agronomic information to enhance their farming practices.

Based on the premise that information is power, the Cabbage Farming Manual is aimed to be an important tool to farmers, and other agricultural advisors among others. The project objective was to develop an informed, educated and a developed agricultural cabbage vegetable packages farmers in Kenya.
CHAPTER 2

Cabbage description

**Cabbage Scientific name:** Brassica oleracea, Family: Crucifers (Brassicaceae, formerly: Cruciferae)

**Uses:**
Cabbage is used as vegetables can be eaten raw, cooked, boiled, stuffed and sauerkraut. The field by-products are good source of animal feeds.

**Advantages of Cabbage:**
Cabbage contains mustard oil that give them distinctive odor and taste. It is an excellent source of minerals such as potassium and high in vitamins A and C and calcium. Crucifers (cabbage, broccoli, cauliflower, etc) are particularly effective against colon cancer and also protect against cancers of the skin, breast, stomach, bladder, liver and lung; provided there are not much pesticide residues.
CHAPTER 3

Climatic and soil requirements

Cabbage is generally considered to be a cool weather crop and germinates at a minimum soil temperature of 4°C and at an optimum temperature of between 18°C and 35°C. The optimum temperature for growth is approximately 18°C with an average maximum of 24°C and an average minimum of 4.5°C. The crop is also generally frost resistant.

Soil requirement: well drained loamy soils with an effective rooting depth of approximately 600mm is recommended
Soil pH: 5.5 - 7.5 pH
CHAPTER 4

Variety Selection

Numerous varieties of cabbage are available in Kenyan market; Cultivars differ with respect to size, shape and maturity dates, as well as adaptability and disease resistances. Several factors should be considered in selecting appropriate varieties. Yield, of course, is important to every grower. However, this should not be the sole factor in determining variety. Disease resistance/tolerance is important in many of these crops and should be critically examined. Buyer preference and market acceptability are probably two of the most important factors to consider. Horticultural characteristics such as product color, growth habit and shape should also be considered. Finally, the variety should be adapted to the area in which it is to be grown.

Local variety trials are a good source of information regarding variety selection. With any new variety, always try a small planting of the variety first before adapting it to your operation. Also, give every new variety at least a couple of tries before making a decision on its use for your production system. Environmental conditions can strongly influence varietal performance. Therefore, conditions in one year may not produce the same results in another year for a given variety. Good varieties are adaptable over a wide range of conditions.

Tables 1: Common cabbage varieties in Kenya are outlines from page 59 - 62 in chapter 15.
CHAPTER 5

Seedling production in seedbeds

Seed requirement:
200 – 250 g of certified seeds needed for a hectare area.
Seedlings should be grown in a well-aerated medium, which has good water holding capacity and at a pH of around 6.5. Generally, peat, bark and vermiculite mixes are used. Media problems typically include excessive tannins and low air filled porosity, which results in poor drainage and the build up of green mould. The medium should be pre-enriched and the seedlings should be fertilized. For optimum germination, the seedling trays should be placed in a germination chamber, at 20 °C with high relative humidity. The seedlings should be moved to the tunnel at the first sign of germination. The ideal temperature for seedling cultivation is 20 °C.
Seedling management is a critical factor in cabbage production, as the following factors related to seedling production may result in physiological disorders in cabbage:

- Incorrect sowing time.
- Cold temperatures, particularly below 7 °C.
- Cold grown seedlings.
- Over-fertilization of seedlings.
- Oversized seedlings at transplant.
- Temperature differences between the seedling nursery and the farm.
- Outbreak of the pest and diseases

Seedbed preparation
Seedbed is prepared approximately 5 - 15 cm high and 1.0 m wide. Apply a thin layer of compost on the seedbed before mulching (with rice straw).

In a square meter seedbed, incorporate 40 g ammonium sulfate, 50 g super phosphate, 30 g potassium chloride, and 2 kg of compost. Commercial inorganic fertilizer could be skipped for organic farming. Ask assistance from the local agriculturist office for advice in growing organic cabbage and in order to maintain and supply the nutrient requirement of the plant.

Protect the seedbed with a net or shed to prevent the seedlings from early pest infestation, heavy rain, and direct sunlight.

Post commercial inorganic fertilizer could be skipped for organic farming. Ask assistance from the local agriculturist office for advice in growing organic cabbage and in order to maintain and supply the nutrient requirement of the plant.

Protect the seedbed with a net or shed to prevent the seedlings from early pest infestation, heavy rain, and direct sunlight.
Seedbed protection using a net
Sowing

In the seedbed, sow 15 - 20 seeds per 30 cm (1 foot) at a depth of 0.5 – 1.0 cm. In seed trays (grown under greenhouse), sow 2 – 3 seeds per hole at a depth of 0.5 – 1.0 cm. Optimum temperature requirement for germination is 20 – 25°C. The seeds germinate after 3 – 5 days.

Thinning

In seed trays, leave only 1 healthy seedling (removing 1-2 unhealthy ones) during the first leaf stage.

Hardening

Five (5) days before transplanting, gradually expose seedlings daily to strong sunlight and also reduce the water supply to lessen stress of the seedlings after transplanting.
CHAPTER 6

Field preparation and planting

Plough and harrow the field until the soil is fine, level and free of weeds and plant debris. Form the bed with a plow by opening furrows to a depth of 20 cm during the dry season or at least 30 cm during the wet season.

Ploughing of the land seed requirement for direct seeding

600g - 1.5 kg of seeds/ha are needed for direct seeding if the planting distance ranges from 100 150cm in between rows and 25 - 45 in between hills. 3 kg/ha if the distance of planting ranges from 40 - 50cm in between rows and 25 - 45 in between hills.
size. Thirdly the grower should ensure that seedlings are planted at the correct depth in a little hole that has been formed into the ground prior to planting. If the seedlings are forced into the ground, without a hole being prepared for them to be inserted into, the root system will be compromised and the plant will experience stress resulting in poor yield.

Once the seedling is placed inside the hole the area should be firmed so that sufficient contact is made between the seedling and the soil.

When planting seedlings a choice can be made between the square method and the staggered method of planting. The staggered method is more advantageous as there is less competition between plants compared to the square method where plants are directly opposite each other, thus maximizing competition.

Planting distance

The planting distance may vary according to variety, planting season, and soil conditions. In between rows and in between hills

PLANT POPULATION AND SPACING

It is recommended that 26 – 30 000 plants/ha is planted for the loose head market. Higher plant populations raise the average yield per hectare, but the heads are smaller. For the bagging or chain-store / pre-pack market a density of 35- 45 000 plants/ ha is recommended. However it must be noted that the population of a cabbage field per hectare for a commercial grower can vary and planting is dependent on what the specific market needs and available resources are.
The following guidelines explain the recommended spacing and requirements for the various markets.

**LOOSE HEAD - / HAWKER MARKET**

- Head size, weight & hold-ability are important features.
- Plant density of ± 26 – 30 000 plants / ha.
- Plant spacing of 60 - 70cm X 60cm.

**BAGGING - / CHAIN-STORE - / PRE-PACK MARKET**

- Quality, uniformly filled heads, firmness and colour are important.
- Yield per hectare and uniform cut.
- Plant density of 35 – 45 000 plants / ha.
- Plant spacing of 45 – 55cm X 60cm.

For baby cabbage, varieties have a smaller head size and the population can be increased. A plant spacing of 25cm (in row) X 25 cm can be used as a guideline.
CHAPTER 7

Fertilization

Cabbage needs plenty of nutrients. NPK is needed for head formation. However, excess nitrogen (N) may cause loose head formation and internal decay. Potassium (K) deficiency can result in marginal necrosis and lower head quality, but its excess can cause the heads to open. The plants have high Sulfur requirement; sensitive to deficiencies of Calcium, Magnesium, and Boron.

The general fertilizer recommendation: 100 - 150 kg/ha N; 50 - 65 kg/ha P; 100 - 130 kg/ha K. Split the recommended fertilizer amount into 3 and apply it as basal, 3 weeks after transplanting, and during heading.

During land preparation, incorporate 10-20 tons of manure/ha. Remember that these are just general recommendations. Proper adjustments should be made according to your local soil conditions. To be sure, soil analysis is highly recommended to determine nitrogen, phosphorus, and potassium requirements of your soil.

Commercial inorganic fertilizer could be skipped for organic farming. Ask assistance from the local agriculturist office for advice in growing organic cabbage and in order to maintain and supply the nutrient requirement of the plants.
CHAPTER 8

Crop Water requirement

Cabbage needs sufficient amount, although young cabbage transplants or seedlings have a lower water requirement. However, water requirement increases rapidly as complete canopy cover and head development occurs. Water daily until the plants establish fully. Always water the plants when wilting happens. However, the plants are very sensitive to flooding. During rainy season, appropriate drainage canals must be in place to drain off the excess water after a heavy rain. Irrigation must be closely monitored to ensure soil moisture remains even in the beds during the cropping period. It is particularly important in the days following transplanting when seedlings are establishing new root systems. Excessive irrigation promotes root rot and results in leaching of nutrients away from the root zone. Supplying water in equal amounts throughout the season prevents cracking of the heads. Application of soluble fertilizers as fertigation can be carried out during a normal irrigation

Total water requirement is approximately 440mm. In wet seasons, as a general guideline apply 10 to 15 mm per week for the first third to half of the growing season, and about 25 mm per week thereafter.

In hot days, apply 20 to 25 mm per week for the first third to half of the growing season and 40 to 50 mm per week thereafter.

watering of seedlings
CHAPTER 9

Plant protection, Pests, damage & control measures

Plant protection
Many pest and disease problems can be avoided through Integrated Pest Management (IPM) procedures.
The following will help to ensure any pests and diseases in your cabbage crop remain below the economic threshold and swift action is taken should they become a problem.

Use of pest resistant varieties:
This ensures your crop has natural resistance to pests and diseases, minimising the need for expensive chemical control.

Row covering of seedlines with nets:
These should be put up immediately after transplanting and left up for 10 – 15 days. They protect your crop from numerous insect pests, such as caterpillars, aphids, leafhoppers, leaf miners, beetles and white-flies.

Crop rotation:
Do not plant cabbages more than once every 3 – 4 years in the same field. This will minimize the risk of fungal and bacterial diseases such as bacterial black rot and fungal diseases such as downy mildew, powdery mildew, white rot and damping off.

Soil solarization:
This involves preparing land to a fine tilth so as to expose soil to the sun for one month during the hot season. This helps to control soil borne pathogens, soil insects, weeds and root-knot nematodes.

Companion crops:
Planting corn and squash as a trap crop around the borders of your cabbage crop keeps aphids away, reducing the incidence of turnip mosaic virus.

Traps:
Placing yellow and blue sticky traps and pheromone traps around your cabbage crop will help control whitefly, leaf miners and caterpillars.

Removing and destroying all crop residues immediately after harvest:
All crop residues should be removed and destroyed by burning or burying in deep pits. This helps prevent last season’s pests including caterpillars, aphids and beetles re-infesting your new crop and also control fungal and bacterial diseases.

Good weed management:
Irrigate the beds to stimulate germination of weed seeds and remove all weeds prior to transplanting. Following planting, the field should be monitored regularly and kept free of weeds. Remove weeds by hand at early growth stages of cabbage and before canopy covers over.

Crop monitoring:
Cabbage crops should be monitored for pests and diseases every week. This is especially important during the early stages of growth when cabbages are susceptible to pests and diseases. Consistent monitoring enables a swift and effective response should an outbreak occur, which will minimize crop damage and expense. Thorough composting of all organic matter. All manure put on the crop should be thoroughly composted to prevent pest and disease outbreaks.

Weeds:
Weeds are the unwanted plants found in your fields and gardens. They compete with your crops for nutrients, moisture, and sunlight which can decrease the crop quality. They increase production costs due to increased cultivation and hand weeding, and considerably reduce the crop yields. They also
serve as alternate hosts of insect/mite pests and diseases.

**Preventative methods:**
- Thorough land preparation, example: by plowing and harrowing
- During the seed bed preparation, make sure that the seed bed is free of weeds.
- Place the fertilizer where the crop has the access to it but the weeds do not. This allows the crop to be more competitive with weeds.
- Maintain cleanliness on the drainage canals
- Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies
- Mulching: Use rice straw as mulch to partially control weed. Apply straw perpendicularly to the rows at a rate of 5 t/ha. Apply mulch within a few days after transplanting.
- Crop rotation. Do not continuously plant crucifers in the same field.
- Regularly monitor the status of your crops

**Mechanical and physical practices:**
- Hand weeding. The weeds are easier to control in their earlier growing period. Do not let the weeds to flower. Remove them from the field before they start to flower. Weeds bearing seeds should not be placed in compost since seeds may not be killed in the process of decomposition. Otherwise, compost might be a source of reintroduction of weeds into your fields.
- Hoeing, mowing, and cutting

Plastic mulch soil solarization
CHAPTER 10

Insects’ pests /Mites

At the different growth stages of cabbage pests might occur. Table 1 shows the pests that can infest cabbage in its different growth stages.

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<td>Seedling stage</td>
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<td>- Leaves and leafstalks</td>
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<td>- Roots</td>
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<td>- Roots</td>
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<td>Vegetative stage</td>
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<td>(true leaf development up to cupping)</td>
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<td>- Leaves and leafstalks</td>
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<td>Maturation stage</td>
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<td>(Pre head formation up to head fill)</td>
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<td>- Developing and maturing head</td>
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<td>- Roots</td>
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Ants

Damage:

Ants take the sown seeds back to their colony and feed on germinating seeds and on young seedlings. They tend insect pests like aphids, scales, whiteflies, mealy bugs, and other honeydew producing insects. These actions result in missing hills, thus loss of plant stand, uneven growth distribution in the field, and an increased incidence of diseases caused by the mentioned insect pests.

Description

Eggs are delicate, soft, white, and are laid in clusters of 75-125 eggs. The larva is grub-like, legless, very soft, and whitish in color. It inflicts no damage as it depends on the worker ant (older sibling) for care and food. The pupa is whitish and develops inside the ant’s nest. It has visible legs and in some cases, wings. The pupal stage is the transitional stage between the larva and the adult which emerges during the final molt.

An adult ant varies in color, from blackish to reddish-brown depending on its species. It has robust mandibles with strong teeth that could inflict painful bites. It has elbowed- antennae, a thin waist, and if it is winged, the hind wings are smaller than the front wings and have few veins.

Ants are also beneficial insects because they prey on termites, eggs, pupa, and caterpillars of other insect pests. Nevertheless, ants should not be introduced into vegetable gardens for insect pest control.

Suggested control practices

Cultural practices

1. Increase the seeding/seedling rate. This practice turns out cheaper than with the use of insecticide.
2. Control aphid, whitefly, and other insects that excrete honeydew. The ants are likely to be found in plants infested by these insects because they protect them for their food.

Spray solutions

Ant oil spray

Mix 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt, and few drops of vinegar into 4 liters of water.
Aphids

Damage

Both the nymphs and the adults pierce the plant tissues to feed on plant sap. The infected leaves become severely distorted when the saliva of aphids are injected into them. Heavily infested ones will turn yellow and eventually wilt because of excessive sap removal. The aphids’ feeding on the plant causes crinkling and cupping of leaves, defoliation, and stunted growth.

Aphids produce large amounts of a sugary liquid waste called honeydew. A fungus, called sooty mold, grows on honeydew deposits that accumulate on leaves and branches, turning leaves and branches black. The appearance of a sooty mold on plants is an indication of an aphid infestation.

Description

The eggs are very tiny, shiny black, and are found in the crevices of bud, stems, and barks of the plant.

The nymphs look like the young adults, mature within 7-10 days, and are then ready to reproduce.

The adults are small, 3-4 mm long, soft-bodied insects with two projections on the rear end and two long antennae. Their body color varies from yellow, green, brown, to purple. Females can give birth to live nymphs as well as can lay eggs. However, the primary means of reproduction for most aphid species is asexual, with eggs hatching inside their bodies, and then giving birth to living young. Winged adults, black in color, are produced only when it is necessary for the colony to migrate, or there is either overcrowding in colonies, or unfavorable climatic condition.

Suggested control practices

Cultural practices
1. Control and kill ants. Cultivate and flood the field. This will destroy ant colonies and expose eggs and larvae to predators and sunlight. Ants use the aphids to gain access to nutrients from the plants.
3. Intercrop with onion, garlic, spider plant, coriander.
4. Avoid too much N.
5. Plant in a well prepared fertile seedbed to promote crop vigour.
6. Keep the fields free of weeds and alternative hosts such as wild mustards.
7. Manage the field to favour natural enemies such as lady bird beetles, hover flies and Aphidiu.
8. Encourage growth of milk weed within the field. Milk weed is a host of other types of aphids which are natural enemies.
9. Mulch with wheat straw or clear/transparent polyethylene sheet as reflectors of UV light discourage aphids from landing on the crop.
10. Use overhead irrigation to knock aphids off the leaves.

**Monitoring**
- Early in the season after transplanting and when the conditions are cool and dry favouring aphid development.
- Look at the lower leaves, stems and growing point for soft bodied insects, curled or capping of infested leaves, black sooty mould.
  - Institute control measures when 1 to 2% of plants are infested

**Direct control**

**Traps**

**Sticky board traps**
Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

**Yellow basin trap**
Half-fill yellow pan or basin with soapy water. Place the pan close to the plant but exposed enough so that aphids will see it. This will also trap cabbage root maggot.

**Botanical pesticides**

**Ginger rhizome extract**
Grind 50 g of ginger and make into paste. Mix with 3 liters of water. Strain. Add 12 ml of soap. Mix well. Ten (10) kg of ginger is needed for 1 ha.

Use garlic or a mix of garlic and neem; red chilli pepper and soap (take 50g mix in 2 lts of water, boil for 15 minutes, allow to cool and spray) and pyrethrum flower.

**Custard apple leaf extract**
Boil 500 g of leaves in 2 liters of water until the remaining liquid is about ½ liter. Strain. Dilute filtrate with 10 - 15 liters of water.

**Soap Spray solutions**
- Ammonia spray
- Mix 1 part ammonia with 7 parts water. This spray also controls flea beetles.
- Mix 2½ tablespoons of liquid soap to a gallon of water.
Spray soapy solution (potassium soaps) (add 10-15 table spoon full of liquid soap in 20lt bucket and spray). Avoid powder detergent soaps because they can burn plant leaves and if used frequently, will reduce soil fertility.

### Chemical control

<table>
<thead>
<tr>
<th>Active ingredient</th>
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<tbody>
<tr>
<td>Acetamiprid</td>
<td>Twiga ace®, Manik®</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>Atom®, Decis®, katrin®</td>
</tr>
<tr>
<td>Imidaclorpid</td>
<td>Tata Mida®, murcloprid®, Confidor®</td>
</tr>
<tr>
<td>Natural pyrethrins + Garlic extracs</td>
<td>Pyegar</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Sulban®</td>
</tr>
<tr>
<td>Beta-Cyfluthrin</td>
<td>Bulldock®, Star®</td>
</tr>
<tr>
<td>Thiacloprid</td>
<td>Calypso®</td>
</tr>
<tr>
<td>Imidaclorpid</td>
<td>Confidor®</td>
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</tbody>
</table>

### Restrictions for chemical applications on aphids

- Moderately hazardous (WHO Class II)
- Toxic to aquatic organisms
- Avoid near water ways
- High risk to bees and other non-target arthropods
- Don’t spray when plants are flowering
- Contact pesticide with residual activity

### Cabbage head caterpillar

**Damage**
The cabbage plant has ‘window-liked’ damage on its outer leaves. Larval damage during early head formation results in an aborted or multiple heads. The larva bores holes on the developing head. A damaged developing head contains waste matters.
Attract almost the entire population of the cabbage head caterpillar and 90% DBM. Remove the trap crops when these are heavily infested with the pests or else these pests will transfer to the main crop.
Description
The eggs are laid in clusters and held together by gelatinous glue. An egg mass contains 30-40 eggs. The newly hatched egg mass is colored green and turns reddish-brown as it matures. The eggs are laid close to the midrib or on the veins at the lower surface of leaves. The egg development lasts for about 5-7 days.

The newly hatched larva is slender and greenish yellow in color and has a dark-brown head and thorax. As the larva grows, its body becomes green and its head becomes brown with light patches, and then turns whitish with longitudinal stripes as it matures. A larva undergoes five instars.

The early larval instar feeds in group and as it grows, it disperses moving from plant to plant. A mature larva measures 1.2-1.6 cm long.

The pupa is yellowish-green and turns dark-brown as it grows. The pupa is enclosed in a silken cocoon. Pupation takes place in the soil, 2-6 cm below the soil surface.

The adult has a black thorax and a reddish-brown abdomen. The male has a thicker tuft of hairs along the costal margin near the base of the forewing than that of the female. The female has a curved ovipositor for reproduction. A female can lay 2-10 egg masses. The adult is a weak flier.

Suggested control practices
Cultural practices
Plant Indian mustard (Brassica juncea) as a trap crop between several rows of common cabbage to attract most Cabbage head caterpillar moths and some Diamondback moth (DBM) adults. Mustard larvae feed primarily on leaves causing irregular, rugged holes, bore through the pods, and contaminate pods and leaves with their frass (excreta). Plants can be severely defoliated and stunted. Sometimes, they damage the seedlings, but heavy injury usually occurs during pod stage. Attract almost the entire population of the cabbage head caterpillar and 90% DBM. Remove the trap crops when these are heavily infested with the pests or else these pests will transfer to the main crop.

Chemical control application

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<td>Bridge®, Brigade 25EC®,</td>
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<td>Beta-Cyfluthrin</td>
<td>Bullock®,</td>
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Cabbage lopper

Description

The egg is very small and bowl-shaped with a flat side, yellowish to greenish-white in color, and found singly lying on the leaves.

The larva is light green and about 3-4 cm long when fully developed. It has 3 pairs of slender legs near the head and 3 pairs of thickened prolegs on the abdomen. It moves by arching its back to form a loop and then projecting the front section of the body forward. It usually feeds on the leaves and into the cabbage head.

The pupa is green or brown in color and is nearly 2 cm long. It is enclosed in a flimsy, silken cocoon. Pupation occurs in a folded webbed leaf or between two webbed leaves.

An adult is a grayish-brown moth and has a wingspan of about 3.3-3.8 cm. Each of the mottled and brown front wings bears a small and silvery-spot. The hindwings are paler-brown. Adults are strong fliers and are primarily nocturnal. During the day the adults can be found resting in foliage or in crop debris.

Moths feed on various wild and cultivated hosts where they obtain water and dissolved nutrients. A female moth can produce 300 - 1600 eggs.

Suggested control practices

Botanical pesticide

Gliricidia sepium leaf extract

Grind or pound ½ kg of Gliricidia leaves.

Soak overnight in water. Strain.

Add 20 liters of water to the filtrate.
The larva eats the later roots, then tunnels into the tap root and sometimes bores to the base of the stem. Attacked plants will wilt and the leaves will turn bluish. The plants becomes stunted or eventually die.

**Description**

Eggs are white, oval-shaped and less than 1mm in size. These are laid on the stems or in the soil near the base of the plants. Maggots (larvae) are soft and white about 3-8mm long. They have a pair of prominent forked tubercles below the hind spiracles that separate them from other Delia species.

Pupae are found close to the roots or sometimes within the plant where the larvae last feed. These are brown and hard and are ovate-shaped.

Adults are dark gray flies slightly smaller than the common housefly. They can fly up to 2 km to find suitable hosts to lay their eggs upon.

**Suggested control practices**

**Cultural practices**

- Planting clover (Trifolium spp.) as soil cover
- **Mulching** with dried grasses and rice straw
- Planting onions as trap crops around the borders and down the rows of cabbage protects cabbage from egg laying moths. **Pull and destroy trap crops 2 weeks after they sprout.**
- Row covers Cover the seedbed with a screen covering or fine nylon net placed immediately after seeds are sown. The covering should extend at least 18 cm on either side of the seed row, with the edges buried in the soil.

**Other substances**

The feeding damages made by the larvae are the mined and/or bore leaves and bore stems. They feed first externally on the leaves and continue feeding into the terminal bud. Infested plants produced small heads and in severe cases, they do not form heads at

**Powdered hot pepper or powdered ginger** – place the powdered hot pepper or ginger around the base of the stem when the cabbage root maggot population is moderate

**Wood ash** – if population is moderate repels moths by mounding wood ashes and diatomace earth placed around the base of the stem. Buy D.E at your local agricultural suppliers
Cabbage webworm

Damage

The larvae feed beneath their protective webs made from the silken like threads that they form. The silken webs are found on the inner leaves’ surfaces and stalks.

The cabbage webworm can be detected by their webs, frass, and other feeding debris produced while.

Eggs are oval and creamy-white in color. These are laid in clusters from 28 to 214 eggs. The egg stage lasts from 2-5 days.

The larva has dark-brown or black heads. Its body is creamy-white with light pinkish-brown longitudinal stripes. It is about 1.2 to 1.5 cm when fully grown. The larval stage is about 6 to 18 days.

The pupa is contained inside a loose cocoon. It has a shining pale-brown color with a dark dorsal stripe. The pupal stage is about 4 to 20 days.

The adult is grayish-brown with pale-dusky hindwings. Each forewing has a prominent black spot and zigzagging light-brown lines. The central band between the lines is sometimes filled with darker brown scales. The adult moth is capable of flying long distances. It occasionally migrates to areas outside its normal breeding range.

Suggested control practices

Botanical pesticide

Mammey spray

Pound 10g of ripe and dried Mammey seeds. Add to 1 liter of water. Mix in few drops of soap. Stir well. Shake from time to time while in the process of application to avoid separation. This spray material controls other worms found on crucifers.

Physical control

• Cut off webbed leaves and kill the caterpillars inside.
• Screen seedling beds when seedlings are about 15 cm high. See to it that the seedlings are growing vigorously.

Pathogens

Bacillus thuringiensis (BT)

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use
The larva chews the leaves, hearts, and curds of crucifers. The young larva is hatched on the outer leaves and feeds superficially leaving the upper leaf surface intact. As it grows older, it makes holes in the leaves and eats through small veins. It continues feeding into the center of the head damaging the edible portion of the plant.

When there is a heavy infestation, all the leaf tissues are eaten leaving the veins and large stem. The larva's waste matters contaminate and stain the produce.

**Description**

The eggs are pale yellow in color, about 1 mm long, and bullet-shaped. These are laid singly on the lower surface of the outer leaves of the plant.
The newly hatched larva has a pale-yellow head and body with fine clear hairs arising from the small white spots. As it matures, its head and body are velvety-green with short hairs. The body has a broken yellow line or series of yellow spots which are found on both sides. The larva has five pairs of prolegs. A matured larva fastens itself to the lower leaf surface by silk bands. It can reach up to a length of 3 cm long. The pupa is attached to some parts of the plant or other nearby objects. It is 1.8 to 2.0 cm long with a pointed anterior spine. Its color varies depending on where the pupa is situated because it camouflages with its environment.

The adult butterfly is white. Its body is covered with dense white hair which is more prominent on the male butterfly. The butterfly's wings are white with a black area near the tip of each forewing and have a small black spot on the front edge. The back wings are dull-yellow, dusted with black. It has a wingspan of 4 to 6 cm. The adult is active during the day and is often seen flying on crucifers and on flowering weeds to feed.

**Suggested control practices**

**Botanical pesticide**

**Garlic oil spray**

Chop finely 100 g of garlic. Soak garlic in 2 tbsp of mineral oil for a day. Add ½ liter of water and 10 ml of soap. Blend well by stirring thoroughly. Strain. Dilute the filtrate with 10 liters of water. Shake sprayer from time to time to avoid oil from floating.

**Physical control**

• Handpick the larvae. Put collected larvae in a bucket with soapy water to drown.

• Scatter large pieces of eggshells amongst the cabbages to confuse the Cabbage white butterfly. The eggshells are mistaken for as other butterflies which make them leave the area to look for a less populated one.

• Catch butterflies with sweep nets. Their presence suggests a future problem.

Cover plants with very fine nets to prevent Damage caused by larvae of Cabbage white butterfly eggs on plants female butterfly flies from laying

**Pathogens**

**Bacillus thuringiensis (BT)**

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use for the first time.
Chemical control

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Cutworms feed on seedlings. The seedlings are often cut off at ground level. The larvae can be found in the soil (up to a depth of about 5 cm) near the plant. They always curl-up when disturbed. Cutworms feed only at night. Generally, they are not found on plants or on the soil surface during the day. The newly hatched larvae feed from the base towards the tip of the leaf. At this stage, they first feed on the epidermis and may discolor the entire leaf surface. Young caterpillars eat the soft leaves of the plant. The full grown caterpillars are capable of eating the entire plant.

Description

The eggs are tiny pearl white, round, and have a ridged surface. The newly hatched larvae are greenish and about 1 mm long. The full-grown larva has a cylindrical body, brown or brownish-black with a tinge of orange. The thoracic segments have one to two dark spots near the base of the legs. The abdominal segments generally have two light brownish lateral lines on each side, one above and one below the spiracles. Above the top lines are broken lines composed of velvet semi-crescent patches that vary in color among cutworms.

The pupa is black or brown in color and measures about 22.5 mm long and 9.2 mm wide.
The adult has dark brown forewings with distinctive black spots and white and yellow wavy stripes. The hind wings are whitish with grayish margins. The total developmental period from egg to adult is about 35-40 days.

**Suggested control practices**

**Cultural practices**

Interplant onion, garlic, peppermint, coriander, or garlic every 10-20 rows to repel cutworms and attract natural enemies. Sunflowers and cosmos can also be planted as a trap crop in or around fields.

**Botanical pesticides**

**Finger euphorbia plant extract**

Cut a branch and collect the oozing sap. Add 1 liter of water to every 10 drops of the sap. Another method is to cut a mature branch and pound it finely to make it into a paste. Add this to 10 liters of water. Leave it for sometime then strain.

**Basil plant extract**

Pound or grind of 50 g of basil leaves. Soak it overnight in 2-3 liters of water. Add 8 - 12 ml of soap. Stir well.

**Bait**

**Bacillus thuringiensis (BT)/bran bait**

Moisten bran with a diluted solution of BT. Sprinkle the moist bran on the planting plots' surfaces 2 weeks before planting. Buy BT at your local agricultural suppliers.

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**Diamondback moth**

**Damage**

Newly hatched larvae mine tunnels in the leaves. As they grow older, the larvae feed on the undersides of leaves but do not eat the veins, leaving the surfaces untouched, resulting in the 'window effect'. Larvae make irregular holes, tunnel into the cabbage heads preventing further development. In broccoli and cauliflower, Diamondback moths (DBM) feed on the leaves and not on the flower heads.

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Damage caused by larvae of Diamondback moth

**Description**

Eggs are tiny, ovate-shaped, and yellowish-white in color. These are laid singly or in groups of 2-3 along the veins in the upper and lower leaf surfaces. The eggs hatch in about 5-6 days.

Larvae are pale yellowish-green to green covered with fine, scattered, erect hairs and with a forked posterior end. Mature larvae are cigar-shaped and about 12 mm long. The larval period lasts for about 10-21 days. DBM larva is easily identified because it can wriggle violently backwards when disturbed then drops from the plant suspended by a silken thread and finally climbs its way back up and continues feeding.

Pupae are delicate, white open-mesh cocoons that are attached to the leaves, stems or seedpods of the host plant. Pupae are light green but become brown as the adult moth becomes visible through the cocoon. The pupal stage lasts from 5-15 days depending on the environmental conditions.

The adult moth is approximately 8-9 mm long with a wing span of 12-15 mm. The moth folds its wings over the abdomen in a tent-like manner when immobile.
The wing tips are fringed with long hairs. Adult females can lay an average of 160 eggs during their life span of about 16 days. Egg laying occurs at night. The greatest number of eggs is laid the first night after emergence and egg laying continues for about 10 days. In the field, moths will fly up out of the plant canopy when disturbed.

**Suggested control practices**

**Cultural practices**

Planting mustard as trap crops every 15 rows of crucifers reduces attack. Bold seeded Indian mustard could also be sown densely all around the area 10 days before cabbage are planted. The plants attract up to 80% DBM. However, monitor trap crops frequently so as to control DBM before it can transfer to the main crop. Unattended trap crops can generate large populations of DBM. Care is needed to manage intercrops in order to use them as part of a control practice.

**Botanical pesticides**

Chili and neem seeds extract: Grind 200 grams of fully dried and shelled neem seeds. Soak overnight in 4 liters of water. Add 12 pieces chopped hot chilies. Strain. This spray material also controls aphids and other sucking and chewing insects.

Tomato leaf spray: Pound 500g of tomato leaves. Add to 8.5 liters of water. Strain. Stir in few drops of liquid soap.

**Vitexnegundo leaf extract**

Soak 2 kg of leaves overnight in 5 liters of water. The next day, boil the mixture for 30 minutes. Cool then strain. Add 10 liters of water and 10 ml soap to the filtrate. Stir well.

**Pathogens**

*Bacillus thuringiensis (BT)*

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use for
the first time.

**Biological control**
The use of beneficial insects to control DBM *Diadegmasemiclausum* for control of DBM in the highland and *Cotesiaplutellae* for the control in the lowland.

**Chemicals control**

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**Flea beetles**

**Damage**

Flea beetles feed on seedlings. They usually feed on the undersides of leaves leaving numerous small round or irregularly shaped holes, although not generally all the way through the leaf. Because the beetle is small and active, it usually does not feed much in one spot. The larvae are root feeders. They trim the root hairs and make circular pits in taproots. The adults feed on the leaves and stems of emerging seedlings. They chew small holes or pits, usually less than 3 mm in diameter giving the leaves a characteristic 'shot hole' appearance.

**Description**

The eggs are tiny white when freshly laid and gradually become yellowish-gray in color.

The larva is white with a brown head and three pairs of brown legs near its head.
The pupa is white, shaped roughly like adult and pupates in the soil. It is found in the soil near the base of the plant on which it has been previously feeding.

The adult is small, hard, elongated, oval-shaped, with enlarged black hind legs and slightly hairy wing covers. It is about 2 mm in size. It is bronze, darkmetallic bronze or black in color. It has enlarged hind legs. They all jump vigorously like fleas when disturbed, hence the name.

**Suggested control practices**

**Cultural practices**

Plant the barrier crop along the edges of the field ahead of the main crop. Radish and Chinese mustard are good trap crops. Adult flea beetles are attracted to the tallest and earliest crop available. Another method is; Chinese mustard (Brassica juncea var. crispifolia) planted every 100 m between rows of crucifers. Remove or treat trap crops when these are infested by pests or else the pests will transfer to the protected crops. 

Row covers

Keep flea beetles away by putting row cover on seed boxes and/or seed beds immediately after sowing.

**Mulching**

Place 2-3 inches of cut grasses or 2-4 inches of bark mulch and wood chips or 3-4 inches of compost as your mulching materials to interfere the larvae’s root feeding activities.

**Botanical pesticides**

**Neem oil extract**

Add 30 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

**Neem kernel extract**

Add 30 grams of powdered kernel in 1 liter of water. Let it stand for 6 hours but not more than 16 hours. Add soap and stir. Constantly shake the container or stir the extract while in the process of application.

**Red Spider mites on cabbages**

**Damage**

Generally, mites feed on the undersides of leaves. They use their sucking mouthparts to remove plant saps. The upper leaf surface has a speckled or mottled appearance while the underneath appears tan or yellow and has a crusty texture. Infested leaves may turn yellow, dry up, and drop in a few weeks. Mites produce large amount of webbing. Heavy infestation will result in a fine cobwebby appearance on the leaves. Plants die when infestation is severe.
Description

The eggs are tiny, spherical, pale-white, and are laid on the undersides of leaves often under the webbings. Eggs hatch in 4 or 5 days.

Nymph looks similar to the adult but is only the size of an egg. It has only 6 legs. It molts 3 times before becoming an adult.

The adult is also very tiny, maybe yellowish, greenish, pinkish, or reddish depending on the species. It looks like a tiny moving dot. It has an oval body with 8 legs and with 2 red eyespots near the head of the body.

The male is smaller than the female with a more pointed abdomen. A female usually has a large, dark blotch on each side with numerous bristles covering her legs and body. Spider mite is not an insect.

Suggested control practices

Cultural practices

Provide plants with adequate water. Water stressed plants are prone to damage by mites. Avoid the use of broad spectrum insecticide for this may cause a mites' outbreak. This practice kills the natural enemies of mites and stimulates mites' reproduction.

Botanical pesticides
Coriander seed extract

Pound or crush 200 grams of coriander seeds. Boil in 1 liter of water for 10 minutes. Cool and strain. Dilute extract with 2 liters of water. This extract also prevents fungal diseases.

Basil leaf extract

Pound or grind of 50 g of basil leaves. Soak it overnight in 2-3 liters of water. Add 8 - 12 ml of soap. Stir well. Spray on infected plants.

Other solution

Horticultural oil

Spray 2% solution against mites. To make a 2% solution, pour 1/3 cup oil into a 1 gallon container, and then fill with water to make a 1 gallon solution. For a 3% solution, start with ½ cup of oil. Apply successive sprays at least 6 weeks apart. You can apply 1% oil solution by mixing 2.5 tbsp of oil in 1 gallon of water. Horticultural oil is concentrated and must be mixed with water.

Whiteflies

Damage

Both the larvae and adults pierce and suck the sap of the leaves. This causes the weakening and early wilting of the plant resulting in reduced plant growth. Their feeding may also cause yellowing, drying, premature dropping of leaves that result in plant death. Whiteflies produce honeydews that serve as the substrates for the growth of black sooty molds on leaves and fruit. The mold reduces photosynthesis causing the poor plant growth of the plant. They are the most important carriers of plant viruses that cause diseases of fiber crops, vegetables, fruit trees, and ornamentals.

Description
The eggs are tiny, oval-shaped, about 0.25 mm in diameter, and stand vertically on the leaf surface. Newly laid eggs are white then turn brownish. They are deposited on the underside of leaves, sometimes in a circle or oval-shaped patterns.

The larvae are transparent, ovate, and about 0.30-0.7 mm in size and they move around on the plants looking for a feeding site upon hatching.

The pupae are dirty-white and surrounded by wax and honeydews. During this stage, the red eyes of the emerging adults are visible.

The adults are about 1 mm long with two pairs of white wings and light yellow bodies. Their bodies are covered with waxy powdery materials. They are found feeding on top of the plants. A female can produce as many as 200 eggs in her lifetime and mating is not necessary. It takes about 40 days to develop from egg to adult.

Suggested control practices

Botanical pesticides

Garlic oil spray

Chop finely 100 g of garlic. Soak the chopped garlic in mineral oil for a day. Add ½ liter and 10 ml of soap. Dilute filtrate with 10 liters of water. Constantly shake the container or stir the extract while in the process of the application to prevent oil from separating.

Madre de cacao & neem

Shred 1 kg of Madre de cacao leaves and 1 kg of neem leaves. Soak leaves in 5 liters of water for 3 days. Strain. Add water to make up 20 liters of filtrate. Spraying interval is 4-5 days.

Neem oil extract

Add 15 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Spray solution

Soap spray

Mix 2 ½ tablespoons of liquid soap to a gallon of water. Potato starch spray

Mix 2-4 tablespoons potato flour to 1 litres of water and add 2-3 drops of liquid soap, shake the mixture and spray thoroughly before spraying.
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<td>Deltamethrin</td>
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**Snails**

**Damage**

Snails feed on the seedlings and the growing plants. Their feeding damage on the leaves is irregular large holes but they can consume the young seedlings completely.

**Suggested control practices**

**Cultural practices**

Limit the addition of organic matters into the area when the infestation is causing economic loss because organic matters are very attractive to slugs. Slugs eat on organic matters found in the soil.

Screen the seedbed or seedling plot using a fine mesh screen of about 7.5 cm high that surrounds the plot and securely fix about 2.5 cm of it into the ground.
Trap the snails using 30 cm x 30 cm white painted-surface wooden boards. Place them securely along the plant's rows. At daytime, snails take shelter underneath the cooler places. Be sure to check the wooden traps before sunset and collect the snails. Crush or place them in a bucket of soapy water. Potato or cabbage, cereal bran or chicken food can be placed under the board as an attractant.

Over-turned earthen flower pots, placed under the shady part of the plant, is another way of trapping them. Make sure to make an opening to let them crawl underneath and to collect them before sunset. Crushing them in the pots also make the pots more attractive to other snails.

Plant ash, saw dusts, sand, or eggshells

Sprinkle enough ash, sand, or crushed eggshells at the base of the plants. The snails are sensitive to harsh objects which prevent them from crawling into the plants. Remember to keep these substances dry to be effective. But make sure that your control method is not a waste of time because snails are problematic only when the soil is moist.

Baits

Grapefruit and melon peel baits

After eating grapefruit and/or melon, invert the peel as food and as a cool shelter for the pests. Be sure to collect peels and kill the trapped pests.

Yeast and water solution

Dissolve 1 tbsp of yeast in 100 ml of water. Fill any shallow container with the solution. Bury up to the rim near the plant. Make some modifications to cover your trap to avoid non-target pests from entering. The snails drink, get drunk and drown in the pan. Monitor the pans and the trapped snails. Change the solution when necessary, especially after rain.

Spray solution

A 2% caffeine solution in water. Spray directly on the trapped pests. Test solution on a few plants first as it can cause yellowing to some leaves.

Thrips

Prevention

• Eliminate previous crop residues

• Plant tolerant varieties

• Can practice solarisation methods to kill the pupa

• Plant living barriers; Mexican marigold followed by sunflower. (Mexican marigold attracts thrips from beans and sunflower hosts Oriusspp which feeds on the thrips)
• Deep plough so as to incorporate previous crop residue into the soil (kills thrips at all stages of development).
• Intercrop with onion, garlic, spider plant, corriander
• Avoid too much N. Split applications of recommended fertilizer rates.
• Plant in a well prepared fertile seedbed to promote crop vigour
• Keep the fields free of weeds and alternative hosts such as wild mustards
• Manage the field to favour natural enemies such as lady bird beetles, Orius, hover flies and Aphidius to help manage

**Monitoring**

• Randomly check for thrips damage before flowering stage at the growing tips of the plants
• Monitor for thrips early in the mornings before sunrise (i.e. 9-2.30 o’clock) since thrips tends to hide inside the flowers or underneath the leaves
• Monitor with sticky traps (blue ones) to capture adults.
• Shake the flowers on a white piece of paper to check for adult thrips presence
• Take action when you notice three thrips per plant
• Monitor leaves for larvae (silvery appearance) so that you act early

**Direct**

• Use mass trapping using blue sticky traps. To be placed above the vegetative part of the plants
• Imidacloprid
• Deltamethrin 10ml-15ml/20L, after 8 days Azadirachtin 50-60ml/20L, after 8 days follow with Metarhiziumanisoplae (ICIPE 69) 10g
• Lambda Cyhalothrin 2.5 % W/V (10-15ml/20L)

**Restrictions**

---

40
- Good spray coverage is essential as thrips hide underneath the flowers of leaves
- Use recommended rates of insecticides and rotate between chemicals
- Observe Pre Harvest Interval (PHI) as indicated on the product label
- Wear protective clothing when handling chemicals
- Apply chemicals early in the mornings or late in the evenings and NEVER on sunny weather to prevent chemical evaporation thus losses
- Apply Insecticides at 50% flowering on the crop; then follow alternating with botanicals after every 8 days to avoid chemical residues on the harvested beans.

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetamiprid</td>
<td>Manik®, Golan®, Twiga Ace®</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Tata Mida®, Murchlorpid®, Confidor®</td>
</tr>
<tr>
<td>Bifenthrin 2.5%</td>
<td>Brigade</td>
</tr>
<tr>
<td>Pirimiphos-Methyl</td>
<td>Actelic 25EC</td>
</tr>
<tr>
<td>Thiacloprid</td>
<td>Calypso®</td>
</tr>
</tbody>
</table>
CHAPTER 11

Diseases

Bacterial soft rot
An initial infection occurs on the outer petiole (leafstalk) which is in contact with the soil, and then progresses to its head. An infected head is watery and often has a complete head rot. The affected area becomes soft and mushy and generally turns dark in color. Soft rot infection on crucifers almost always emits a foul odor when other secondary organisms invade the infected tissues.

**Suggested control practices**

Control nematodes and other insect pests that serve as vectors (carriers) of the bacteria to invade the plant tissues. If possible, avoid plant injury during weeding especially when the disease symptoms are observed.

Remove infected plants immediately and destroy by burning.

**Black rot**

Black-rot, caused by the bacterium *Xanthomonas campestris pv. campestris*, is the most serious disease of crucifers in Kenya. The bacterium attacks many species of the *Brassica* family. Among these are cabbage, collard, kale, mustard and turnip. Plants may be affected at any stage of growth. This disease is seed borne and is often introduced by contaminated seeds or infected transplants. In some areas of the country, the disease is of minor importance; however, in some parts of Kenya the conditions, the disease becomes serious and many growers sustain severe economic loss. In some cases, the crop may be destroyed. In the field, the disease is easily recognized by the presence of large yellow to yellow-
orange V-shaped lesions extending inward from the margin of the leaf.

When infected seeds germinate, the resulting young plants usually die quickly; however, these plants serve as an inoculum source for other plants. If infection occurs in young seedlings, the disease is much more severe because the main stem becomes infected and the disease becomes systemic and moves throughout the plant. These plants remain stunted and the veins in the stem are black. Heads developed from these plants deteriorate rapidly after harvest.

The bacterium enters the vascular system of the plant principally through natural openings and injuries on the leaf. In time, the bacterium spreads in the vascular system of the leaf and stem. The disease spreads and causes most damage in wet, warm weather. It does not usually spread in dry weather and is inactivated at temperatures below 50°F. The bacterium can survive in the soil for 14 to 42 days, depending on the season, and in old cabbage stems for 244 days. The disease is also carried over on weed hosts such as “pepper grass” and with wild species of mustard, radish and turnip. The bacterium is spread by splashing rain, irrigation and running surface water as well as insects and other movement in the field while the plants are wet. Disease management strategies such as crop rotation away from contaminated land for two years and use of certified seed or transplants are effective. There is no remedial control for this disease.

Management:

Prevention

- Use certified tolerant varieties like Baraka F1, Globe Master F1, Blue dynasty F1, Riana F1.
- Rotate with non-brassicas like maize and legumes for at least 2 years.
- Keep field free from weeds to avoid alternate host of brassica family.
- Alternate dry and wet spells in the soil
- Crop rotation

Monitoring
Monitor for

• Yellow, brown v-shaped patches at the edge of the leaves.

• If the yellow/black lesion is held against the light, black veins are visible.

• A cross section of infected stem reveals a black ring.

• In later stages, head turns black with an offensive foul smell.

• Disease is common during wet conditions with high temperatures.

• Take immediate action when first symptoms appear.

**Direct Control**

• Remove all infected plant and debris from the field and destroy by burning.

• Spray the remaining plants using a protective fungicide to suppress further damage. (See direct control yellow option)

• Copper based fungicides may be used as a protective spray e.g. copper oxy chloride. (Kocide or Isacop) to prevent disease development.

**Chemical control**

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Oxychloride</td>
<td>Sulcop®, Isacop®</td>
</tr>
<tr>
<td>Copper Hydroxide</td>
<td>Funguran®</td>
</tr>
</tbody>
</table>
Restrictions

• Moderately hazardous (WHO Class II).

• Spray interval of 14 days during wet weather.

• Use a maximum of 3 sprays.

• Wear protective clothing.

• Follow instructions as per manufacturer.

• Recommendation on pre-harvest interval.

Downy mildew

The plant is stunted with the leaves wilting and becoming yellow particularly on hot and sunny days club-like galls are formed on roots.

Suggested control practices

• Use disease free transplants, do not use any club rooted seedlings as transplants

• Avoid moving infected transplants and/or infested soil on farm equipment to clean fields.

• Maintain soil pH at 7 – 7.3 with hydrated lime.

• Provide and maintain well drained soil.

• To reduce the risk of club root occurrence in fields that have not had the disease, grow crucifers on the same soil no more than once every 3-4 years.

• In fields where the disease has occurred, rotate cruciferous crops with unrelated crops for a period of 7-10 years. Each time cabbage is planted in the rotation, hydrated lime should be applied.

The disease initially appears as irregular yellow patches on the leaves. These lesions later turn tan.
to light-brown. During cool and humid weather condition, the fungus develops white fungal growths on the undersides of leaves. Heavily infested leaves will have a blighted appearance as a result of numerous infection sites. Early symptoms on transplants may resemble bacterial leaf spot. Severely diseased seedlings are stunted that will die eventually.

Suggested control practices

Compost tea

Put a gallon of well-matured compost into a 5 gallon (20 liters) container. Add water until the container is full. Stir well. Place in warm place for 3 days to ferment. Strain.

Baking soda Dissolve 1 tbsp of baking soda in 4 cups of warm water. Add 1 tsp of liquid soap. Mix well.

Downy mildew

The disease initially appears as irregular yellow patches on the leaves. These lesions later turn tan to light-brown. During cool and humid weather condition, the fungus develops white fungal growths on the undersides of leaves. Heavily infested leaves will have a blighted appearance as a result of numerous infection sites. Early symptoms on transplants may resemble bacterial leaf spot. Severely diseased seedlings are stunted that will die eventually.
Chemical control

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tebuconazole</td>
<td>Score®</td>
</tr>
<tr>
<td>Hexaconazole</td>
<td>cotaf®</td>
</tr>
<tr>
<td>Di and Mono potassium Fosphite</td>
<td>Fosphite®</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Microthiol special disperse</td>
</tr>
<tr>
<td>Axystrobin</td>
<td>Twiga-AZ</td>
</tr>
<tr>
<td>Propineb</td>
<td>Melody Duo®</td>
</tr>
<tr>
<td>Fluopicocolide</td>
<td>Infinito®</td>
</tr>
</tbody>
</table>

Nematodes in vegetable

Root-knot nematode is the only nematode of economic importance that affects crucifers. All species of root-knot are considered pests of crucifers. Cabbage, turnip, mustard and spinach are the main crops affected. Stunted growth and chlorosis are the above-ground symptoms. Classic galling of the root system is key for diagnosing root-knot nematode damage. Rotation and chemical treatment are the control practices. Effects on roots, on plants have stunted growth and premature flowering.

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Application method</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metam sodium</td>
<td>• Soil fumigation</td>
<td>Nemasol®</td>
</tr>
<tr>
<td></td>
<td>• drenching</td>
<td></td>
</tr>
<tr>
<td><em>Paecilomyces-lilacinus</em></td>
<td>-</td>
<td>Bio-nematon®, PL- plus®</td>
</tr>
<tr>
<td></td>
<td>seed dressing</td>
<td>marshal 350std®</td>
</tr>
</tbody>
</table>
CHAPTER 12

Intercrop Pest control

Plants that repel insect pests
Pre-harvest interval (PHI)

Pre-harvest interval is the time between the last pesticide application and harvests of the treated crop. The PHI must be adhered to for all crops. Failure to adhere to the PHI will result in pesticide residues in the harvested produce, which will render the crop unfit for human consumption and for sale. It is illegal to sell crops where the PHI has not been adhered to. Heads are cut when they are firm. Heads for the loose head / hawker market should be cut with a few outer leaves to protect them during transportation. However as outer leaves are not required for the bagging market, the heads can be cut higher up on the stem. After harvesting, cabbage stumps should not be left in the ground as they may contribute to field contamination via pests or insects. The ideal is to have a high first cut percentage, (80% +) this can be achieved through good management and choosing a cultivar that produces uniform heads. If the cultivar does not mature uniformly it adds further costs as irrigation and labour continues for every cut after the first cut.

Field Hygiene during harvest Good field hygiene is required to ensure your crop is free of contami-
nants. This is essential for it to be sold in the market. Good field hygiene practices must always be adhered to when harvesting fresh vegetables.

Crop maturity, handling and storage
Cabbages should be harvested during the cooler parts of the day to avoid heat and sun damage. To ensure best prices, the base should be neatly trimmed with a clean, sharp instrument to prevent from tearing and rotting. Cutting blades should be regularly cleaned to prevent the spread of disease. For field packed cabbages, the leaves should be stripped away to present a neat and clean product with the shape typical of the variety. For best prices, consult the most recent marketing specifications for size requirements. Smaller size cabbages can be more profitable than larger sized ones. Cabbages are prone to damage which reduces shelf-life and sale ability of the product. They must be handled with care and never be thrown or dropped. Harvested cabbage should be moved from the field to a cool shaded location for short term storage. They must never be left exposed to direct sun. This is especially important during late season harvesting when air temperatures and intensity of the midday sun will dramatically reduce quality. Cabbages should be free from mechanical damage and be of uniform shape and size in each tray. Cabbages should be packed carefully to reduce risk of damage in transit. Crates must be stacked safely and securely so they are not resting on the produce beneath.

Grading

To ensure cabbages receive the best price, they must be graded according to the current ADFSC specifications. These can be obtained from your local procurement officer.
CHAPTER 14
Managing agrochemicals

Effective techniques of chemical application.

• Be keen to also spray under the leaves
• Spray early in the morning 6 a.m.
• Spray when the wind is calm.
• Directed pre-harvest interval (PHI) shall be adhered to.
• ADD GENERAL MGT GUIDELINES ON IRRIGATED SYSTEMS.
• Water quality, application consistency, weed control,
• Choose the right product for target pest,
• use the right knapsack sprayer nozzles for the product
• Use spreaders and wetters to increase product efficacy e.g. agral 90®

• Ensure good crop coverage of the spray

• Always read the product label

Safety measures when handling pesticides

Pesticides refer to chemicals used in agriculture to control insect pests, diseases, weeds and other pests in the homestead. These chemicals are dangerous to human beings, livestock, wildlife and the environment if not handled or used carefully.

When handling pesticides one should have full protective kit, i.e an overall suit, gumboots, eye goggles, gloves, masks to ensure no chemical comes into contact with any part of the body or inhaling of the chemical or its fumes. Before any chemical application read instructions carefully to know its mode of action for prevention of any poisoning, antidote and the rate of use.

When spraying avoid eating, drinking, smoking and windy condition, in case of weather changes ensure you spray following the wind direction. After spraying wash the sprayer, the clothes worn during spraying and then take a bath. After cleaning dispose the water in safe area where it will not contaminate food, grass for livestock and underground water.

In case of any accidental poisoning urgently go to hospital for treatment.

Identification of Illegal Pesticides

Products come in the following forms;

1. Counterfeit/Fake – an imitation of the original in physical aspects but no active ingredient as compared to original.

2. Unregistered products and Improperly labeled products – not registered for any use locally. Therefore contains unknown compounds which might be very toxic. Do not have PCPB approved labels whose information has been vetted to be true and conveying the correct information for safe use.

3. Expired products – shelf-life or storage period over which the product remains effective is over and product quality cannot be guaranteed

4. Repacked/decanted products - transferred into another container, not authorized and unapproved material/packs without labels

Key points to note about illegal products;

• Poor labeling – poor workmanship, Photocopied, scanned or typed labels
• Batch numbers- rubber stamped, photo-copied and not clear, not consistent with the supplier
• Shelf life- normally very long as compared to established duration  (researched/package)
• Addresses/Telephone numbers-untrue/any and in some cases of a different place
• Pictograms -just put without due consideration of the product (toxicity)
• PACKAGING /WEIGHT - wrong weight as per pack size.
• TERMS OF SALE -Very good terms- cheap and on cash
• Stockists – mostly sold through non approved stockists and distributors
CHAPTER 15

Common cabbage varieties in Kenya
<table>
<thead>
<tr>
<th>No.</th>
<th>Variety Name</th>
<th>Plant spacing</th>
<th>Head weight</th>
<th>yield (T/acre)</th>
<th>Maturity (Days)</th>
<th>Resistance/Reliance</th>
<th>General remarks</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AMIGO</td>
<td>60cm x60cm</td>
<td>Semi-round head 4-6kg</td>
<td>45-70</td>
<td>90-100 Days</td>
<td>Black rot and Diamond back moth</td>
<td>requires warm cool areas</td>
<td>SEMINIS</td>
</tr>
<tr>
<td>2</td>
<td>AMUKO SI F1</td>
<td>60cm x60cm</td>
<td>Round Head 1.5-2.5kg</td>
<td>70-120</td>
<td>60-65 Days</td>
<td>Black rot, Ring spot and Cabbage yellow</td>
<td>fat growing with compact Head</td>
<td>SEMINIS</td>
</tr>
<tr>
<td>3</td>
<td>BARAK A F1</td>
<td>60cm x60cm</td>
<td>Round Head, bluish green. 4-6kgs</td>
<td>75 Days</td>
<td>Black rot, Fusarium Yellow, Diamond back moth.</td>
<td>High yielding bluish green, good field holding capacity</td>
<td>EA.SEED</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BLUE DYNASTY F1</td>
<td>60cm x60cm</td>
<td>Roundcombact head 4-6kg</td>
<td>45-68</td>
<td>80-85 Days</td>
<td>Black rot, fusarium Yellow, Diamond back moth.</td>
<td>Medium, Late maturing, blue green cabbage low protection cost, high yielding and market demand, high profit margins</td>
<td>SEMINIS</td>
</tr>
<tr>
<td>5</td>
<td>CABBAGE F1 PRETORIA</td>
<td>compact Head 4-5kg</td>
<td>45-56</td>
<td>70-75 Days</td>
<td>Fusarium yellows</td>
<td>excellent head cover, fast uniform growth, Early maturing, high yielding</td>
<td>KENYA HIGHLAND SEED COMPANY</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CHINESE MICHI ILI</td>
<td>60cm x50cm</td>
<td>Oval 1-5-2kg</td>
<td>10</td>
<td>50 Days</td>
<td>Early maturing</td>
<td>Early maturing</td>
<td>SEMINIS HORTITEC</td>
</tr>
<tr>
<td>7</td>
<td>COPEN HAGEN MARKET</td>
<td>60cm x60cm</td>
<td>Uniformround, firm 2-3kg</td>
<td>28 - 5 0 T/acre</td>
<td>60-65 Days</td>
<td>Black rot and Diamond back moth.</td>
<td>Early maturing, short stemmed rather small, highly dependable and productive in warm conditions, resistance to bursting</td>
<td>AMIRAN SAFARI, SEMINIS, SMLAW, EASEEDHYGROTECH, VETAGRO, HORTITEC, FARM C H E M, GRIFFATION</td>
</tr>
<tr>
<td>8</td>
<td>EARLYDRUM HEAD</td>
<td>70cm x 60cm</td>
<td>flat 4 kg</td>
<td>15-30</td>
<td>90 Days</td>
<td>Black rot, Fusarium yellow</td>
<td>Late maturing</td>
<td>SIMLAW, HORTITEC</td>
</tr>
<tr>
<td>9</td>
<td>EARLY MARKET F1</td>
<td>60cm x60cm</td>
<td>Round 2kg</td>
<td>15-30</td>
<td>65 Days</td>
<td>Black rot, Fusarium yellow</td>
<td>Early maturing</td>
<td>EASEED</td>
</tr>
<tr>
<td>10</td>
<td>FANAKA F1</td>
<td>60cm x60cm</td>
<td>Flat round 4kg</td>
<td>75-80 Days</td>
<td>Blue green colour, high yielding, good flavour, heat tolerance, good field holding capacity</td>
<td>EASEED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>FIELD WINNER F1</td>
<td>60cm x60cm</td>
<td>Semi flat 4kg</td>
<td>15-30</td>
<td>80 Days</td>
<td>Black rot</td>
<td>Medium maturing</td>
<td>SIMLAW</td>
</tr>
<tr>
<td>12</td>
<td>GLOBE MASTER F1</td>
<td>60cm x60cm</td>
<td>Globe 3-5 kg</td>
<td>15-30</td>
<td>75 Days</td>
<td>Black rot, Fusarium, Yellows, wide adaptively, blue green colour, high yielding, good field holding capacity</td>
<td>EASEED</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Variety</td>
<td>Dimensions</td>
<td>Shape</td>
<td>Weight</td>
<td>Days</td>
<td>Planting Period</td>
<td>Comments</td>
<td>Supplier(s)</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------</td>
<td>------------</td>
<td>---------------------</td>
<td>--------</td>
<td>--------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>13</td>
<td>GROLIA F1</td>
<td>60cm x 60cm</td>
<td>Round Head</td>
<td>2-5kg</td>
<td>15-30T</td>
<td>75-90 Days</td>
<td>Black rot, Fusarium yellows, wide adaptively, medium early hybrid, good field holding capacity</td>
<td>SIMLAW, EASEED</td>
</tr>
<tr>
<td>14</td>
<td>GLORY OF ENKHUI ZEN</td>
<td>60cm x 45cm</td>
<td>Flat round head 3.5kg</td>
<td>15-30T</td>
<td>90 Days</td>
<td></td>
<td>Very attractive variety, firm and sweet.</td>
<td>EASEEDS, SIMLAW</td>
</tr>
<tr>
<td>15</td>
<td>GOLDEN ACRE</td>
<td>60cm x 60cm</td>
<td>Round 2kg</td>
<td>15-30T</td>
<td>65 Days</td>
<td></td>
<td>Early maturing</td>
<td>SIMLAW; SAFARI, HORTITEC</td>
</tr>
<tr>
<td>16</td>
<td>GREEN CHALLA GER F1</td>
<td>30cm x 30cm, 60cm x 60cm</td>
<td>Round and cobalt 2.5-3kg</td>
<td>40-50T</td>
<td>60 Days</td>
<td>Diamond back moth, Black rot, Fusarium yellow</td>
<td>medium maturing, blue green cabbage</td>
<td>SEMINIC</td>
</tr>
<tr>
<td>17</td>
<td>GREEN CORONET F1</td>
<td>60cm x 60cm</td>
<td>Oblate, head 4kg</td>
<td>15-30</td>
<td>75-80 Days</td>
<td></td>
<td>Medium early maturity, deep green</td>
<td>EASEED</td>
</tr>
<tr>
<td>18</td>
<td>HARAK F1</td>
<td>60cm x 60cm</td>
<td>Round uniform hybrid 2.5kgs</td>
<td>60 Days</td>
<td>60 Days</td>
<td>Resistance to Fusarium, Yellows and Diamond back moth</td>
<td>Bluish green, very compact, good field holding capacity</td>
<td>EASEED</td>
</tr>
<tr>
<td>19</td>
<td>HERO F1</td>
<td>60cm x 60cm</td>
<td>Oval, 2kg</td>
<td>15-30</td>
<td>65 Days</td>
<td></td>
<td>Black rot heat and cold Chinese cabbage</td>
<td>EASEED</td>
</tr>
<tr>
<td>20</td>
<td>OXYLUS F1</td>
<td></td>
<td>Compact head 4-5kg 45-56</td>
<td>70-75 Days</td>
<td></td>
<td></td>
<td>Easily sold, early and uniform maturity, transport well, adapts well, high yielding with high profit margins</td>
<td>SEMINIC</td>
</tr>
<tr>
<td>21</td>
<td>PRICE DRUMHEAD</td>
<td>70cm x 60cm</td>
<td>Flat 4kg</td>
<td>15-30T</td>
<td>95 Days</td>
<td>Black rot, Diamond back moth</td>
<td>Late maturing</td>
<td>SIMLAW</td>
</tr>
<tr>
<td>22</td>
<td>PRUKTOR F1</td>
<td>60cm x 60cm</td>
<td>High round 5.5kg</td>
<td>15-30T</td>
<td>80 Days</td>
<td></td>
<td>Medium maturing</td>
<td>SIMLAW</td>
</tr>
<tr>
<td>23</td>
<td>RED DYNASTY</td>
<td>60cm x 60cm</td>
<td>Compact head 4kg</td>
<td>45</td>
<td>75-85 Days</td>
<td>Diamond back moth, Black rot</td>
<td>Red cabbage medium maturing</td>
<td>SEMINIS</td>
</tr>
<tr>
<td>24</td>
<td>RED MONTE CHRISTO F1</td>
<td>60cm x 45cm</td>
<td>Round smooth head 2-4kg</td>
<td>15-30</td>
<td>90-100 Days</td>
<td>Black rot, Fusarium yellows</td>
<td>Blue reddish cabbage</td>
<td>SIMLAW</td>
</tr>
<tr>
<td>No.</td>
<td>Variety</td>
<td>Size</td>
<td>Shape</td>
<td>Weight</td>
<td>Days</td>
<td>Comments</td>
<td>Supplier(s)</td>
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<td>----------</td>
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<td>--------</td>
<td>------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>RED ROCK</td>
<td>60 cm x 45 cm</td>
<td>Round</td>
<td>3 kg</td>
<td>15-30</td>
<td>70 Days</td>
<td>SIMLAW</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>RIANA F1</td>
<td>60 cm x 60 cm</td>
<td>Round head</td>
<td>1.5-2.5 kg</td>
<td>15-30</td>
<td>90-100 Days</td>
<td>SIMLAW, EASEED</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>RINDA F1</td>
<td>60 cm x 60 cm</td>
<td>4.8 KG</td>
<td></td>
<td>110-180</td>
<td>90-105 Days</td>
<td>SEMINIS</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>ROMEN COR S</td>
<td>60 cm x 60 cm</td>
<td>2.5-4 kg</td>
<td>60-113</td>
<td>70-75 Days</td>
<td>SIMINIS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>ROTAN F1</td>
<td>60 cm x 45 cm</td>
<td>Semi flat</td>
<td>4.5 kg</td>
<td>15-30</td>
<td>70 Days</td>
<td>SIMLAW</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>RUBY BALL</td>
<td>60 cm x 45 cm</td>
<td>Round 2kg</td>
<td></td>
<td>20-Oct</td>
<td>75-85 Days</td>
<td>AMIRAN</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>RUBY PER FECTION F1</td>
<td>60 cm x 60 cm</td>
<td>round 2kg</td>
<td></td>
<td>20-Oct</td>
<td>75-85 Days</td>
<td>EASEED</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>SANTA F1</td>
<td>60 cm x 40 cm</td>
<td>Soherical</td>
<td>3-6 kg</td>
<td>16-32</td>
<td>80-90 Days</td>
<td>AMIRAN</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>SAVOY SAGA</td>
<td>60 cm x 60 cm</td>
<td>round 3-4 kg</td>
<td></td>
<td>34-45</td>
<td>75-90 Days</td>
<td>SEMINIS</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>STAR 3308</td>
<td>60 cm x 60 cm</td>
<td>semi globe</td>
<td>45-65</td>
<td>80-90 Days</td>
<td>FARMCHEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>STAR 3317 F1</td>
<td>60 cm x 60 cm</td>
<td>semi globe</td>
<td></td>
<td>80-90 Days</td>
<td>PANNAR DEED K LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SUGAR LOAF</td>
<td>60 cm x 60 cm</td>
<td>conical 2 kg</td>
<td></td>
<td>16/32 T</td>
<td>75 Days</td>
<td>SAFARI, SIMLAW, AMIRAN, HORTITEC</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>SUPER MASTER</td>
<td>60 cm x 60 cm</td>
<td>round or flat</td>
<td>4-5 kg</td>
<td>20-40</td>
<td>80-85 Days</td>
<td>EASEED</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Variety</td>
<td>Height x Width</td>
<td>Shape</td>
<td>Size</td>
<td>Days</td>
<td>Resistance</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>----------------</td>
<td>-------------</td>
<td>------------</td>
<td>-------</td>
<td>------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>SUZANNA F1</td>
<td>90cm x 45cm</td>
<td>pear blocky</td>
<td>35-50</td>
<td></td>
<td>Verticillum wilts, Fusarium races 1&amp;2, Stem Phylum, Tolerance: Bacterial wilt, Nematodes &amp; Fungal blight</td>
<td>Determinate for both outdoor and indoor. Suitable for all soil types. Firm fruits that transport well &amp; high quality, long shelf life, tolerant to water logging, suitable for fresh market and processing.</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>VICTORIA F1</td>
<td>60cm x 60cm</td>
<td>round head 4-5kg</td>
<td>45-56</td>
<td>70-75 Days</td>
<td>Verticillum wilts, Fusarium races 1&amp;2, Stem Phylum, Tolerance: Bacterial wilt, Nematodes &amp; Fungal blight</td>
<td>Compact head, uniform growth. Blue green in colour. Matures fast &amp; high profits. Transports well.</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>ZAWADI F1</td>
<td>60cm x 60cm</td>
<td>flat topped bluish green compact head 4-6kg</td>
<td>90 Days</td>
<td>Black rot and Downy Mildew</td>
<td>Excellentfieldholding capacity, good heat tolerance excellent uniformity, transport well</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Fiona F1</td>
<td>60cm x 45cm</td>
<td>round compact head with uniform maturity head 4-6kg</td>
<td>45-65</td>
<td>70 Days</td>
<td>Tolerance to Black rot, Ring spot, yellow and Downy Mildew</td>
<td>Excellentfieldholding capacity, good heat tolerance excellent uniformity</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>ROSSY F1</td>
<td>45 x 45 cm for medium head or 45 x 30 cm for medium head</td>
<td>3.5 kg at 80 days maturity</td>
<td>40 - 60 tons/acre</td>
<td>80 days</td>
<td>Diamond back moth (DBM) attack</td>
<td>Strong vigorous plant type with blueish green leaves and medium large frames. Excellent wrapper leaves that allow the head to remain fresh for a long time in the market and shelves.</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 16

Costs in cabbage production in Kenya

Gross margin: Cabbage production per acre. Prucktor variety

The total cost of producing any crop includes variable and fixed costs. The variable (operating) costs vary with the cultural practices used. Common variable costs include seed, fertilizer, chemicals, fuel and labor. Fixed costs include items such as equipment ownership (depreciation, interest, insurance and taxes), management and general overhead costs. Most of these costs are incurred even if little production takes place.

Variable costs are further broken down into pre-harvest operations in the budgets. This provides an opportunity to analyze the costs at different stages of the production process.

Land cost can be a variable or a fixed cost. Even if you own the land, cost is involved. Land is fixed cost in the sample budget. If land is double-cropped, charge each enterprise half the annual cost.

A fixed cost per hour of use shows ownership costs for tractors and equipment (depreciation, interest, taxes, insurance and shelter). Overhead and management are 15 percent of all pre-harvest variable expenses. This figure pays for management and farm costs that cannot be allocated to any one specific enterprise. Overhead items include utilities, farm shop and equipment, pick-up trucks and fees.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Costs/Units(KES)</th>
<th>Value(KES)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GROSS INCOME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable costs ploughing/harrowing</td>
<td>Acre</td>
<td>1</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Seeds</td>
<td>10g sachets(grams)</td>
<td>150</td>
<td>40</td>
<td>6,000</td>
</tr>
<tr>
<td>Manure</td>
<td>lorries</td>
<td>1</td>
<td>7,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Fertilizer (DAP)</td>
<td>Bags</td>
<td>2</td>
<td>3,400</td>
<td>6,800</td>
</tr>
<tr>
<td>Fertilizer (CAN)</td>
<td>bags</td>
<td>3</td>
<td>2,000</td>
<td>6,000</td>
</tr>
<tr>
<td><strong>Diseases and Pests control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karate</td>
<td>litres</td>
<td>1</td>
<td>2,100</td>
<td>2,100</td>
</tr>
<tr>
<td>Thuricide</td>
<td>litres</td>
<td>1</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>Brigade</td>
<td>litres</td>
<td>1</td>
<td>850</td>
<td>850</td>
</tr>
<tr>
<td>Fungicide</td>
<td>litres</td>
<td>1</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>Man-days</td>
<td>6</td>
<td>300</td>
<td>1,800</td>
</tr>
<tr>
<td>Weeding labour</td>
<td>Man-days</td>
<td>20</td>
<td>300</td>
<td>6,000</td>
</tr>
<tr>
<td>Spraying labour</td>
<td>Man-days</td>
<td>10</td>
<td>300</td>
<td>3,000</td>
</tr>
<tr>
<td>Nursery</td>
<td>Man-days</td>
<td>30</td>
<td>300</td>
<td>9,000</td>
</tr>
<tr>
<td>Harvesting</td>
<td>Man-days</td>
<td>15</td>
<td>300</td>
<td>4,500</td>
</tr>
<tr>
<td><strong>Total variables costs</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>69,050</strong></td>
</tr>
</tbody>
</table>
The above table indicates that the cost of production for cabbage is KES 6. (Six Shillings only) per head. However, the gross margin will largely depend on the variety grown, the level of management employed by the farmer and prevailing market situation.
# CHAPTER 17

Common chemicals used by Farmers in Kenya

## A1.1 Insecticides

<table>
<thead>
<tr>
<th>TRADE NAME</th>
<th>ACTIVE INGREDIENT</th>
<th>USES</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actara 25WG</td>
<td>Thiamethoxam</td>
<td>Systemic broad spectrum insecticide for control of sucking and some chewing insects in vegetables, tobacco ornamentals and flowers and leaf miner in coffee.</td>
<td>3-7 days</td>
</tr>
<tr>
<td>Asataf</td>
<td>Acephate</td>
<td>Insecticide for use in control of aphids and thrips on flowers and vegetables. Aphids, white flies and bud worms on tobacco.</td>
<td>3-7 days</td>
</tr>
<tr>
<td>Bulldock 025EC</td>
<td>Beta Cyfluthrin</td>
<td>Insecticide for control of biting and sucking insecticides.</td>
<td>7 days</td>
</tr>
<tr>
<td>Bulldock Star</td>
<td>Beta Cyfluthrin + Chlorpyrifos</td>
<td>Broad spectrum insecticide for control of aphids in barley. Aphids, whiteflies and caterpillar in tomatoes, beans, egg plants and kales. Thrips in tomato, beans, egg plants and kales. Boll worms, aphids and cotton strippers in cotton.</td>
<td>7 days</td>
</tr>
<tr>
<td>Confidor 200SL</td>
<td>Imidacloprid</td>
<td>Insecticide for control of coffee leaf miner (Soil drenching)</td>
<td>3 days</td>
</tr>
<tr>
<td>Decis 0.5 ULV</td>
<td>Deltamethrin</td>
<td>Insecticide for use in cotton, vegetables, cereals and ornamentals</td>
<td>1 day</td>
</tr>
<tr>
<td>Decis 2.5EC</td>
<td>Deltamethrin</td>
<td>Insecticide for use in cotton, coffee, fruit trees, vegetables, ornamentals and cereals for maize stock borer control.</td>
<td>1 day</td>
</tr>
<tr>
<td>Decis Tab</td>
<td>Deltamethrin</td>
<td>Insecticide for control of bean flower thrips, aphids, white flies in French beans, tomatoes. Boll worms on tomatoes</td>
<td>1 day</td>
</tr>
<tr>
<td>Duduthrin 1.7EC</td>
<td>Lambda Cyhalothrin</td>
<td>Insecticide for use on cotton, horticultural crops, cereals, ornamentals</td>
<td>1-7 days</td>
</tr>
<tr>
<td>Dynamec 1.8 EC</td>
<td>Abamectin</td>
<td>Control of diamond back moth and aphids on kales. Bean flower thrips on French beans. It has miticidal activity.</td>
<td>3-7 days</td>
</tr>
<tr>
<td>Karate 2.5WG</td>
<td>Lambda Cyhalothrin</td>
<td>Control of aphids thrips, caterpillars and white flies on vegetables</td>
<td>1-7 days</td>
</tr>
<tr>
<td>Kelthane 18.5EC</td>
<td>Dicofol</td>
<td>Controls mites in cotton, Fruit crops, berries, nuts, vegetables, tea and ornamentals</td>
<td>3-7 days</td>
</tr>
<tr>
<td>Lannate 25WP</td>
<td>Methomyl</td>
<td>Control of thrips, aphids and caterpillars on French beans. Aphids, saw flies, white flies, and diamond back moth on cabbage.</td>
<td>1 day</td>
</tr>
<tr>
<td>Omite 57EC</td>
<td>Propargite</td>
<td>Control of mites on cotton, ornamentals/flowers</td>
<td>7 days</td>
</tr>
<tr>
<td>Ortus 5SC</td>
<td>Fenpyroximate</td>
<td>Insecticide/miticide for control of red spider mite on vegetables</td>
<td>1 day</td>
</tr>
<tr>
<td>Talstar 50EC</td>
<td>Bifenthrin</td>
<td>Insecticide/miticide on cotton.</td>
<td>3 days</td>
</tr>
<tr>
<td>Mitac 20EC</td>
<td>Amitraz</td>
<td>Miticide/Insecticide control of mites and white flies in cotton, fruits, vegetables, ornamental or flowers</td>
<td>7-14 days</td>
</tr>
<tr>
<td>Nemacur 400EC</td>
<td></td>
<td>Insecticides/Nematicide for use with drip irrigation (on flowers).</td>
<td></td>
</tr>
</tbody>
</table>

## A1.2 Biological Pesticides
<table>
<thead>
<tr>
<th>TRADE NAME</th>
<th>ACTIVE INGREDIENT</th>
<th>USES</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achook EC</td>
<td>Azadirachtin</td>
<td>Neem based insecticide for control of insect pests in horticultural crops</td>
<td>N/A</td>
</tr>
<tr>
<td>Neemroc EC</td>
<td>Azadirachtin + Neem</td>
<td>Neem based insecticide for use in horticultural crops</td>
<td>N/A</td>
</tr>
<tr>
<td>Neemros</td>
<td>Azadirachtin</td>
<td>Neem based insecticide for use in horticultural crops</td>
<td>N/A</td>
</tr>
<tr>
<td>Pesthin 6% EC</td>
<td>Pyrethrin</td>
<td>Control of caterpillars, aphids, thrips on brassicas and French beans</td>
<td>N/A</td>
</tr>
<tr>
<td>Nimbecidine EC</td>
<td>Azadirachtin</td>
<td>Neem based insecticide for use in horticultural crops</td>
<td>N/A</td>
</tr>
<tr>
<td>Thuricide HP</td>
<td>Bacillus thuringiensis</td>
<td>A bacteria culture for control of caterpillars.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### A1.3 Fungicides

<table>
<thead>
<tr>
<th>TRADE NAME</th>
<th>ACTIVE INGREDIENT</th>
<th>USES</th>
<th>PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amistar 250SC</td>
<td>Azoxystrobine</td>
<td>Broad spectrum foliar fungicide for the control of leaf rust, leaf and glume in barley spot brotch, net brotch and scald in wheat.</td>
<td>3 days</td>
</tr>
<tr>
<td>Antracol WP 70</td>
<td>Propineb</td>
<td>Broad spectrum for control of fungal diseases on vegetables fruit crops, ornamental/flowers. On potatoes and tomatoes to control late and early blight.</td>
<td>7 days</td>
</tr>
<tr>
<td>Cobox WP</td>
<td>Copper oxychloride</td>
<td>Control of coffee berry disease and leaf rust on coffee. Also blights and leaf spots in vegetables</td>
<td>7 days</td>
</tr>
<tr>
<td>Copper nodox</td>
<td>Cuprous oxide</td>
<td>Control of coffee berry disease and leaf rust on coffee. Also blights and leaf spots in vegetables, tomatoes and potatoes</td>
<td>7 days</td>
</tr>
<tr>
<td>Cosavet DF</td>
<td>Sulphur</td>
<td>Control of powdery mildew in vegetables</td>
<td>1 day</td>
</tr>
<tr>
<td>Cupravit 50WP</td>
<td>Copper oxychloride</td>
<td>Control of leaf rust in coffee and vegetables</td>
<td>7 days</td>
</tr>
<tr>
<td>Cuprocaffaro WP</td>
<td>Copper oxychloride</td>
<td>Control of coffee berry and leaf rust on coffee. Use on potatoes and tomatoes against early blight, cucurbits and brassicas against anthracnose. Bean rust, bacterial blight in cucurbits and brassicas.</td>
<td>7 days</td>
</tr>
<tr>
<td>Daconil 2787 WP</td>
<td>Chlorothalonil</td>
<td>Broad spectrum protectant fungicide for control of coffee berry disease and many diseases in fruits, vegetables, ornamentals and citrus against fruits and leaf spots.</td>
<td>7 days</td>
</tr>
<tr>
<td>Daconil 720SC</td>
<td>Chlorothalonil</td>
<td>Contact fungicide for control of coffee berry disease, bean rust, angular leaf spot, anthracnose and botrytis on French beans. Aschochyta and botrytis on snow peas</td>
<td>7 days</td>
</tr>
<tr>
<td>Dithane M45</td>
<td>Mancozeb</td>
<td>Control of rusts, leaf spots on French beans.</td>
<td>3-14 days</td>
</tr>
<tr>
<td>Equation pro</td>
<td>Famoxadine + Cymoxanil</td>
<td>Broad spectrum and penetrating fungicide against early and late blight on potatoes, downy mildew on snow peas, sugar snaps, onions and ornamental, powdery mildew on cucurbits, bean rusts, bean anthracnose and angular leaf spot on French beans.</td>
<td>3 days</td>
</tr>
</tbody>
</table>
CHAPTER 18

Natural enemies

<table>
<thead>
<tr>
<th>TRADE NAME</th>
<th>SUBSTANCE</th>
<th>USES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thuricide HP</td>
<td><em>Bacillus thuringiensis</em></td>
<td>Biological insecticide for control of Lepidoptera larva and other pests on vegetables eg Giant Lopper, green lopper, leaf skeletonizers and jelly grab in coffee</td>
</tr>
<tr>
<td>BB Plus</td>
<td><em>Beauveriabassiana</em></td>
<td>Natural fungal organism for control of white flies, thrips, aphids, mites and scales</td>
</tr>
<tr>
<td>Amblytech</td>
<td><em>Amblyseius californicus</em> (Predatory mites)</td>
<td>An indigenous natural enemy for control of red spider mite on vegetables.</td>
</tr>
</tbody>
</table>
# CHAPTER 19

## Organic products in the markets

<table>
<thead>
<tr>
<th>PRODUCTS TRADE NAME</th>
<th>ACTIVE INGREDIENT</th>
<th>PCPB NO.</th>
<th>TARGETS</th>
<th>DOSAGE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC-3</td>
<td>Garlic Extracts</td>
<td>PCPB(CR)0787</td>
<td>✓ Powdery mildew, ✓ Leaf spots ✓ A good insect repellant</td>
<td>3ml per lit</td>
<td>Spray at first instance of infestation for effective management of powdery mildews, alternate GC-3 with Fosphite</td>
</tr>
<tr>
<td>PL PLUS</td>
<td>Paecilomyces cesilacinus</td>
<td>PCPB(R)0472</td>
<td>✓ Nematodes</td>
<td>2kg per Ha</td>
<td>Biological Nematocides that lasts in media/soil killing nematode eggs, nymphs, young juveniles and adults</td>
</tr>
<tr>
<td>PYEGAR</td>
<td>Natural Pyrethrins + Garlic extracts</td>
<td>PCPB(CR)0794</td>
<td>✓ Controls Aphids, ✓ mites, ✓ bollworms, ✓ caterpillars, ✓ Whiteflies and scales</td>
<td>3ml per lit</td>
<td>Good biological pesticide which is also a repellant to insect pests</td>
</tr>
<tr>
<td>FOSPHITE 53SL</td>
<td>Mono and Di-potassium Phosphite</td>
<td>PCPB®0365</td>
<td>✓ Blights, ✓ mildew, ✓ rots, ✓ Pythium, dumping off, leafspot</td>
<td>Soil drench or foliar spray 3-5mls per lit</td>
<td>A systemic fungicide with both curative and protective properties against a wide range of rangeof plant disease.</td>
</tr>
<tr>
<td>ROOTGARD</td>
<td>Fungi, bacteria and enzymes</td>
<td>PCPB(CR)0796</td>
<td>✓ Fusarium, ✓ Pythium ✓ Caterpillars, ✓ DBM botrytis and solubilisation of bonded phosphates</td>
<td>2-4kg per Ha</td>
<td>Good soil conditioner containing 14 microorganisms. A rare product with both insecticidal and fungicidal activity.</td>
</tr>
<tr>
<td>Natural Wet</td>
<td>Saponins</td>
<td>N/A</td>
<td>✓ When applied in the soil, it facilitates nutrient and water absorption into the plant and stimulates plant growth and development ✓ Sticker and very compatible with most products</td>
<td>5mls/20liters of water</td>
<td>A Botanical soil conditioner and organic wetter. Can be applied as a foliar spray or as a drench.</td>
</tr>
</tbody>
</table>
| Mycomax | Mycorrhizal Fungi | N/A | ✓ The fungi play an important role in plant physiology.  
✓ Mineral nutrition,  
✓ water absorption and disease resistance. | 2kgs/Acre | Plants may exhibit nutrient deficiencies and reduced vigor without the symbiotic relationship with mycorrhizal fungi |
| --- | --- | --- | --- | --- | --- |
| Pyneem | Natural Pyrethrins and Neem oil | 3mls/liter | ✓ Management of a wide range of pests including bollworms, caterpillars, thrips, aphids, scales, whiteflies and mites.  
✓ It can be used on cotton, coffee, cabbages, tomatoes, beans, oranges, mangoes, roses and carnations. | It can be used on cotton, coffee, cabbages, tomatoes, beans, oranges, mangoes, roses and carnations. It can be used during harvesting as it will not leave residuals on the produce. |
| Pyerin | Natural pyrethrins, Neem oil and garlic extracts | PCPB(CR) 0795 | ✓ Management of a wide range of pests including bollworms, caterpillars, thrips, aphids, scales, whiteflies and mites  
✓ Pathogenic plant nematodes. | 3mls/liter | It can be used in a wide range of crops including beans, tomatoes, oranges, mangoes, roses, beans, hypericum, runner beans, snow peas and carnations. Can be applied as a soil drench for the control of nematodes and as a foliar spray |
| Humax | Humic acid | N/A | ✓ It is a soil conditioning agent,  
✓ Improves soil structure, stimulates the activity of soil micro-organisms,  
✓ Promotes seed germination, enhances nutrient uptake thereby promoting plant growth, | 2kgs/ha | Aids in the conversion of nutrients into available form, increases soil's water holding capacity and increases soil aeration, tilth and workability. |

Annex 1: Table 2. monthly cropping calendar of activities
I. Seed preparation  
1. Seed selection  
2. Seed treatment  

II. Seedling production  
1. Seedbed preparation  
2. Sowing  
3. Fertilization  
4. Mulching  
5. Hardening

III. Land preparation  
1. Seedbed preparation  
2. Sowing  
3. Fertilization  
4. Mulching  
5. Hardening

IV. Fertilization  
1. organic (chicken dung; compost)  
2. inorganic (commercial; NPK)

V. Irrigation  
1. Drip irrigation  
2. Rain fed  
3. overhead

VI. Pests  
1. Weeds  
2. Insect pests  
3. Diseases 
4. Slugs and snails  
*Innumerate the name of the pests*

VII. Pest control  
1. Herbicides (organic, inorganic)  
2. Insecticide (organic, inorganic)  
3. Fungicide (organic, inorganic)  
4. Natural enemies  
5. Traps and baits

VIII. Harvesting

IX. Post harvest

Annex 2: Table 3: Weekly activities

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<th>Field activities</th>
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<td>Annex 4: Table: 4. Crop lifecycle</td>
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<td><strong>Growth stages</strong></td>
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<td>Vegetative (true leaf development until cupping)</td>
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<td>Maturation (early head formation until head fill) harvesting</td>
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**Parasitoid rearing unit**
GLOSSARY

Absorption: The process by which a chemical product and/or micro-organisms passes through an organism’s natural barriers.

Active Ingredient: The biologically active portion of a pesticide present in a formulation.

Biological Control: Use of natural enemies from the animal or plant kingdom to control pests.

Biological Product: An organism, a substance or a preparation used to control pests, whose active ingredient consists of living organisms or products of their metabolism.

Blanching: It means bending four or five of the large, outside leaves over the crown of a cole crop, then tucking the leaf tip into the opposite side.

Brassicas: Common name for crops such as cabbage, rape, broccoli, kales, turnips e.t.c due to them being in the brassicaceae family. This family is also known as Cruciferae so some people call these crucifers.

Compost Manure: Plant material which has been piled up and left to rot, break down, release nutrients and kill the pests and pathogens which may be present. This manure is then added to the soil to improve soil structure and fertility.

Control: Successfully killing or reducing pests and pathogens to economically acceptable levels.

Defoliation: Causing leaves to fall off.

Distortion: Abnormal change of plant shape or appearance often caused by pests or diseases.

Dose: The amount or portion of an active ingredient or preparation applied per unit of treated material.

Drench: Use of high volumes of dilute pesticide solution applied directly to the soil with sprayer or bucket to control pests and diseases in the soil.

Drip irrigation: Type of irrigation where water is supplied directly to plants through small holes in pipes laid on or in the soil next to crop rows.

Extension Service: Those entities in the country responsible for the transfer of information and advice regarding agricultural practices with a view to improving production, handling, storage and marketing of agricultural commodities.

Field hygiene: Taking care not to spread diseases and pests on to new crops by removing crop debris from previous diseased crops.

Fungicide: An active ingredient or formulated product that kills moulds and fungus.

Furrow irrigation: Type of irrigation where water is channeled down furrows which run beside the crop rows.

Gall: A swelling on plants (roots) caused by disease like club root on cabbage.

Growth Regulators: Product that affects physiological mechanisms, particularly cell growth and differentiation, after penetrating and circulating inside the plant without destroying it. This action usually triggers a change in the plant’s morphology and structure (the term “growth regulator” is inaccurate because it implies regularity).

Herbicide: An active ingredient or formulated product that kills vegetation.

Honeydew: Sticky sugary substance excreted by pests which suck plant sap such as whitefly and aphids.

Insecticide: An active ingredient or formulated product that kills insects.
**Integrated Pest Management (IPM):** An ecologically based pest control strategy that relies heavily on resistant crops, hygiene and natural predators, parasitoids and tries to disrupt these factors as little as possible by only using appropriate chemical pesticides when necessary.

**Label:** The written, printed or graphic matter on, or attached to, the pesticide or the immediate container thereof and also to the outside container or wrapper of the retail package of the pesticide.

**Mulching:** Covering the surface of the soil with material such as crop residues, compost or plastic sheeting to reduce water loss, splashing and break some pest life cycles.

**Nutrients:** Chemicals in the soil made available either from breakdown of organic matter or added by farmers as artificial fertilizer which plants use for growth.

**Pathogen:** Infectious micro-organism which can cause disease.

**Pesticide:** It is a synthetic (man-made), biological (containing a living organism) or botanical (made from plant extract) product designed to kill pests (including diseases).

**Post-Emergent Treatment:** Treatment applied after the weed or crop has emerged from the soil. It should be specified whether the treatment is postcrop emergent or post-weed emergent.

**Post-Plant Treatment:** Treatment applied immediately after planting.

**Pre-Emergent Treatment:** Treatment applied before the crop or weed has emerged from the soil.

**Pre-Harvest Interval (PHI):** The minimum number of days that must pass between the last application of a pesticide and the start of harvesting.

**Pre-Plant Treatment:** Treatment applied before planting a crop.

**Product:** A pesticide in the form in which it is packaged and sold; it usually contains an active ingredient plus adjuvant and must be diluted before use.

**Residue:** Any specified substances remaining on or in food, agricultural commodities, or animal feed. The term includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance. The term “pesticide residue” includes residues from unknown or unavoidable sources (e.g. environmental) as well as known uses of the chemical.

**Roguing:** This is destroying plants which are affected/infested by pests or diseases in order to prevent infestation/infection from spreading to other plants in the field.

**Sap:** Plant juices containing water and nutrients.

**Solarization:** Covering the soil with plastic (preferably clear) so that hot sunshine will heat the soil and kill pests and diseases in it.

**Susceptible:** Capacity to be affected by something.

**Spray:** A solution or suspension, usually in water, to be applied by spraying, watering or dipping, containing formulated products and sometimes adjuvants.

**Stunted:** Plants which are small and poorly developed.

**Systemic:** A substance or preparation that acts after being absorbed and translocated from one organ to another in the treated plant.

**Tolerance:** A plant’s capacity to withstand attack from pests, so that damage does not cause economic injury.
Trap crop: Crop which is planted to attract a pest and is then destroyed together with the pest.

Treatment: The application or introduction of one or more physical, chemical or biological agents to protect or improve agricultural production.

Variety: The particular type of crop being grown, with its own characteristics such as yield potential, disease resistance and time to maturity.

weed: Any plant growing where it is not wanted.
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Vegetables constitute the fourth largest among the major food groups and agricultural commodities. Cabbages (Brassica oleracea Var. capitata) are one of the most widely grown vegetable crops in Kenya. The crop is mostly sold in the local markets with almost negligible exports. These crops are highly nutritious and are an excellent source of vitamins and minerals required for the well-being of a population and can economically (income), are produced on small land parcels and take relatively short periods to mature. High incidences of pest and diseases infestation, lack of high quality seeds as well as inadequate knowledge and skills on Good Agricultural Practices are among the major constraints to low yields in cabbage production.

Pests and diseases are a major constraint in vegetable production in Kenya causing yield losses ranging from 50 -100%. Diamond-back Moth, Plutella xylostella, is the most damaging insect pest of crucifer and difficult to control. The pest infestations are more serious during the warm and dry weather periods. Farmers rely heavily on pesticide-based management strategies that are a health hazard to the farmer and the environment. Furthermore some of the pests have developed resistance to organophosphates and pyrethroids thus complicating their management. Progress has been made on testing and promoting the use environmentally safe control methods such as biological control to reduce health risks to farmers, consumers and the environment. Cultural cultivation practices like mulching, crop rotation; minimum tillage and field sanitation were used for management of some of the diseases. During the project duration progress was made in developing a need based use of insecticides and use biological control methods such as use of parasitoid, biological pesticides and good agronomic practices in order to increase production and lower production costs these was achieved during the period.