Cabbage:

Introduction:

Cabbage (*Brassica oleracea* var. *capitata)* is a leafy vegetable belongs to Cruciferae family. It is an annual leafy plant with purple or green leaves. The edible part of Cabbage is known as **"Head".** Cabbage leaves are low in calories, fat and Carbohydrates. It is a good source of protein, calcium, magnesium and minerals.

Cabbage is commonly used as cooked vegetable, but sometime it is also served with tomatoes, carrot as salad. Flavor in cabbage is due to glycoside called **"Sinigrin".**

Season:

Season depends on climatic conditions and variety. Early Cabbage is sown during July-November in plains and April-August in Hills, as these require longer period for their head formation. In Southern India, Cabbage is sown during the month of June-July or October-November.

States:

West Bengal, Orissa, Gujarat, Madhya Pradesh, Assam, Bihar, Chhattisgarh, Uttar Pradesh, Jharkhand, Tamil Nadu, Karnataka, Maharashtra, Himachal Pradesh. West Bengal is the highest producer of Cabbage in India.

Climate:

Cabbage can be grown in wide range of climatic conditions but cool moist climate is more suitable for its cultivation. The Sowing temperature should be around 25-30^{o}C while harvesting temperature of 10-15^{o}C in winter and 21-26^{o}C in summer is appropriate.

Soil:

Cabbage grows well in heavy sandy soil rich in organic matter. Early crops prefers light soil while late cultivars thrives best on heavy soils. pH should be between 6-6.5.

Seed Rate & Treatment:

Seed Rate-

Seed rate depends on various factors like variety used, planting method, spacing and seed viability but the average seed rate for cabbage production is 200-250gm/acre.

Land Selection & Preparation:
Bring soil to fine tilth by ploughing land 3-4 times. Planking should be done to level the soil. Add well decomposed cow dung at the end of last ploughing. Form raised bed of suitable height for cabbage cultivation. This promotes better drainage and root development.

Propagation:
Cabbage is a transplanted crop. Cabbage seeds are sown in seed bed. Seeds are planted in designated seed bed and seedlings of 4-6 weeks are used for transplanting. Initially, cabbage seeds are sown in nursery bed. For this raised nursery beds are used measuring 3m in length and 0.6m in width with a height of 10-15cm. Distance of 70 cm is maintained between each seed bed to facilitate watering and weeding. To prevent seeds from Damping off, treat the seeds with Bavistin @2gm/kg of seeds before sowing.

Water Management:
Growth of Cabbage is subsequently depends on soil moisture. First irrigation should be given immediately after transplanting the seedlings. Then, after 10-15 days of interval regular irrigation should be given. For Cabbage, Furrow irrigation is best suited method of irrigation. Avoid heavy irrigation during the head formation.

Nutrient Management:
Apply well decomposed cow dung @30-40 tons/acre before 15-20 days of transplanting. It should be thoroughly mixed with soil. For achieving optimal cabbage yield, it is recommended to apply 80-120kg of N, 60-100 kg of P_2O_5 and 60-120 kg of K_2O. At the time transplanting, incorporate half dose of N and full dose of K and P. Remaining N dose should be applied during 6 weeks of transplanting.

Weed Management:
Crop is kept weed free for optimal growth and to avoid competition among weeds and crop. 2-3 hand weeding via hoeing should be done. Proper aeration of the

root system and effective weed control are essential for promoting healthy growth in cabbage through regular intercultural operations. Manual weeding two to three times during the growth period is necessary to manage weed competition effectively. Additionally, herbicides such as Trifluralin @120-125ml/ha and Fluchloralin @300-400gm/ha can be utilized to supplement manual weeding efforts and ensure efficient weed management in cabbage fields.

Nutritional Deficiency and their Management:

1. **Nitrogen-**

   Symptoms-

   Nitrogen deficiency in plants manifests as yellowish-green foliage, starting with older leaves and eventually affecting the entire plant. Some leaves may show reddish or orange hues in certain areas. Leaf shape typically remains unchanged. Growth is stunted, leading to delayed crop development, and older leaves may deteriorate. Severe nitrogen deficiency can prevent the formation of flower heads or fruits.

   Management-

   To prevent the cure of Nitrogen deficiency apply nitrogen rich fertilizer such as urea, ammonium nitrate.

2. **Phosphorus-**

   Symptoms-

   Initially, symptoms of Phosphrous deficiency appear at the edges of leaves, characterized by a light yellowing between veins that intensifies to reddish shades with increased severity. Phosphorus deficiency commonly coincides with acidic soils, causing leaves to turn purple or reddish-purple. These discolorations typically begin on older leaves, while younger leaves often retain a dark green hue.

   Management-

   Apply phosphorus rich fertilizers such as Superphosphate, triple superphosphate, rock phosphate to cure its deficiency.

3. **Potassium-**

   Symptoms-

   Older leaves exhibit a dry, brown, and withered border that indicates necrosis. As the deficiency persists, this necrosis spreads inward from the edges towards the center of the leaf. Additionally, the margins of the leaves curl upwards. The overall growth of the plant is significantly hindered by these conditions.

Management-

Apply potassium rich fertilizer such as Muriate of potash, potassium sulphate or potassium nitrate.

4. **Zinc-**

   Symptoms-

   Plants affected by zinc deficiency exhibit stunted growth and pale yellow-green leaves. They have a sparse, stretched-out appearance with elongated leaves and fail to form heads properly. These symptoms worsen especially in cold and wet conditions.

   Management-

   Avoid watering to the plant as this can leach zinc from soil. Apply zinc based fertilizer such as zinc sulfate, zinc oxide as foliar spray or can be applied directly. Use Mulch to conserve soil moisture.

5. **Sulphur-**

   Symptoms-

   Sulfur deficiency in plants can resemble nitrogen deficiency due to similar symptoms of delayed and stunted growth. However, a key distinction is that sulfur deficiency shows chlorosis primarily on younger leaves initially, while nitrogen deficiency affects older leaves first. This means with sulfur undersupply, the newer foliage turns yellowish-green, whereas with nitrogen deficiency, the older leaves exhibit chlorosis first.

   Management-

   Application of Gypsum, ammonium sulfate can treat sulphur deficiency.

6. **Molybdenum-**

   Symptoms-

   Molybdenum deficiency in plants presents with a faint yellow-green chlorosis, affecting mature leaves which appear large, elongated, and drooping. The overall plant structure is sparse, with inhibited head formation. This deficiency is most prevalent in acidic or sandy soils with low organic content. Young seedlings suffering from molybdenum deficiency exhibit stunted growth and severe leaf deformities, including reduced leaf size and upward cupping.

   Management-

   Raising the soil pH by applying lime can somehow overcome Molybdenum deficiency. Foliar application of Sodium Molybdate can cure its deficiency.

7. **Manganese-**

   Symptoms-

Manganese deficiency in plants manifests as enlarged leaf blades that do not curl inward as they normally would. This condition is exacerbated by factors such as over-liming, which leads to excessively loose and well-aerated soils, as well as drought conditions, all of which reduce the availability of manganese. Crops grown in soils with high organic matter, peat soils, or substrates also commonly experience inadequate availability of manganese. Recognizing these symptoms and understanding the environmental conditions that affect manganese uptake are crucial for effective management and supplementation of this essential micronutrient in plant nutrition.

Management-

Apply Manganese sulfate to cure its deficiency.

8. **Magnesium-**

   Symptoms-

   Magnesium deficiency symptoms initially appear on older leaves of plants. yellowing develops between the veins and begins at the edges of the leaf, gradually spreading towards the center. Initially, affected areas show a yellow-green coloration, which may later change to orange or red hues. While the smaller veins within the leaf also become chlorotic (yellowish), the larger veins retain their green color, creating a distinctive pattern of green and yellow on the leaf surface.

   Management-

   Apply magnesium based fertiliser such as magnesium sulfate or magnesium oxide to treat its deficiency.

9. **Iron:**

   Symptoms-

   Iron deficiency in brassicas typically manifests as a subtle yellow-green tint on younger leaves. This condition is notable because iron is the micronutrient that brassicas require in the largest amounts, although deficiencies are not commonly observed. Iron deficiency is more likely to occur in soils that are light, alkaline, and calcareous, with low organic matter content.

   Management-

   Apply iron chelate to control iron deficiency in cabbage. Foliar application of iron sulfate @10gm/L of water.

10. **Copper-**

    Symptoms-

Copper deficiency in plants is characterized by elongated, downward-bent leaves that appear pale in color. A notable feature is the presence of broad, white veins running through the leaves. This deficiency often results in a sparse plant structure with inhibited head formation. It is more prevalent in soils with organic matter or sandy textures, particularly in instances where excessive nitrogen fertilization has been applied.

Management-

Soil application of copper sulfate. Foliar application of copper sulfate or copper based fertilizer.

11.Calcium-

Symptoms-

Calcium deficiency in plants is characterized by a condition known as "tip-burn," where necrotic lesions appear on the tips and edges of leaves. Initially, these symptoms develop on the inner leaves of the plant. As the deficiency persists, the necrosis progresses from the leaf tips and margins towards the center of the leaf.

In plants lacking calcium, buds exhibit twisting, and the leaf margins curl downward while the leaf tips hook downward. As the leaves continue to grow, these symptoms become more pronounced. The margins of the leaves may separate, giving them a scalloped or wavy appearance.

These symptoms are indicative of calcium deficiency and can significantly affect plant health and growth.

Management-

Adjust the pH of soil if soil is acidic apply lime or calcium carbonate. Apply calcium rich fertilizer such as Calcium nitrate, gypsum or calcium sulfate.

12.Boron-

Symptoms-

Symptoms of boron deficiency typically appear first on the younger leaves of plants. These leaves tend to remain small and exhibit downward curling and deformation. Chlorotic mottling, characterized by yellowing between the veins and along the edges of the leaves, becomes evident. Necrotic spots may develop along the leaf margins and in the spaces between veins.

In cabbage and other cole crops, the heads may remain small and have a yellowish tint. Stems, petioles, and midribs often develop cracks and become corky. These symptoms collectively indicate boron deficiency, which can severely affect plant health and crop quality.

Management-

Apply Bordeaux mixture to the soil to incorporate boron deficiency.

Physiological Disorders:

1. **Whiptail-**

Caused by- Whiptail is caused due to the deficiency of Molybdenum.

Symptoms –

Under this condition, the leaves fail to develop properly and instead become strap-like in shape. The growing points of the plant are severely deformed, preventing the formation of a marketable curd. Young leaves exhibit noticeable distortion, characterized by elongated mid-ribs and poorly developed, ragged blades. These symptoms indicate a significant developmental disorder affecting the plant's ability to produce healthy and marketable curds. Addressing the underlying cause, such as nutrient deficiencies or environmental stressors, is crucial to ensure proper growth and yield.

Management-

This condition can be managed by adjusting soil pH through liming, Another effective method is applying 1-2 kg per acre of sodium or ammonium molybdate.

2. **Blindness-**
   Caused by- When the terminal bud does not develop and eaten by the insects, this condition is called blindness.
   Symptoms-
   Affected foliage of these plants grows excessively large, turns dark green, and takes on a leathery texture.
   Management-
   - Remove all the affected plants from the field.

- Avoid excessive fertilization
- Avoid water stress and provide proper irrigation to the crop.

3. **Internal Tip Burn-**
   Caused by- Inadequate transport of calcium
   Symptoms-
   It first manifests at the center of the vegetable head. This condition involves the breakdown of tissue, leading to brown, papery changes. The inner leaves of the heads are commonly affected, often showing symptoms internally without external signs.
   Management-
   Foliar application of calcium rich fertilizer can cure internal tip burn.
4. **Oedema of Cabbage-**
   Caused by- Caused due to excessive soil moisture.
   Symptoms-
   - Numerous small, rough patches appear on the undersides of the cabbage leaves.
   - Moist patches appears on leaves surface.
   - Corky growth, tan to brown found beneath the leaves
   - Yellowing of foliage which wilt after severe infections.

   Management-

   - Avoid overwatering during cool temperature.
   - Maintain proper spacing between the plants to plant.

Insect-Pest and their Management:

1. **Cutworms-**

Symptoms of damage-

- Cutworms burrow into cabbage heads, primarily feeding at night, causing several plants in a row to wilt or be cut off abruptly.
- Damage from feeding can appear on leaves, fruits, or flower buds, often with no visible pests during daylight hours.
- cutworms have been known to tunnel cabbage heads.

Management-

- Destruct infected plants from the field.
- Application of Delamethrin 2.5% SC @25gm/30L of water

2. Imported Cababge Worm-

Symptoms of damage-

- Larvae of the cabbageworm chew on seedlings, creating large, irregular holes in leaves, and can bore into cabbage heads, potentially contaminating harvested produce with greenish-brown fecal pellets. The most significant economic damage occurs to the parts of the plants that are sold.
- They typically chew holes in the upper leaf surface near the midrib, which can be large and irregular in shape. As these older larvae move towards the center of the plant, they may consume all leaf tissue except the main veins. Severe feeding can stunt the growth of cabbage heads. Damage to the developing buds of young cabbages by larvae can cause the heads to fail to form properly.

Management-

- Use seedlings that are free from larval contamination for transplants.
- Maintain field sanitation by destroying infected plants from the field.
- Use floating row covers to exclude cabbage worms
- Manage weeds from the field
- Use *Bacillus thuringiensis* based insecticide

3. Cabbage Looper-

Symptoms of damage-

Feeding damage by cabbage loopers resembles that caused by imported cabbageworms. Young cabbage loopers scratch the leaves, while older larvae create irregularly shaped holes of various sizes. Young plants can perish if loopers damage the growing point, and their early feeding can induce branching in brassicas. In cabbage, loopers may feed directly on the head or hide within the heads at harvest, contaminating them with excrement. Leafy vegetables show obvious signs of damage, with significant portions of leaves consumed by insects.

Management-

Foliar application of Carbaryl @60gm/100L of water

4. Diamond Backmoth Larave-

Symptoms of damage-

- Caterpillars feed on the underside of leaves creating holes and damage to the leaves.
- Leaves wilting symptoms

Management-

- Remove and destroy all the affected debris from the field
- Set up Pheromone trap @3/acre
- Application of *Bacillus thurigensis* based insecticide.

5. **Cabbage Head Borer-**
   Symptoms of damage-

   - The presence of caterpillars leads to web on leaves, and burrowing into stems, stalks and leaf veins.
   - Caterpillars feeds on cabbage head making it unfit to eat.
   - Holes in cabbage head

   Management-

   Apply Malathion 50 EC @250ml/acre

6. **Cabbage Leaf Webber-**
   Symptoms of damage-
   - Web the leaves with facial matter
   - Skeletionzation of leaves

   Management-

   - Use only pest-free seedlings
   - Use *Bacillus thurigensis* based insecticide
   - Foliar application of Cypermethrin or Deltamethrin @30ml/10L of water

7. **Cabbage Aphids-**
   Symptoms of damage-
   This pest commonly attacks cruciferous plants during the cold season. Both nymphs and adult insects feed by extracting sap from the plants, which leads to a decline in vigor. The excreted honeydew attracts sooty mold, which further reduces photosynthesis.

Management-

- Destroy crop remains after harvesting
- Remove alternate host
- Introduce natural enemies such as ladybirds, spiders to control the population of aphids
- Install yellow sticky trap @5/acre
- Spray any one of the following insecticide-

कीटनाशक	**मात्रा**
अजडिरेक्टिन 3000 पीपीएम	5 ग्राम प्रति लीटर पानी
डाईमेथोएट 30% इसी	6 मिली लीटर प्रति 10 लीटर पानी
मैलाथायन 50 % इसी	1.5 मिली लीटर प्रति लीटर पानी
क्विनालफ़ॉस 25% इसी	1 मिली लीटर प्रति लीटर पानी

8. **Painted Bug-**
   Symptoms of damage-
   Damage from feeding can be observed across leaves, stems, and flowers. Adults leave white scars on both sides of the leaves. Thinner leaves may develop dry, whitish patches. Infected plants exhibit symptoms such as wilting, yellowing, and leaf desiccation.
   Management-
   Apply Malathion 50%EC @1.5ml/L of water to control the bug.
9. **Tobacco Caterpillar-**
   Symptoms of damage-

- During the initial stages, the caterpillars gather in groups and scrape the chlorophyll from the leaf surface, causing it to appear papery and white. As they mature, they become aggressive feeders, creating uneven holes in the leaves.
- Initially, the leaves show irregular holes caused by caterpillars, and later they are reduced to skeletonized structures with only the veins and petioles remaining visible.
- The infestation leads to extensive defoliation of the plants, where large areas of leaves are stripped away.
- Fruits bore into by the pests exhibit irregular holes, making them unsuitable for consumption or market.

Management-

- Plough the soil to expose and kill pupae.
- Set up light trap @2/acre
- Foliar application of Chlorpyriphos 20EC @500ml/acre

10. **Cabbage Butterfly-**
    Symptoms of damage-
    Signs of their presence include damage to the outer leaves, which often display visible holes. Damage to the cabbage head becomes evident upon slicing through the core and examining the inner leaves. Caterpillars and their waste products are frequently present on the plants as well.
    Management-
    - Collect and destroy infected plants from the field.
    - Apply Malathion 5% @200ml/acre

Diseases and their Management:

1. **Damping Off-**
   Causal Organism- *Rhizoctonia solani*
   Symptoms-

- Damping off of cabbage occurs in two stages: pre-emergence and post-emergence.
- In the pre-emergence phase, seedlings are killed just before reaching the soil surface. The young root and shoot are destroyed, leading to complete decay of the seedlings.
- During the post-emergence phase, infection targets the tender collar tissues near ground level. These tissues become soft and waterlogged, causing seedlings to wilt, topple over, or collapse.

Favourable Conditions-

High humidity, high soil moisture, temperature below 24^{o}C favors the growth of fungus.

Management-

- Prevent overcrowding

- Avoid overwatering
- Discard all the infected seedlings from the field and maintain field sanitation.
- Spray Metalaxyl +Mancozeb @50g/20L of water

2. **Club Root of Crucifers-**
   Causal Organism- *Plasmodiophera brassiacae*
   Symptoms-
   - Stunted growth
   - Yellowing of plants
   - Swelling of roots

   Favorable Conditions-
   Neutral to acidic soil, temperature between 12-25^{o}C favors the growth of fungus.
   Management-
   - Apply Calcium nitrate to the soil
   - Remove weeds
   - Do not rotate with cruicfers crops
   - Seed treatment with Captan, Thiram @4gm/kg of seeds
   - Drench the soil with Copper oxychloride 0.25% @2-3L/plant
3. **Alternaria Leaf Spot-**
   Causal Organism- *Alternaria brassicae*
   Symptoms-

- Symptoms on leaves manifest as rounded brown lesions encircled by concentric rings. These lesions are often accompanied by a yellowish halo and can develop splits in the center. Typically, older leaves are affected first.
- Over time, the disease spreads, causing spots to merge and create large areas of dead tissue on the leaves.

  Favorable Conditions-
  High humidity with soil temperature of 28^{o}C favors the growth of fungus.
  Management-
- Apply few fungicide such as Mancozeb @2gm/L of water, Azxoytrobin 23%SC @300ml/acre.
- Avoid overhead irrigation
- Collect and destroy the infected plants from the field.

4. **Black Rot-**

Causal Organism- *Xanthomonas campetris*
Symptoms-

- Initially, symptoms can be seen as yellow or chlorotic areas near the edges of leaves, often forming angular patterns.
- The yellow areas spread towards the veins and midrib, creating distinct 'V'-shaped chlorotic spots that later darken and turn black.
- Veins and smaller veinlets progressively change from brown to black.
- The blackening of the vascular system extends beyond the affected veins, affecting the midrib, petiole, and stem.
- In advanced stages, the infection can reach the root system, causing blackening of the vascular bundles. Bacterial ooze may also be visible on affected plant parts.
- Early infections lead to wilting and death of plants.
- In late-stage infections, plants may succumb to soft rot and eventual death.

Favorable Conditions-
High soil moisture, Relative humidity of upto 80% favors the growth of this fungus.
Management-

- Drench the soil with Formaldehyde 0.5%
- Apply bleaching powder to controls the disease.
- Collect and remove infected plants from the field.
- Apply Fungicide such as Mancozeb, Ziram27%SC @2.5gm/L of water, 1ml/L of water respectively.

5. **Downy Mildew-**
   Causal Organism- *Hyaloperonospora brassicae.*

Symptoms-

In young brassica seedlings, a fluffy or powdery-white growth of spores underneath their cotyledons can be seen. As the infection progresses, the upper surface of the leaves develops black speckles and becomes puckered. Eventually, the leaves turn yellow and drop prematurely from the plants. Symptoms on mature plants typically start near the ground, where leaves may show black speckles surrounded by yellow patches. If the infection spreads throughout the plant, the stems might display streaks or flecks ranging from black to grey.

Favorable Conditions-

Disease favored with cool temperature of 8-12^{o}C.

Management-

- Use seed treatment with hot water
- Plant disease-resistant variety.
- Maintain field sanitation
- Apply broad spectrum fungicide such as Mancozeb @2.5gm/L of water
- Foliar application of Metalaxyl 35% WS @1.5gm/L of water

6. **Powdery Mildew-**
   Causal Organism- *Erysiphe cruciferarum*
   Symptoms-
   Affected leaves exhibit curling and distortion, while infected flowers on the panicle fail to open and eventually drop without producing fruit. Mildew leads to skin cracking on developing fruits, which subsequently drop from the plant. Seedlings that are infected eventually succumb and die. It's worth noting that mature leaves and fruits are resistant to mildew and do not show susceptibility to the disease.
   Favorable Conditions-
   Warm, dry conditions, high relative humidity favors the growth of this fungus.
   Management-
   - Plant disease resistant variety
   - Avoid overhead watering to avoid high humidity
   - Remove and destroy all the infected plants from the field.
   - Avoid applying excessive fertilizer
   - Use sulphur based fungicide ti control the fungal growth of the plant.

7. **White Rust-**
   Causal Organism- *Albugo candidans*
   Symptoms-
   White rust manifests as small, white pustules appearing on the undersides of infected leaves. These pustules can expand and merge, forming larger, irregular-shaped lesions filled with white spores. The upper surface of

affected leaves displays a noticeable mosaic pattern. In some cases, the disease can cause root swellings that resemble clubs.

Favorable Conditions-

Cool temperature, heavy dews, high relative humidity favors the growth of this fungus.

Management-

- Practice crop rotation with non-cruciferous crops.
- Control weed population
- Remove debris after crop harvest.
- Regular spray of Mancozeb 0.25%

Harvesting and Yield:

Harvesting-

Cabbage is typically ready to harvest between 90 to 120 days after planting. It's crucial to harvest cabbage promptly when the heads are firm and fully mature to avoid issues like splitting and increased susceptibility to diseases in the field.

Harvesting cabbage before it reaches full maturity results in lower yields and heads that are too soft, making them prone to damage during handling.

To harvest cabbage, gently bend the head to one side and cut it with a sharp knife. The cut should be made as close to the head as possible, ensuring the stalk remains flat and intact, with at least two to four wrapper leaves left attached. These extra leaves provide protection during handling and may be preferred in certain markets. Avoid snapping or twisting the head off, as this can lead to uneven stalk lengths and increased risk of decay.

Since cabbage heads do not mature uniformly, harvesting is done in stages based on the readiness of each head. After harvesting, it's important to store the cabbage in a shaded area before packing to maintain its quality.

Yield-

Average yield of Cabbage is upto 20-30tons/acre.