



BASICS OF CABBAGE PRODUCTION

A compilation of EME DEN Kenya Farmers for the farmers

The basics of cabbage production
from nursery to harvest

EMEDEN KENYA FARMERS

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Introduction.

CABBAGE is one of the oldest and most widely grown vegetable of the Brassica group, belonging to the mustard family. The word cabbage is a derivation of the French word caboche, a colloquial term for "head." The other members of this group include broccoli, brussel sprouts, cauliflower, chinese cabbage, kale, kohlrabi, and turnips.

Cabbage is distinguished from them by the short, petiole leaves and later development of a compact head, by compressed stem and leaves, the latter developing from within but swelling outward. Selective breeding has produced several distinct types of cabbage: early, midseason, and late; green and purple; large and small heads; flat, oval, conical and globular; savoy types; and those with either smooth or crumpled leaves.

Cabbage is a hardy vegetable that grows especially well in fertile soils and cool temperatures. It is a good source of vitamins "C" and sulfur plus contains glutamine and amino acid. Cabbage has recently been shown to have disease-preventive properties as well. It is a great source of vitamin.

Varieties in Kenya

1. COPENHAGEN MARKET: has large round heads with remarkable sales appeal. It is one of the most popular for home and market gardening. It is a very productive strain; small to medium plants with short stems. They mature early and should be harvested immediately as it is prone to cracking if left for too long.
2. SUGAR LOAF: is one of the finest cabbages for African conditions. It has conical shaped head. It is crisp and sweet and has high market demand. The plants are large and grow well under high rainfall conditions, otherwise they require liberal watering. Early maturing of small to medium quality cabbage.
3. GLORIA F1 HYBRID: it is one of the best F1 cabbages on fresh market processing industry. It is a heavy yielder of top-quality heads. It has blue green color and a thick waxy layer. It has strong rooting and tolerates Black rot diseases. It is also resistance to heat and bolting. Spacing adjustment results in weights of uniform heads between 2 to 7kg. Has good resistance to splitting and keeps well after harvesting.
4. PRUKTOR F1 HYBRID: it has medium sized cabbage with round grey green heads of 3 - 4 kgs which mature 70 -80 days after transplanting. This variety stands for a long time without splitting. It has extremely good internal quality and sweet flavour.
5. CHIHILI is one of the most important chinese cabbage variety. It is uniform and vigorous, producing pale green loaf like heads with pure white core, widely adapted will produce abundance of leaves even where other cabbage varieties will not grow. It is slightly pungent in flavour. It is easy to grow but prone to bolting below 15 degrees celsius.

Propagation

Land Preparation

The selected land should have plenty of sunshine. It is advisable to prepare the land in advance of one month. This will allow organic matter to decompose and mix with the soil well. Land should be nutrient-rich and well tilled to a depth of at least six inches. Loosen soil in the planting bed and mix in a two-inch layer of compost along with a standard application of a balanced organic fertilizer or manure. Soil should be well-draining because if cabbage roots stand in water it will cause heads to split or rot. The best pH range of the soil for cabbage farming should be within 5.5-6.5. It is recommended to test the soil before planting to make it easier to design a soil management program for optimum production

Nursery bed preparation

The site selected for the nursery should be near the proposed land on which cabbage will be grown. This will lessen damage to seedlings during transplanting.

After site selection, prepare the land to a fine soil tilth. Raised beds of size 3 x 0.6 m and 10-15 cm in height are prepared. About 70cm distance is kept between two beds to carry out intercultural operations such as watering, weeding, etc. The surface of beds should be smooth and well levelled. Well-decomposed Farmyard Manure at the rate of 2-3 kg/m² is added at the time of bed preparation. Raised beds are necessary to avoid problem of water logging in heavy soils.

Charcoal dust and ashes can also be mixed in the bed to correct the acidity of soil and keep away worms. Note that inorganic fertiliser can also be added during bed preparation at rate of 900gm of 5-10-5 NPK fertiliser per 9m² of bed area.

Apply earth-friendly systemic fungicide as a soil drench to destroy any fungi that might be present in the soil and protect the seed from fungal infections

Raising of Seedlings:

To plant one acre of cabbage, about 100 to 200g of seed required to be planted in the nursery. Before planting the seed in the nursery, treat them with fungicide to prevent damage from damping-off disease. Sowing should be done thinly in lines spaced at 5-7 cm distance, at a depth of fingernail deep (1-2 cm) and covered with a fine layer of soil followed by light watering by water can. The beds should then be covered with dry straw or grass or sugarcane leaves to maintain required temperature and moisture. The watering should be done by water can as per the need till germination is completed. The cover of dry straw or grass is removed immediately after emergence of seed sprout. If there is over crowding of seedling due to thick sowing, the extra seedlings should be thinned out

The seedlings should be transplanted within 4-6 weeks of sowing or when the transplant is 10 - 15cm tall. Older seedlings when transplanted result in poor growth and yield.

Transplanting

Before transplanting, irrigate the land and transplant during the cooler times of the day into prepared holes. Once they are in, press down firmly and tamp down the soil around the plant.

The transplants can be hardened off by removing the shade a day before transplanting to give the seedling a chance to get used to the direct sun and expose them to field conditions to reduce transplanting shock. Transplant only healthy seedlings with good growth points and discard any that look weak, leggy or unhealthy. The plants should receive water as soon as transplanting is done.

Spacing

The planting distance depends on the cabbage and the target market. Varieties with big heads need more space than the smaller varieties. Small head cultivars plant 30 cm apart in the row with 50 cm between rows, while big head varieties plant 50 cm apart in the row and 70 cm between the rows. The closer the spacing, the smaller the heads. Early varieties are usually planted 30cm apart in all directions. Meanwhile, get the land ready to receive the transplant by applying 8-10 MT/acre of well decomposed farmyard manure and mix well with the soil. Use planting fertilizer such as N:P: K, a base fertilizer rich in phosphorus on the planting hole at a rate of 10gms per hole. Irrigation should be done early or mid-morning. Side-dress with nitrogen fertilizer 2-3 weeks after transplanting with nitrogenous fertilizers. Cultivate shallowly to keep down weeds. Ample soil moisture is necessary throughout the growing season to produce good cabbage. Irrigation is especially important to help the young plants withstand the intense sunlight and heat and to supply the developing heads with enough water to develop quickly.

Crop Management; fertilisers, water and weeds

Cabbage is a heavy feeder and does well fed with manure, compost and organic fertilisers. For the right fertiliser application, analyse the soil. Fertilizer requirement will depend on the soil analysis done prior to planting. However, the following is a guide 120: 60: 60 kg NPK/acre. Split applications are the most recommended. The first split of CAN is applied at 10gms per plant and then the first top dressing (2-3 weeks after transplanting) at the rate of 50 kg of C.A.N/Acre. The second split to be applied two weeks later at the rate of 5g per plant. It is important to avoid excessive nitrogen application as it causes slip heads. The second top dressing is to be done 3-4 weeks after transplanting) at the rate of 100 Kg of Ammonium Sulphate/ acre plus 30 kg of MAP/ acre mixed. Top dressing should be applied in bands and after each application earthing up of plants is necessary. Don't get the fertiliser on the cabbage plant.

Cabbage has shallow root system and hence requires frequent and light irrigations especially during head formation. It is critical for cabbages to have water immediately after sowing or transplanting. Young plants need enough water for growth before they form heads. The bigger the plant is at this stage, the larger the eventual head will be. About 35 mm a week is optimal. Too much water after the heads have formed, can cause them to crack which you do not want. Cracking can also happen when the crop gets water inconsistently.

Weed once the plants are established and carry on with weeding until the cabbage leaves cover the ground. Don't damage the roots when you weed mechanically. Irrigate during the growing period and mulch to conserve moisture. Incorporate crop residues into the soil immediately after harvesting.

Harvesting and Storage

Cabbage can be harvested any time after the heads form. Maturity depends on the variety grown. For highest yield, cut the cabbage heads when they are solid (firm to hand pressure) but before they crack or split. When heads are mature, a sudden heavy rain may cause heads to crack or split wide open. The exposed internal tissue soon becomes unusable. Harvest and salvage split heads as soon as possible after they are discovered. Cut the stem underneath the head with a sharp knife and detach the head from the plant but leave the leaves and other parts on the ground.

In addition to harvesting the mature heads of the cabbage, you can harvest a later crop of small heads (cabbage sprouts). These sprouts develop on the stumps of the cut stems. Cut as close to the lower surface of the head as possible, leaving the loose outer leaves intact. Buds that grow in the axils of these leaves later form sprouts. The sprouts develop to 2 to 4 inches in diameter and should be picked when firm, as a little cabbage that has a great flavor.

Field heat should be removed as quickly as possible to ensure maximum storage life. Store cabbage in a cold, moist place—32°-40°F (0°-4°C) and 95 percent relative humidity. Cold and moist storage is a challenge to create. It is much easier to maintain both the temperature and relative humidity at the optimum level in refrigerated storages than in common or unrefrigerated storages. Continued ventilation in a common storage, to obtain the desired storage temperature, usually leads to low humidity.

Use pallet boxes to store cabbage because these containers facilitate both the loading and unloading of the storage and can be easily arranged in the storage to maximize air circulation which greatly improves the maintenance of an even temperature throughout the storage.

When not in use pallet boxes should be stored outside and subjected to the sun and light to control fungi which develop on the wood. These fungi can cause the staining of cabbage in storage.

Cabbage can be stored in bulk successfully if carefully handled and piled to a depth of no more than 1.5 meters with ample aeration of the pile using forced air.

Pests and Diseases

Various pests and diseases that attack cabbage can lead to serious economic losses. Cabbage farmers can use Integrated Pest Management (IPM) strategies, including scouting, crop rotation, good management and chemical and mechanical controls.

Diseases and their control

1. Black Rot (*Xanthomonas campestris* pv. *campestris*): This bacterial disease is common in areas having a warm and wet climate. Plants can be infected during any growth stage and the symptoms resemble nutritional deficiencies. Infected seedlings become yellow, drop lower leaves, and may die. Leaves may be affected on only one side of a seedling. Plants infected because of contaminated seed may not develop symptoms for many weeks. The classic symptom of black rot is caused by local infection that results when bacteria enter leaves through natural openings of leaf margins. The infected tissue turns pale green-yellow and

then turns brown and dies. Affected areas are usually wedge- or V-shaped. These areas enlarge as the disease progresses, and severely affected leaves may drop off. The veins in infected leaves, stems, and roots sometimes become black. The heads of the infected plants remain small and its quality is reduced making it unfit for marketing.

Control: An integrated approach is needed to manage black rot successfully. Use of black rot tolerant varieties is the best method to control the disease. Considerable reduction in disease has been observed when seeds are treated with Agrimycin-100 (100ppm) or Streptocycline (100 ppm). Planting should be done on raised beds to facilitate drainage. Cultivation in the fields where crucifers have been continuously grown during last 2 years should be avoided. Plants should be thoroughly inspected for black rot symptoms and the affected plants should be removed and destroyed.

2. Downy Mildew (*Peronospora parasitica*): The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread. The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface. The spots turn yellow as they enlarge. During periods of high humidity, a grayish white moldy growth is developed on the undersurface of the leaf. Later the leaf may become papery and die. Cabbage heads develop sunken black spots. Though, some plants are infected at the seedling stage, the symptoms do not become apparent until near harvest.

Control: All the weeds serving as alternate host to the fungus should be destroyed. The crop should be irrigated judiciously to avoid periods of high humidity. Spraying the seedlings in the nursery beds with Copper Oxychloride (0.3%) is effective in controlling the disease. The first spray should be given as soon as the seedlings appear. Subsequent sprayings are given at weekly intervals until the plants are transplanted in the field. For controlling the disease in the field, the crop is sprayed with Copper Oxychloride (0.5%).

3. Wire Stem (*Rhizoctonia solani*): This disease is more serious in nursery beds. The affected young seedlings show reddish brown discoloration of the stem near the ground level. This area gets constricted and the plants bent or twist without breaking. In some cases, the seedling continues to grow even though the lesion girdles the stem. The lesion is quite sunken, and the stem resembles a wire, hence the name 'wirestem'. The girdled seedling eventually dies. Cool, cloudy weather, high humidity, wet and compact soil, and overcrowding especially favours development of the disease.

Control: Soil used for preparing raised beds should be well- drained. Excessive irrigation should be avoided to reduce humidity around the plants. The seedlings in the seedbed should be adequately spaced to allow maximum air movement. While transplanting, the seedlings showing symptoms of 'wirestem' disease should be discarded. Preventive measures such as seed treatment with antagonist fungal culture of *Trichoderma viride* (3-4 g/kg of seed) or Thiram (2-3 g/kg of seed) are effective. Soil around the affected seedling should be drenched with Dithane M 45 (0.2%) or Bavistin (0.1%) to control the spread of the disease.

4. Leaf Spot and Blight (*Alternaria brassicae* and *A. brassiciola*): It is a destructive disease on seed crop. Older leaves are more susceptible. The initial symptoms are in the form of small dark yellow spots on the leaf surface. Later on, the spots enlarge to circular areas with concentric rings and possibly surrounded by yellow halos. In severe cases, the entire plant

defoliates. Violets to tan spots develop on infected cabbage seed pods which intensifies in wet weather.

Control: Use of disease-free seeds, practicing proper crop rotation and seed treatment with hot water (50°C for 30 minutes) helps to minimize the disease incidence. Crops grown for seed purpose should be sprayed at full bloom, pod set and pre-harvest stage with Captan (0.2%) or Copper Oxychloride (0.5%) for the control of disease.

5. **Yellows or Fusarium Wilt (*Fusarium oxysporum f. sp. conglutinans*):** The disease affects the seedlings in nursery stage; however, plants exhibit symptoms 2 to 4 weeks after transplanting. Disease development is promoted by warm weather conditions. Initial symptom appears as the development of yellowish green colour on one side of the plant. A lateral warping or curling of the stem and leaves occurs. The lower part of the leaf blade adjoining the petiole or midrib wilts and dies. The lower leaves turn yellow and later the upper leaves are affected. With time, the yellow leaves turn brown and the affected tissue becomes dry and brittle. The speed of progress of disease in the plant depends upon the degree of varietal susceptibility and the soil temperature.

Control: The conventional controls such as rotation, seed treatment, fungicide sprays, and destruction of crop refuse are of little value once the fungus has established itself on a farm or in a specific field. Therefore, the use of resistant varieties is the only control. However, as a preventive measure the vulnerable stage of the young seedlings to the infection can be avoided by very early sowing of cabbage.

6. **Black Leg (*Phoma lingam*):** This disease generally does not reduce seed crop yields; however, low levels of seed infection coupled with weather favorable for disease spread in seedbeds can lead to severe losses after transplanting. Pale, irregular spots develop on leaves, which later become ashy gray with scattered black dots on the surface. Stem lesions are elongated with purple borders near the ground level and extend below the soil surface, causing a black rot of lower stem and roots. Severely affected plants remain stunted and finally wilt. As plants mature, they fall sideways from lack of root anchorage. Seed crop symptoms include occasional cankers on stem bases and spots may appear on overwintered leaves. Symptoms on seed pods are rare and inconspicuous. Infection can spread to the base of leaves of cabbage heads in storage.

Control: Disease free seeds should be used for planting. As the main infection is through seeds, hot water treatment of seeds is recommended. For seed production plots, seed stock used should be free from fungal pathogen. Cultivation in the fields where crucifers have been continuously grown during last 2 years should be avoided. Seedbeds and seed plots should be regularly inspected for obvious foliar infections. Seedlings before transplanting should not be dipped in water. Plant debris and disease susceptible weeds should be removed and destroyed.

7. **Clubroot of Cabbage (*Plasmodiophora brassicae*):** Cool, wet and acidic soils favours the development and spread of the disease. Roots develop clubs (swellings) that can be 12-15cm wide. The largest clubs are usually on the larger roots just below the soil surface. Affected seedlings do not show any root swellings until about 3 weeks after infection. Infection in the nursery stage results in the death of seedlings. When plants are attacked at a later stage, the disease rarely kills the plant, but the capacity of the affected roots to absorb minerals and

water gets reduced. Plants wilt in hot weather but partly recover at night. Finally leaves become stunted, yellowish and prematurely bolt in hot weather.

Control: Early infection of seedlings can be destructive, so it is important to use only uninfected seedbeds and clean equipment. Long rotations (6 years or longer) help prevent a pathogen buildup and reduce disease incidence. When susceptible varieties are grown in acidic soils, finely ground limestone is thoroughly mixed into the soil six weeks before planting to raise the soil pH above 7.0. Lime inhibits disease development but will not prevent a disease outbreak if the spore load in the soil is sufficiently high. The quantity of lime is determined by initially measuring the pH of the soil.

8. **Sclerotinia rot/ White Mould (*Sclerotinia sclerotiorum*):** This fungus can cause serious losses in the field, in storage, and under transit and market conditions. Generally, damp weather favours the occurrence of the disease. Infections may occur on the stem at the ground level, on the leaves at their bases, or where the foliage comes in contact with the soil. The infections begin as water-soaked, circular areas, which soon become covered by white, cottony fungal growth. The affected tissue becomes soft and watery as the disease progresses. The fungus eventually colonizes the entire cabbage head and produces large, black, seedlike structures called sclerotia on the diseased tissue.

Control: The disease can be managed most successfully by combining cultural practices that discourage disease development. Planting cabbage in fields that are surrounded by dense woods will restrict air circulation and subsequently delay drying. Rows should be planted in the direction of the prevailing winds to promote free flow of air movement within the plants. Fields with a history of white mold should be planted with non-susceptible crops such as grains (corn, rye, wheat, etc.). Cabbage and other susceptible crops (cauliflower, beans, peas, etc.) should not be planted in fields where white mold has become a problem because continuous cropping of susceptible crops will result in a buildup of the fungus in the soil and increased disease incidence. Mechanical injuries to cabbage heads during harvesting operations should be avoided.

9. **Damping off (*Pythium debaryanum*):** The disease causes severe damage in the nursery. Cool, cloudy weather, high humidity, wet soils, compacted soil, and overcrowding especially favor development of damping-off. Damping-off kills seedlings before or soon after they emerge. Infection before seedling emergence results in poor germination. If the decay is after seedlings emergence, they fall over or die which is referred to as "damp-off." The destructiveness of the disease depends on the amount of pathogen in the soil and on environmental conditions. Seedlings that emerge develop a lesion near where the tender stem contacts the soil surface. The tissues beneath the lesion become soft due to which the seedlings collapse.

Control: In the nursery, soil used for preparing raised beds should be well- drained. Excessive irrigation should be avoided to reduce humidity around the plants. Seed treatment with antagonist fungal culture of *Trichoderma viride* (3-4 g/kg of seed) or Thiram (2-3 g/kg of seed) and soil drenching with Dithane M 45 (0.2%) or Bavistin (0.1%) affords protection against the disease. The nursery should be regularly inspected for the disease affected seedlings. Such seedlings should be removed and destroyed.

Pests and their control

1. Cabbage Diamondback Moth (DBM) (*Plutella xylostella*): It is one of the most serious pests of cabbage grown under comparatively high temperature conditions. The DBM derives its name from the white markings along the back of the forewings which when folded form a diamond shaped pattern. The caterpillars are green or brownish green in colour. The adult female lays eggs on the leaves either singly or in groups. Small slender green caterpillars on emergence feed on the leaf epidermis and later make holes in the leaves. Severely affected leaves are completely skeletonised. Pupation takes place in a loose mesh of silken cocoon spun by the caterpillar.
Control: Spraying the crop with Malathion (0.1%) or Profenofos (0.25-0.5 kg a.i./ha) gives excellent control of the larvae. Intercropping mustard in the cabbage crop 15 days prior to sowing and 25 days after planting cabbage was effective. As the pest preferred mustard, major pest population is attracted towards it, which can be destroyed by spraying the crop with Dichlorvos (1 ml/ litre of water).
2. Leaf Webber (*Crocidolomia binotalis*): It is one of the most destructive pests of cabbage. Eggs are laid in clusters on the undersurface of the leaves and held together by gelatinous glue. Green caterpillars web up the leaves and live inside the knotted mass. Flowering and pod formation are adversely affected. **Control:** Removal and destruction of webbed bunches of leaf help to check the further spread of the disease. Dusting the crop with Carbaryl (4%) or spraying with Malathion (0.05%) is effective.
3. Cabbage Borer (**Hellula undalis**): The adult female lays eggs on the growing point or on the older leaves. The pale-whitish caterpillars mine the foliage, feed on the shoots and finally bore into the stem. As a result, the infested plants are killed or produce side shoots, which do not form heads.
Control: Spraying the crop with Malathion (0.1%) or dusting 4% Carbaryl gives excellent control of the larvae.
4. Cabbage Butterfly (*Pieris brassicae*): The larvae of the pest after hatching from the eggs feed gregariously on the foliage and burrow into the heads. In case of severe cases the heads become completely unfit for marketing.
Control: The caterpillars should be handpicked and destroyed. Spraying the crop upon the emergence of the pest with Malathion (0.1%) or dusting Carbaryl (0.15%) gives excellent control of the pest.
5. Aphids (*Brevicoryne brassicae*, *Myzus persicae*, *Lipaphis erysimi*): Yellowish green nymphs and adults suck cell sap and devitalize plants. Affected parts become discolored and malformed. High humidity favours rapid multiplication of this pest. The aphids are mostly observed on the lower surface of the leaves.
6. **Control:** Spraying of Monocrotophos (0.05%) or Malathion (0.1%) at 10-15 days interval contains aphid population effectively. To prevent recurrence of the pest granular insecticides like Phorate @ 1.0 kg a.i./ha should be applied to soil.

Common Problems in cabbage

1. Splitting is caused by the pressure of excessive water taken up after the heads are solid. Cutting the roots (spading on two sides of the plant) or breaking the roots (lifting and

twisting the head to one side) can often reduce excessive splitting or bursting, but it also damages the plant and requires that the head be harvested relatively soon.

2. Cabbage plants "bolt" (form premature seed stalks) when they are exposed to low temperatures (35 to 45 degrees F) for extended periods. Such chilling may happen if plants are set out too early or if an unseasonable blast of cold assaults the garden. After the plants have stems as large as a pencil, they are subject to this "cold conditioning," that initiates the flowering response.
3. Swellings and distorted roots on stunted, wilted plants may be symptoms of clubroot disease. This disease is caused by a fungus that remains in the garden soils for many years once it becomes established. It is spread by movement of infested soil and infected transplants. Other related cole crops (like broccoli and cauliflower) also may become infected. If, in fact, you have clubroot in a location, destroy infected plant parts (including the roots) and for at least 4 years avoid planting any member of the cabbage family there, including radishes, turnips and ornamental relatives of cabbage.

Nutritional Value

As with broccoli, cabbage is a cruciferous vegetable and may reduce the risk of some forms of cancer including colorectal cancers. Cabbage is also high in beta-carotene, vitamin C and fiber. Other substantial nutrients in a half cup cooked cabbage include the following:

1. Calories: 22
2. Protein: 1 gram
3. Fiber: 2 grams
4. Vitamin K: 85% of the RDI
5. Vitamin C: 54% of the RDI
6. Folate: 10% of the RDI
7. Manganese: 7% of the RDI
8. Vitamin B6: 6% of the RDI
9. Calcium: 4% of the RDI
10. Potassium: 4% of the RDI

Other benefits of cabbage include

1. It is a low-calorie vegetable that is rich in vitamins, minerals and antioxidants.
2. contains powerful antioxidants that may help reduce inflammation.
3. it is a potent antioxidant. Red cabbage is particularly high in this nutrient, providing about 85% of the RDI per cup (89 grams).
4. contains insoluble fiber, which keeps the digestive system healthy by providing fuel for friendly bacteria and promoting regular bowel movements.
5. contains powerful pigments called anthocyanins, which have been shown to reduce the risk of heart disease
6. Contains potassium helps keep blood pressure within a healthy range. Increasing your intake of potassium-rich foods like cabbage may help lower high blood pressure levels.
7. It is a good source of soluble fiber and plant sterols. These substances have been shown to reduce LDL cholesterol.

8. Contains Vitamin K which is critical for blood clotting. Cabbage is an excellent source of vitamin K1, with 85% of the RDI in 1 cup (89 grams).
9. It is a versatile veggie that's easy to incorporate into your diet. You can use it to make many different dishes, including salads, stews, soups, slaws and sauerkraut.

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