## Handbook on

# Good Agricultural Practices (GAP)

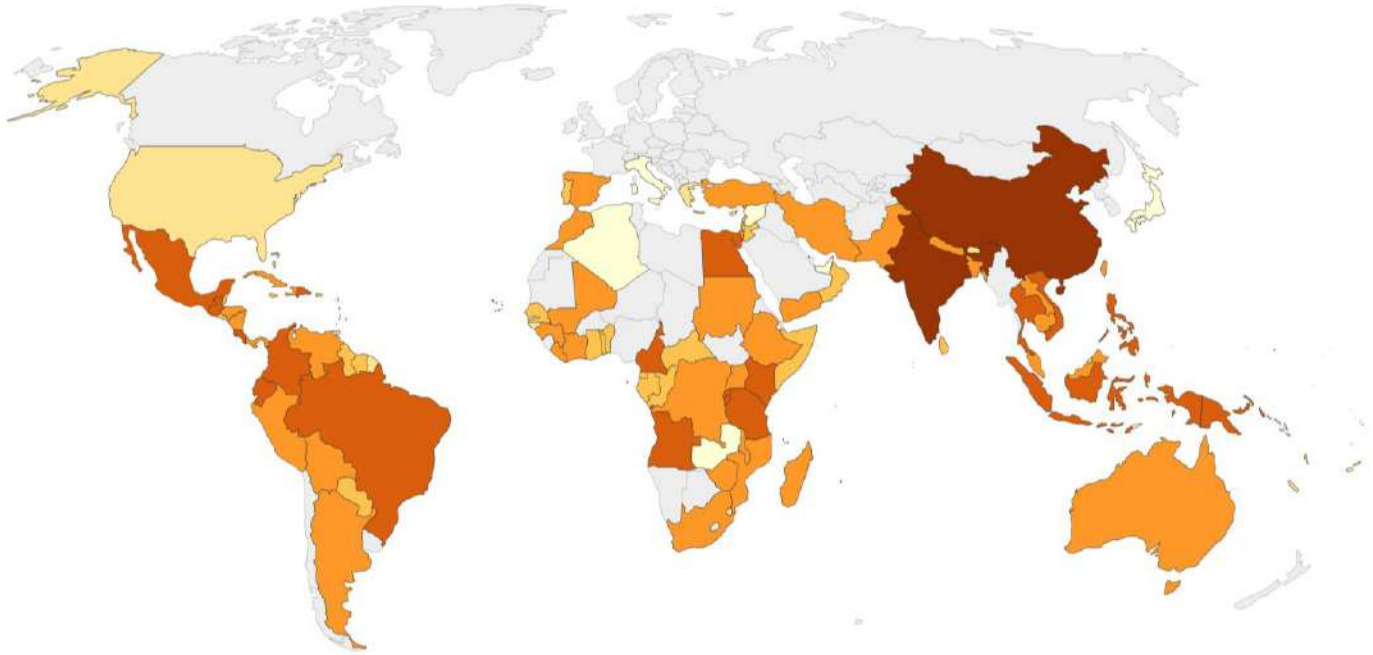
# Banana

# Contents

# Banana: An Overview

- Scientific name: *Musa spp.* (Family: Musaceae)
- Botanically, banana is classified as a berry. The plant is a large herbaceous flowering plant.
- Native to Southeast Asia (Malaysia, Indonesia or the Philippines); the word banana would be derived from the Arab for ‘finger’.
- Banana fruit is the fourth most important global food commodity. It is the second most important fruit crop in India, after Mango.
- Though there are around 300 varieties of bananas cultivated globally, only 15-20 varieties of bananas are commercially grown in India.

# World Banana Production




Source: UN Food and Agriculture Organization (FAO)

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- Grown in more than 140 countries, mainly in tropical and subtropical regions.
- The world's total bananas production was estimated at 120 million tons in 2020.
- The top 5 countries (India, China, Indonesia, Brazil, and Ecuador) account for ~54% of global banana production.

# India’s Banana Production Scenario

- India is the world's leading producer of bananas with a share of around 25% in total output (2022).
- Production: 35 million metric tons. (world production: 125.3 million MT) from 8.6 lakh ha area (world area: 60.2 lakh ha)
- Productivity: 34.0 metric tonnes/ha (world productivity: 19.2 MT/ha).

| State | Production (‘000 Tons) | Share(%) |
|---|---|---|
| Andhra Pradesh | 5,838.88 | 17.99 |
| Maharashtra | 4,628.04 | 14.26 |
| Gujarat | 3,907.21 | 12.04 |
| Tamil Nadu | 3,895.64 | 12 |
| Karnataka | 3,713.79 | 11.44 |
| Uttar Pradesh | 3,391.01 | 10.45 |
| Bihar | 1,968.21 | 6.06 |

- Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu, Karnataka, Uttar Pradesh, and Bihar contribute more than 80% of the country's banana production.

# Maharashtra Production Scenario

**Production belt:**

- Jalgaon, Ahmednagar, Buldhana, Pune, Wardha, Dhule, Nanded, Parbhani, Nandurbar, Satara, Sangli, Osmanabad, Akola, Yawatmal, Amravati, Thane

Estimated annual production of bananas in Jalgaon - 34 lakh tons, contributing around 70% of the state's production and more than 11% of that of India. It is for this reason it is known as the Banana Hub of India or Banana City of India.

- Total area under cultivation is 48000 ha, accounting for 50% of the total area under banana cultivation in the state. Most of the area is under drip irrigation.

# Banana Export Potential

- India’s banana exports (both volume and value) have risen sharply because of adoption of farm practices as per the global standards.
- However it is lagging far behind countries like Ecuador, Philippines, Costa Rica, etc.

# Banana: Uses and Processed Products




**Processed products from fruit:** chips, banana puree, jam, jelly, juice, wine, halwa etc.

**Alternate processed uses:** Banana fiber, stem, banana leaves plates and packing material.

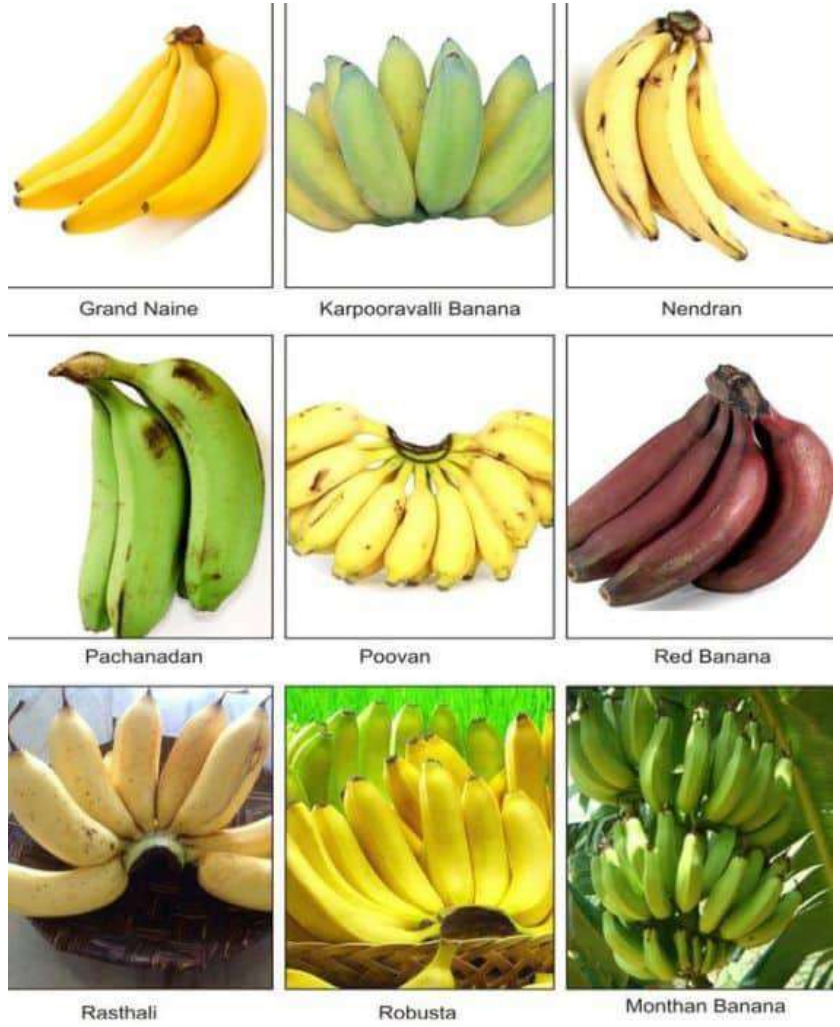
**Cuisine:** The tender stem, green bananas, and flower are used as vegetable in Indian cuisine.

# Banana Varieties

| | |
|---|---|
| Maharashtra | Dwarf Cavendish, Basrai, Robusta, Lal Velchi, Safed Velchi, Rajeli Nendran, Grand Naine, Shreemanti, Red Banana |

**Export varieties:**

- Cavendish cultivar like Grand Naine and Robusta are generally preferred for export. However, there is a scope for export of indigenous varieties viz.,Yelakki (Ney Poovan), Poovan, Nendran, Red Banana, Karpuravalli, Rasthali, Matti, Sannachenkadali etc.,



| Variety | Purpose | Plant height | Fruit Bunch characteristics | Keeping quality | Disease resistance | Remarks |
|---|---|---|---|---|---|---|
| Dwarf cavendish (AAA) | Commercial, table variety | The plant stature is Dwarf making it less prone to wind damage. | The usual bunch weight is 15-25 kg with 6-7 hands and roughly 13 fruits per hand. The selection yields bunches weighing 55-60 kg. Even when the fruits are mature, the thick peel of the fruits retains some of the greenish colours. | Low | It is highly susceptible to Sigatoka leaf spot disease in humid tropics restricting its commercial cultivation. | 'Basrai' is the most popular commercial variety in the dwarf Cavendish group, grown extensively in Maharashtra. Performs well under light soils with high inputs. In combination with high-density planting and drip irrigation, Dwarf Cavendish is becoming a highly successful cultivar |
| Grand Naine | Commercial, table variety | Tall plant stature; taller than the Dwarf Cavendish cultivars but shorter than the Giant Cavendish cultivars. | High yield (Avg. 25-30 kg per plant). Produces long cylindrical bunches with 8-10 hands and 200-220 fruits per bunch. · Long cylindrical fruits with less curvature. Attractive yellowish green colour at maturity. | Good; has a longer shelf life than other varieties. | | The Grand Naine variety is imported from Israel, and it is becoming popular due to its resilience to abiotic stresses and superior quality bunches. · Internationally acceptable both as fresh fruit and in processed form. Pulp to peel ratio is more and highly suitable for processing. |
| Robusta (AAA) | Commercial, table variety | Semi-tall, Requires propping. | It has a high yield and produces enormous, well-developed fruit clusters. The fruit is sweet and has a pleasant aroma. The weight of the bunch is estimated to be between 25 and 30 kg. Depending on the ripening circumstances, dark green fruits turn brilliant yellow. | The fruit has a low keeping quality, resulting in rapid pulp breakdown after ripening, making it unsuitable for long-distance transit. | Robusta is highly susceptible to Sigatoka leaf spot disease in humid tropics. | |

| Variety | Purpose | Plant height | Fruit Bunch characteristics | Keeping quality | Disease resistance | Remarks |
|---|---|---|---|---|---|---|
| Red banana/Lal Velchi (AAA) | Commercial variety | | It is a robust plant with bunches weighing 20-30 kg under good management practices. The fruits are delicious, orange-yellow in colour, and aromatic. The colour of the pseudostem, petiole, midrib and fruit rind is purplish red. | | Highly susceptible to bunchy top, fusarium wilt and nematodes. | |
| Safed Velchi Musa (AB Group) | Table variety | This variety is medium-sized with slender yellowish green pseudostem and can be recognised by the reddish petiole margin | The average bunch weight is about 12 kg with about 150 fruits/bunch. Large fruits, very thin and papery rind and white firm flesh that is very sweet. | | | The duration of the variety is about 13 months. |

# Good Agricultural Practices (GAP)

| | | |
|---|---|---|
| Using disease free and quality plant material of improved cultivars. | Adoption of high planting density. | Proper canopy management. |
| Integrated nutrient and water management. | Keeping proper load of fruits on the tree. | Timely control of pests and diseases by adopting IPM/ IDIPM practices. |

# Culture Practices

# Agro-Climatic Conditions

Banana, a tropical crop, grows well in a temperature range of 15ºC-35ºC with relative humidity of 75-85%.

- Chilling injury occurs at temperature below 12ºC.
- The optimum temperature for leaf emergence is about 25-30°C, the upper and lower limits being about 40°C and 10°C respectively

Banana prefers tropical humid low lands and is grown from the sea level to an elevation of 2000 m above mean sea level.

High velocity of wind which exceeds 80 km /hr severely damages the crop.

Four months of monsoon (June to September) with an average 650-750 mm rainfall are most important for vigorous vegetative growth of banana.

For optimum growth, the area should have evenly distributed monthly rainfall of 20-22 mm.

With sufficient irrigation facilities, areas with distinct long dry season could be developed into good banana producing ones.

# Soil and Land Preparation

Deep, rich loamy soil with pH between 6.5 – 7.5 is most preferred for banana cultivation.

- Soil for banana should have good drainage, adequate fertility and moisture.
- Soil which is neither too alkaline or too acidic, rich in organic material, high in nitrogen content, adequate phosphorous, and plenty of potash is good for banana.
- Ill-drained, poorly aerated, nutritionally deficient soils are not suitable
- Saline, solid, calcareous soil is not suitable
- Avoid soil of low-lying areas, very sandy, and heavy black cotton soil.

Prior to planting banana, green manure crops like sunnhemp, daincha, cowpea etc. may be grown.

The land should be thoroughly ploughed for 2-4 times and leveled. Rotavator or harrow is used to break the clod and bring the soil to a fine till.

During soil preparation, basal dose of FYM (about 50 tons/ha before last harrowing) is added and thoroughly mixed into the soil.

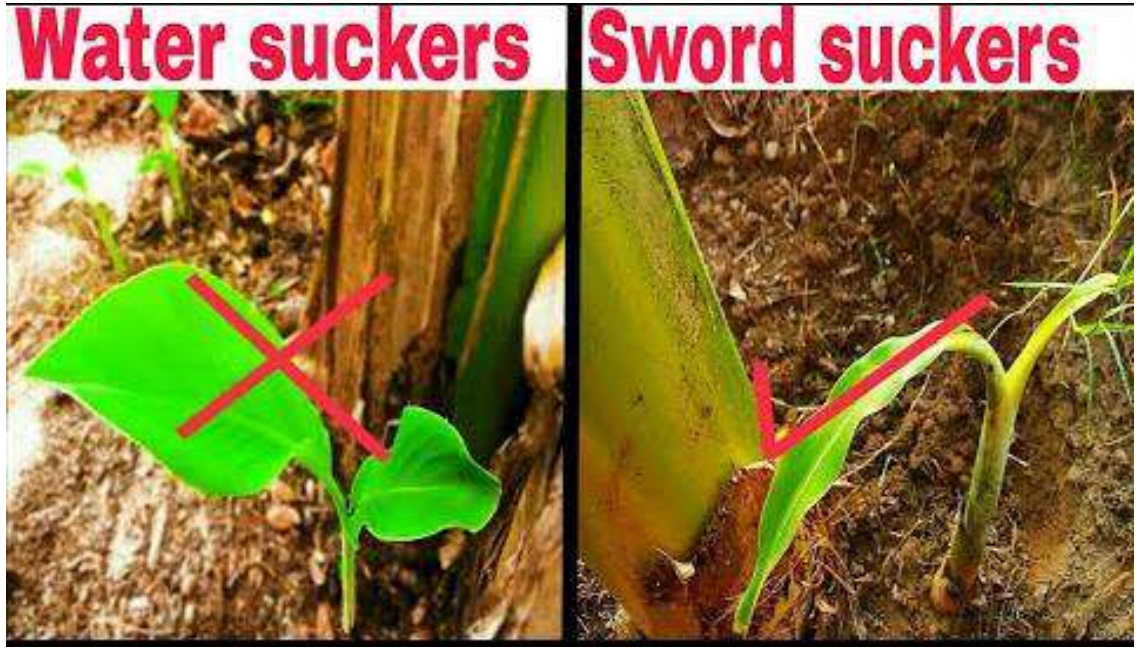
Pit (size 45cm x 45cm x 45cm) or furrows (practiced in Gujarat and Maharashtra) may be prepared for planting, depending on soil strata.

Prepared pits are left to solar radiation helps in killing the harmful insects, is effective against soil borne diseases and aids aeration.

## Planting Material

### Selection of Suckers:

- Select ‘Sword Suckers’ with broad corm with narrow sword like leaves, from viral, fungal and bacterial disease free mother plants.
    - The suckers should be 3-5 months old, uniform in size, weighing 1-1.5 kg for Nendran, Rasthali, Ney Poovan and Poovan Banana varieties.
    - For long duration varieties like Karpuravalli and Red Banana, slightly big suckers weighing 1.5-2.0 kg should be used.
    - For planting of ‘**Tissue Culture’** plants, the secondary hardened plant should be about 30 cm tall, 5 cm girth with atleast five fully opened healthy leaves and true to type.



# Sucker Treatment and planting:

- The selected suckers should be ‘pared’ by trimming of all the roots along with surface layers superficially to remove any rotten portion of the corm.
- Dip the pared suckers in 0.2% Carbendazim (2g/litre of water) solution for about 15 –20 minutes as a prophylactic measure against Fusarium wilt disease.
- The suckers are dipped in a solution of Carbofuran 3% CG before planting
- In case of tissue culture plants, one week before planting apply 10 g Carbofuran and 1.0 % bleaching powder or 0.2 % Emissan in 100 ml water as drench into the polythene bags to protect against nematode infestation and bacterial rot (Erwinia Rot) disease respectively.
- Keep the treated suckers in shade overnight before planting.

# Ratoon Management

- Keeping the field and neighborhood free of weeds generally is advised to avoid spread of infestations.
- Though the TC plants, which are supplied are healthy and virus free, field contamination can be avoided only by keeping the generally field free of weeds.
- Once the flowers emerge and all the fruits have fully opened, the bunches are covered using a skirting bag which prevents the tender fruits from insect attack, besides maintaining uniform temperature inside. This is important for colour and fruit development.

# Spacing

| Season | Spacing |
|---|---|
| Kharif (June – July) | 1.5 x 1.5 m., 2 x 2 m. or 2.5 x 2.5 m |
| Rabi (October – November) | 1.5 x 1.2 m., 1.5 x 1.37 m. |

| Varieties | Spacing | No. of suckers/ha | No. Of suckers per acre |
|---|---|---|---|
| Robusta | 1.8x1.8 | 3080 | 1232 |
| Nendran | 1.8x1.8 | 3080 | 1232 |
| Dwarf Cavendish | 1.5x1.5 | 4440 | 1785 |
| Red banana | 2.1x2.1 | 2267 | 907 |

## High Density Planting:

It can accommodate 4444 to 5555 plants per ha. Planting 3 suckers / pit at a spacing of 1.8 x 3.6 m (4,600 plants per ha) for Cavendish bananas and 2 x 3 m for Nendran banana (5000 plants per ha) is followed.

# Plantation

- The suckers are planted in the center of the pit and soil around is compacted.
- Plants are planted in the pits keeping pseudostem 2cm below the ground level. Deep planting should be avoided.
- The pits are filled with top soil mixed with 10-15 kg FYM and 250g super phosphate, 250 gm of Neem cake and 20 gm of carbofuran. The pits are closed to about a couple of inches below the ground level.
  - In saline or alkaline soil where PH is above 8, Pit mixture should be modified to incorporate organic matter.
  - Addition of organic matter helps in reducing salinity while addition of perlite improves porosity and aeration.
  - In areas where nematode problem is prevalent, nematicides and fumigants are also added to pits before planting. Apply 40 g of Carbofuran granules per pit to protect the plants against nematode attack.
- The field is irrigated immediately after planting.

# Integrated Nutrient Management

# Pre-planting

- Banana requires high amount of nutrients, which needs to be supplied in the form of manures and fertilizers.
- Nutrients should be supplied on the basis of soil test report and recommendations.
- Generally banana crop requires 7-8 Kg N, 0.7- 1.5 Kg P and 17-20 Kg K per metric ton yield.
- In acidic soils, use dolomite (Mg2 CO3 ) or limestone (CaCO3 ) as soil amendments.

# Planting

- At the time of planting, apply 10 kg FYM, 200 – 250 g N; 60-70 g P; 300 g K/ plant.
- Further application of 100 g potash and also 40 g of phosphorus are essential and applied at planting.
- Application of full dose of P and K at planting and N in three equal doses in shallow rings about 8-10 cm deep are recommended.

# Vegetative stage

**Nitrogen:**

- Apply 25 % N in organic form, 75 % N in inorganic form along with growing and mulching of green manure crops.
- Apply 25% N as farmyard manure and 1 kg neem cake.
- Apply 100g-200g of N/plant as top dressing in three equal split doses 60, 90 and 120 days after planting.

**Phosphorous:**

- In acidic soils, triple superphosphate or diammonium phosphate (DAP) is recommended.

**Potassium:**

- Application of 100 g K in two splits during vegetative phase should be done.
- Application of 200-300 g $K_2O$ is recommended depending upon the cultivar.
- Muriate of potash is generally used as a source of K. But in soils with pH above 7.5, potassium sulphate is advantageous.

**Micronutrients:**

- Combined foliar application of $ZnSO_4$ (0.5%), $FeSO_4$ (0.2%), $CuSO_4$ (0.2%) and $H_3BO_3$ (0.1%) applied at 3, 5 and 7 months after planting helps to increase yield and quality of banana.
- Foliar spraying of ICAR-NRCB released banana micronutrient mixture @ 10g/litre of water during 4th, 5th, 6th and 7th month after planting along with good quality surfactant is recommended.
- In order to avoid loss of nutrients from conventional fertilizers i.e. loss of N through leaching, volatilization, evaporation and loss of P and K by fixation in the soil, application of water soluble or liquid fertilizers through drip irrigation (fertigation) should be adopted.

# Daily fertigation schedule for tissue culture banana (1200 plants/acre)

| Days after planting | Urea Daily (Kg) | Super phosphate | MOP (KCL) Daily (Kg) | Water requirement (lit/plant/day ) |
|---|---|---|---|---|
| 30-75 (45 days) | 0.6 | 250 | 0.9 | 4 |
| 75-120 (45 Days) | 1.2 | - | 1.5 | 8 |
| 120-165 (45 days) | 2.4 | - | 3.6 | 12 |
| 165-210 (45 days) | 3 | - | 4.8 | 16 |
| 210-255 (45 days) | 2.7 | - | 3.6 | 20 |
| 255-270 (15 Days) | 2.4 | - | 3 | 24 |

Super phosphate @ 250 gm/plant is applied in the soil as basal dose.

# Calendar of Operations

## During First month

- The soil around the plants should be pressed firmly for better and quick establishment of the plants.
- Wherever necessary, ‘Gap Filling’ should be done to replace the un- sprouted as well as rotten suckers. Seeds of green manure crops viz., cowpea or sunnhemp be sown.
- For additional income and also for effective land use efficiency, short duration crops such as onion, green gram, black gram, beans, radish, greens, marigold and short duration vegetables can be grown as intercrop.
- Tomato, chilly and cucurbits should not be grown as intercrop since these crops harbour nematodes and aphids, which act as vector of virus spread.

## Second Month

- Green manures viz., cowpea or sunnhemp should be ploughed back in to the soil at flowering stage or about 40 days after sowing.
- Slight digging and earthing up to keep the weeds under control.
- For Fusarium wilt susceptible varieties like Rasthali, Karpuravalli, Ney Poovan, Monthan and Pachanadan, drench the soil around the plant with 0.2% Carbendazim as a prophylactic measure, or
- Apply 30g *Trichoderma viride* or *Pseudomonas fluorescense* along with FYM/compost 1 kg in the soil around the plant as a prophylactic measure for the control of wilt disease.

## Third Month

- Application of 40g of Carbofuron to control nematodes.
- Digging and weeding.
- Application of first dose of fertilizers @ 100:300:100 g Urea, Super Phosphate and MOP per plant in basins made about 30 cm away from the plant.

## Fourth Month

- Application of Azospirillum and phosphobacteria @ 30 g and *Trichoderma viride* @ 30g along with 5-10 kg FYM plant-1.
- There should a gap of minimum 2-3 weeks between the application of chemical fertilizers and biofertilizers.
- Periodical removal of side suckers by cutting them above the ground level and pouring 2 ml kerosene at the central core of the sucker.
- If any virus affected plants are noticed in the field, remove and destroy it immediately and spray with any systemic insecticide to kill the insect vectors which spread the virus.

## Fifth Month

- Application of second dose of fertilizers @ 150:150 g Urea and MOP+ 300g neemcake per plant in the basins made about 45 cm away from the plant.
- Removal of dried leaves.
- Digging and weeding.
- To cater the micronutrient need of the plant and to correct their deficiency, apply 50g agricultural lime and 25g magnesium sulphate per plant.
- For Fusarium wilt susceptible varieties like Rasthali, Karpuravalli, Ney Poovan, Monthan and Pachanadan drench the soil around the plant with 0.2% Carbendazim as a prophylactic measure.
- To prevent the egg laying and further attack of stem weevil, spray *'Neemosol'* @12.5ml/litre or Chlorpyriphos @ 2.5ml/litre on the stem especially in Nendran, Red Banana, Karpuravalli and Monthan varieties.
- To monitor the corm and stem weevil, 2 ft long longitudinal stem trap @40 traps/acre can be placed at different places. The collected weevils are to be killed using kerosene.
- Keep the Banana fields as well as surrounding areas weed free and spray systemic insecticides to control the insect vectors.

## Sixth Month

- Digging and earthing up of soil around the plant.
- Removal of the dried and diseased leaves and spraying of 0.1% Propiconazol (TILT) by thoroughly covering both the surfaces adding wetting agent with the spray fluid especially during winter and cool months for control of Sigatoka leaf spot diseases.
- Yellowing of leaves which is a symptom of iron deficiency, spray 0.5% ferrous sulphate + 1.0% urea added with wetting agent on the leaves especially in high pH >8.5 and Calcareous soils.
- To correct the deficiency of zinc, spray 0.5% zinc sulphate solution along with wetting agent.
- Foliar application of 0.5 Borax is recommended to correct the deficiency.
- Apply 30g *Trichoderma viride* or *Pseudomonas flourescense* in the soil around the plant as a prophylactic measure to control the wilt disease.
- For controlling the stem weevil attack, using ‘Banana Injector’, inject 2ml of Monocrotophos (150 ml Monocrotophos mixed in 350 ml of water) at 2 and 4 feet height on opposite direction.

## Seventh Month

- Application of third dose of fertilizers @ 150:150 g Urea and MOP per plant in the basins made about 60 cm away from the plant.
- Removal of the dried and diseased leaves and spraying of 0.1% Carbendazim or Calixin by thoroughly covering both the surfaces along with wetting agent.
- Periodical removal of side suckers by cutting them above the ground level, scoop the core and pour 2 ml kerosene in the core.
- Injection of 2ml of Monocrotophos using ‘Banana Injector’ at 2 and 4 feet height for the control of stem weevil.

## Eighth Month

- After flowering, only one healthy side sucker should be allowed for first ratoon and the remaining suckers should be killed using kerosene or uprooted.
- Spraying of 0.1% Indofil by thoroughly covering both the surfaces.
- After the emergence of the last hand, the male bud has to be removed leaving about 15 cm stalk from the last hand.
- To prevent ‘cigar end rot’ disease, remove the pistil and perianth carefully from the fully emerged fingers and spray the bunch with Indofil M-45 @ 2.5 ml/litre.
- Spray 2% Potassium Sulphate (20g/litre of water) solution with surfactant by thoroughly drenching the bunch and cover the bunch with 100 gauge thick white or blue polythene sleeves having 6% ventilation.

## Ninth Month

- Thirty days after the first spray, give a second spray of 2% Potassium Sulphate (20g/litre of water) solution with surfactant by thoroughly drenching the bunch.
- Provide casuarina pole or bamboo support to the plants for tall and heavy bearing bunches.

# Physiological Problems in Banana

**Choke throat:** It occurs due to low temperature affecting active growth of the plant. In case of normally flowering plants, the stalk carrying bunches elongates freely so that the entire inflorescence comes out of the pseudostem and hangs down. Bunch development is normal, but when the time of flowering synchronizes with low temperature, the bunch is unable to emerge from the pseudostem properly. The distal part of the inflorescence comes out and the basal part gets stuck up at the throat.

Maturity of the bunch is delayed by taking 5-6 months instead of 3.5-4 months for harvest.

Provision of shelter belts using Casuarina or Eucalyptus to prevent the effect of cold wind blowing into the orchard and planting low temperature tolerant varieties like Kullan check the disorder.

## Potassium deficiency:

- **Chlorosis:** The most characteristic of the K deficiency symptoms is the yellowing of older leaf tips followed by inward leaf curling and death.

- **Stunted growth :** Usually, a K deficient banana plant will grow slowly and have a sturdy appearance due to the shortening of internodes.

- **Bunch deformation:** The banana bunches in K deficient plants are short, slim and deformed as a consequence of poor fruit filling caused by reduced photosynthesis and sugar transportation.

# Crop Stage-wise IPM

# Weeds

## Pre-Planting:

- De-weed the field before planting by carrying out
  - Deep ploughing
  - Cross harrowing

## Planting:

- **Cultural Control:**
  - Use weed free suckers for planting.
  - Adopt intercropping of recommended crops (e.g. cowpea etc.) with recommended agronomic practices.
- **Chemical Control:**
  - Pre-emergence application of diuron 80% WP@ 0.8 Kg in 250 l of water/acre if infestation by the weed species as recommended by CIB&RC.

## Vegetative stage

- Regular weeding should be done in the banana basin.
- Regular mowing of weeds between banana rows should be done.
- Ploughing between banana rows.
- Same cultural practices as in planting stage

# Nematodes, banana corm weevil

**Cultural control:**

- Deep ploughing during summer.
- Use of disease free planting material.
- Storage of large corms in the sun for two weeks prior to planting.
- Select healthy suckers.
- Grow less susceptible varieties.
- Intercropping of banana with sunnhemp, marigold reduces burrowing nematodes

**Chemical control:**

- Before planting, the suckers should be dipped in carbofuran 3% CG @ 33g/ sucker then shade dry for 72 hrs then go for planting for rhizome weevil.
- For nematode treat the suckers with carbofuran 3% CG @ 50g/suckers.

# Nematodes, banana rhizome weevil

**Cultural control:**

- Use of cover crop calopogonium.
- Crop rotation with non-host crops.

**Chemical control:**

- Before planting, the suckers should be dipped in carbofuran 3% CG @ 33g/ sucker then shade dry for 72 hrs then go for planting for rhizome weevil.
- For nematode treat the seed with carbofuran 3% CG @ 50g/suckers.

* Apply *Trichoderma viride/harzianum* and *Pseudomonas fluorescens* as rhizome, nursery treatment and soil application (if commercial products are used, check for label claim. However, biopesticides produced by farmers for own consumption in their fi elds, registration is not required).

# Banana stem weevil

**Cultural control:**

- Remove dried leaves periodically and keep the field clean
- Prune the side suckers every month
- Use healthy and pest free suckers to check the pest incidence
- Do not dump infested materials into manure pit
- Uproot infested trees, chop into pieces and burn
- Use longitudinally split pseudostem trap at 26/acre.
- 2ml at 45 cm from ground level; another 2m at 150 cm from ground level.
- Uproot infested trees, chop into pieces and burn.

# Leaf eating caterpillar

**Cultural control:**

- Collect and destroy egg masses and caterpillars
- Use burning torch to kill the congregating larvae
- Summer ploughing to expose pupae.
- Grow pest-repellant plants such as basil
- Avoid plants that attract pests:
  - Carrot family, sunflower family, buckwheat, alfalfa, corn, shrubs (minute pirate bug & lacewing)
  - Nectar rich plants with small flowers i.e anise, caraway, dill, parsley, mustard, sunflower, buckwheat and cowpea (Braconid wasp)

**Mechanical control:**

- Hand pick and destroy the egg masses and caterpillars
- Collect and destroy the damaged plant parts.
- Use pheromone @ 4-5 traps/acre.
- Use light trap to attract and kill the adults.

**Biological control:**

- Field release of egg parasitoids such as Telenomus spodopterae, T. remus
- Encourage the activity of larval parasitoids Ichneumon promissorius, Carcelia spp., Campoletis chlorideae
- Pupal parasitoids such as Ichneumon sp etc.
- Predators such as Chrysoperla zastrowi sillemi, Coccinellids, King crow, Braconid wasp, dragonfly, spider, robber fly, reduviid bug, praying mantis, red ants
- Conserve nematode such as Ovomermis albicans

# Banana rhizome weevil

Cultural control:

- Removal of pseudostems below ground level
- Trimming the rhizome
- Prune the side suckers every months.

Mechanical control:

- Pheromone lure (‘cosmolure’) can be used for monitoring as well as trapping of banana rhizome weevil. Installing traps at low trap density 2/acre.
- Initially placed in a line of 10 meters from a border and 20 meters apart.

Chemical control:

- Soil incorporation at the time of planting carbofuran 3% CG @ 33g/sucker.

# Banana lacewing bug/ tingig bug

Cultural control:

- Collect and destroy the damaged leaves, flowers and fruits along with life stages

Chemical control:

- Spray carbofuran 3% CG @ 166g/sucker or dimethoate 30% EC @ 594-792 ml in 600-800 l of water/acre or oxydemeton – methyl 25% EC @ 600-800 ml in 600-800 l of water/acre or quinalphos 25% EC @ 1200-1600 ml in 200-400 l of water/ acre, direct the spray towards the crown and pseudostem base

# Banana Thrips

Cultural control:

- Collect and destroy the damaged leaves, flowers and fruits along with life stages
- Use blue pan water sticky trap @ 4-5/acre
- Destroy all volunteer plants and old neglected plantations. Use healthy and pest free suckers for planting
- Hot water treatment of suckers prior to planting.
- Bunch covers (which cover the full length of the bunch) protection applied very early.
- Regular checking of fruit under the bunch covers is essential to ensure that damage is under control
- Conserve predators such as coccinellid and lacewings

# Leaf and fruit scarring beetle

Cultural control:

- Practice clean cultivation by removing the grass weeds from the banana plantations

# Banana aphids

Cultural control:

- Use yellow pan water sticky trap @ 4-5/acre
- Ensure clean cultivation
- Encourage activity of predator coccinellids such as Scymnus, Chilomenes sexmaculatus, and lacewing, Chrysoperla zastrowi sillemi

Chemical control:

- Apply carbofuran 3% CG@166g/sucker or dimethoate 30% EC @594-792 ml in 600-800 l of water/acre or oxydemeton – methyl 25% EC @1200-1600 ml in 600- 800 l of water/acre, direct the spray towards the crown and pseudostem base upto ground level.

# Hard scale insect

Cultural control:

- Collect and destroy the affected plant parts.

Biological control:

- Field release of coccinelid predators like Chilocorus nigritus, Symnus coccivora

# Banana scab moth

Cultural control:

- Careful selection of following suckers of equal size will ensure a concentrated bunching cycle that streamlines control.

Biological control:

- A range of spiders and other general predators exert a measure of natural control.

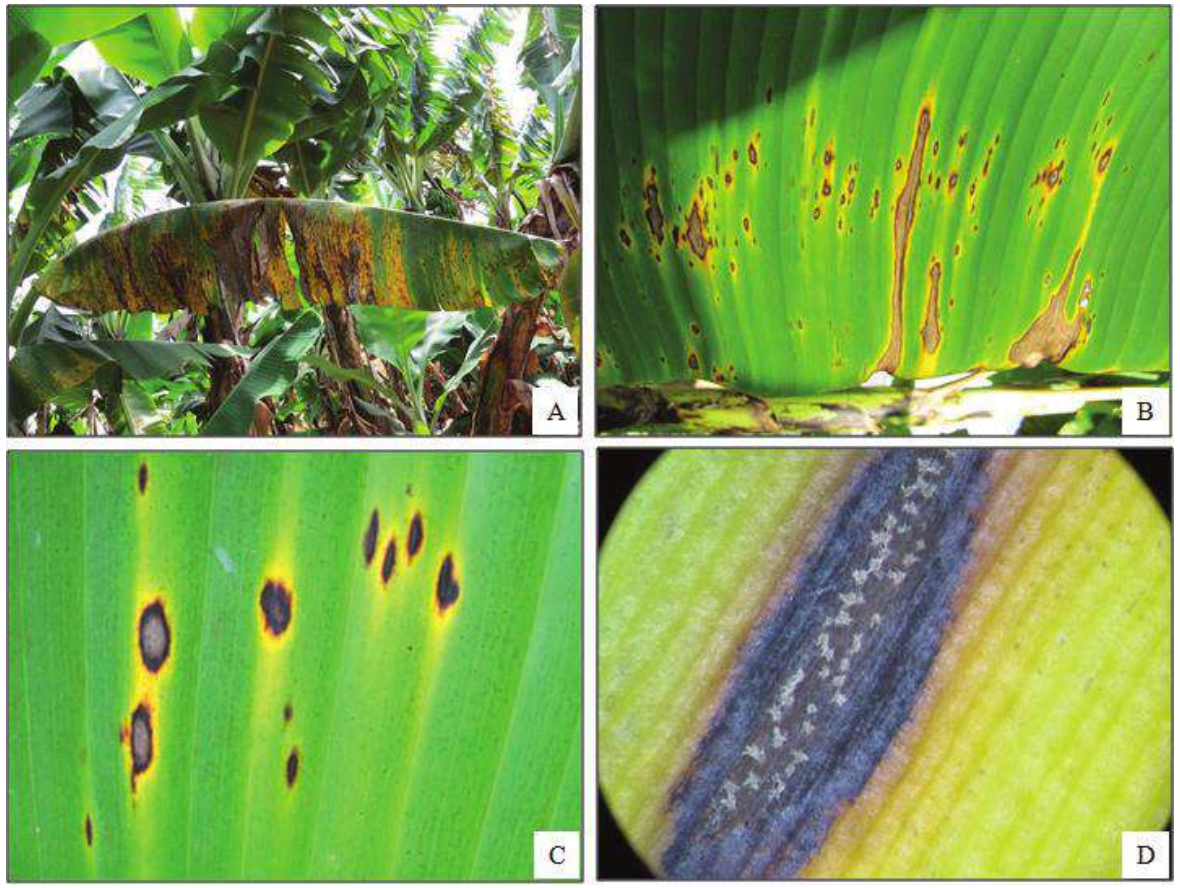
# Sigatoka disease

**Cultural control:**

- Removal and destruction of the affected leaves.
- Prevent water accumulation around the plant and go for periodical weeding.
- Select tolerant varieties

**Chemical control:**

- Mancozeb 75% WP @600-800 g in 400 l of water/acre.
- Propiconazole 25% EC @ 0.1% (100 ml/100 l water.) in 200-400 l of water/acre.
- Copper oxychloride 50% WP @ 1Kg in 300-400 l of water/acre.



# Moko disease

Cultural control:

- Providing good drainage.
- Disinfestation of tools with formaldehyde diluted with water in 1:3 ratio.
- Crop rotation (3 years rotation with sugarcane or rice) & providing good drainage.
- Allow fallow period or flooding during off -season.

# Bunchy top disease

**Cultural control:**

- Select suckers from disease free areas.
- Infected plants are destroyed using 4ml of 2, 4, D (50g in 400 ml of water).
- Remove weeds which are attractant to aphids.
- Select tolerant varieties

**Chemical control:**

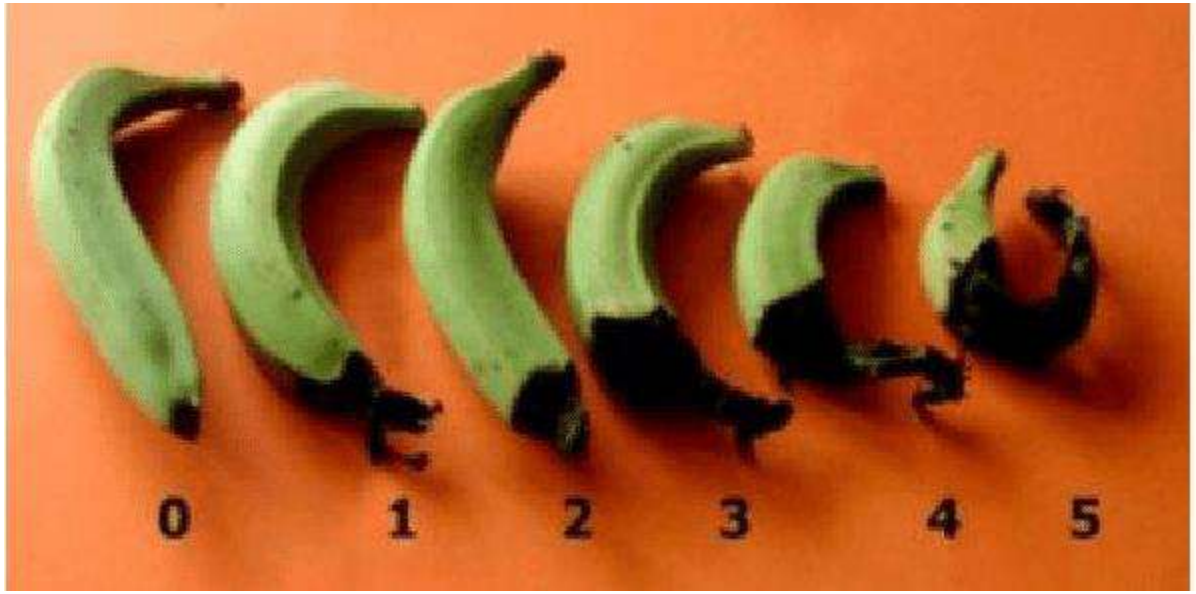
- Control vector by spraying carbofuran 3% CG @166g/sucker or dimethoate 30% EC @ 594-792 ml in 600-800 l of water/acre or oxydemeton – methyl 25% EC @ 1200-1600 ml in 600-800 l of water/acre.

# Panama disease

Cultural control:

- Avoid growing of susceptible cultivars
- Grow resistant cultivar.
- Removal and destruction of affected leaves followed by spraying with BM (1%) +linseed oil (2%).
- Select tolerant varieties


# Tip rot




**Cultural control:**

- Remove infected plants and destroy.

**Chemical control:**

- Drench with mancozeb 75% WP @ 600-800 g in 400 l of water/acre.

# Infectious chlorosis

**Cultural control:**

- Destroy infected plants
- Use disease free suckers
- Dry heat treatment of suckers at 40º C for 1 day
- Avoid growing cucurbits as intercrop

**Chemical control:**

- Control aphid vector by applying carbofuran 3% CG @ 166g/sucker or dimethoate 30% EC @ 594-792 ml in 600-800 l of water/acre or oxydemeton – methyl 25% EC @ 1200-1600 ml in 600-800 l of water/acre.

# Banana bract mosaic virus/ streak mosaic

**Cultural control:**

- Dry heat treatment of suckers at 40º C for 1 day.
- Avoid growing cucurbits as intercrop

# Harvesting

- Done by 2-3 people, one cut and another hold
- Use a cushion to reduce physical injury





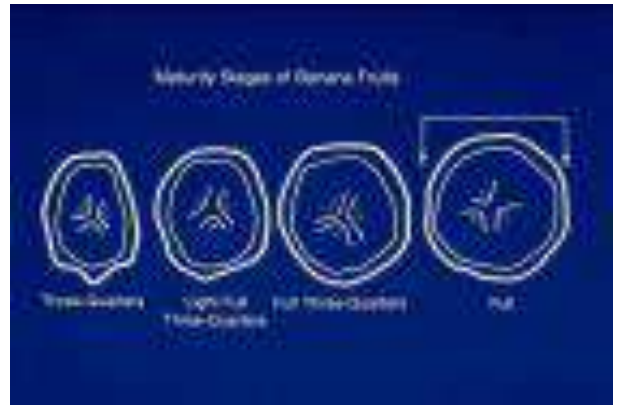






# Maturity/Harvest Indices


- Climacteric fruit
- Moment of harvest: very important
  - Fruit harvested before attaining physiological maturity will not ripen
  - Fruit harvested late will not sustain handling and will have short life
- Do not ripen well on the tree: Ripen well off the tree
  - Fruits ripened on the plant often split and have poor texture.
- Harvest mature green and ripen on arrival to market:

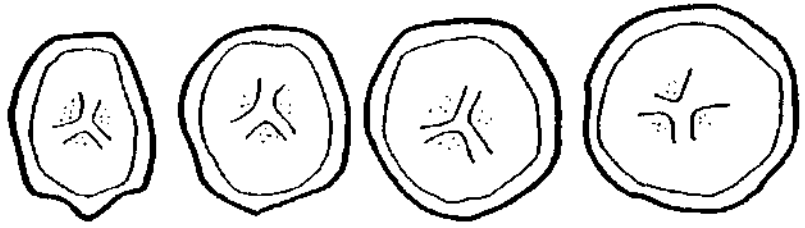


Indices

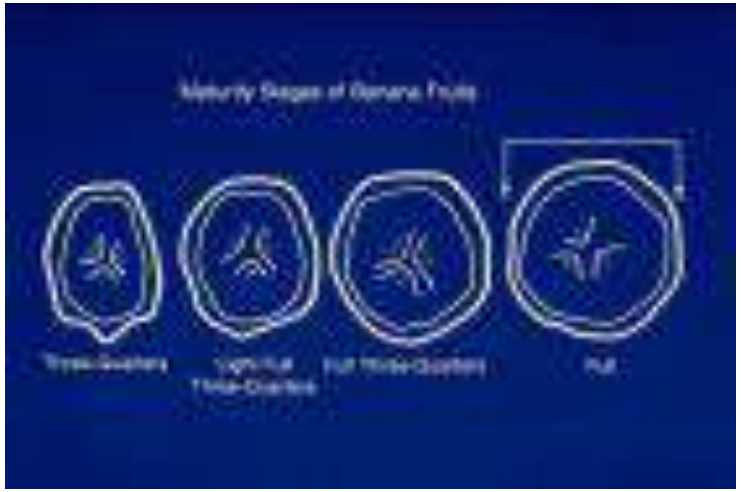
Degree of fullness of the fingers, i.e., disappearance of angularity in a cross section,
Measurement of finger fullness using a caliper

# Maturity/Harvest Indices

- Degree of fullness of the fingers, i.e., disappearance of angularity in a cross section,
- Measurement of finger fullness using a caliper

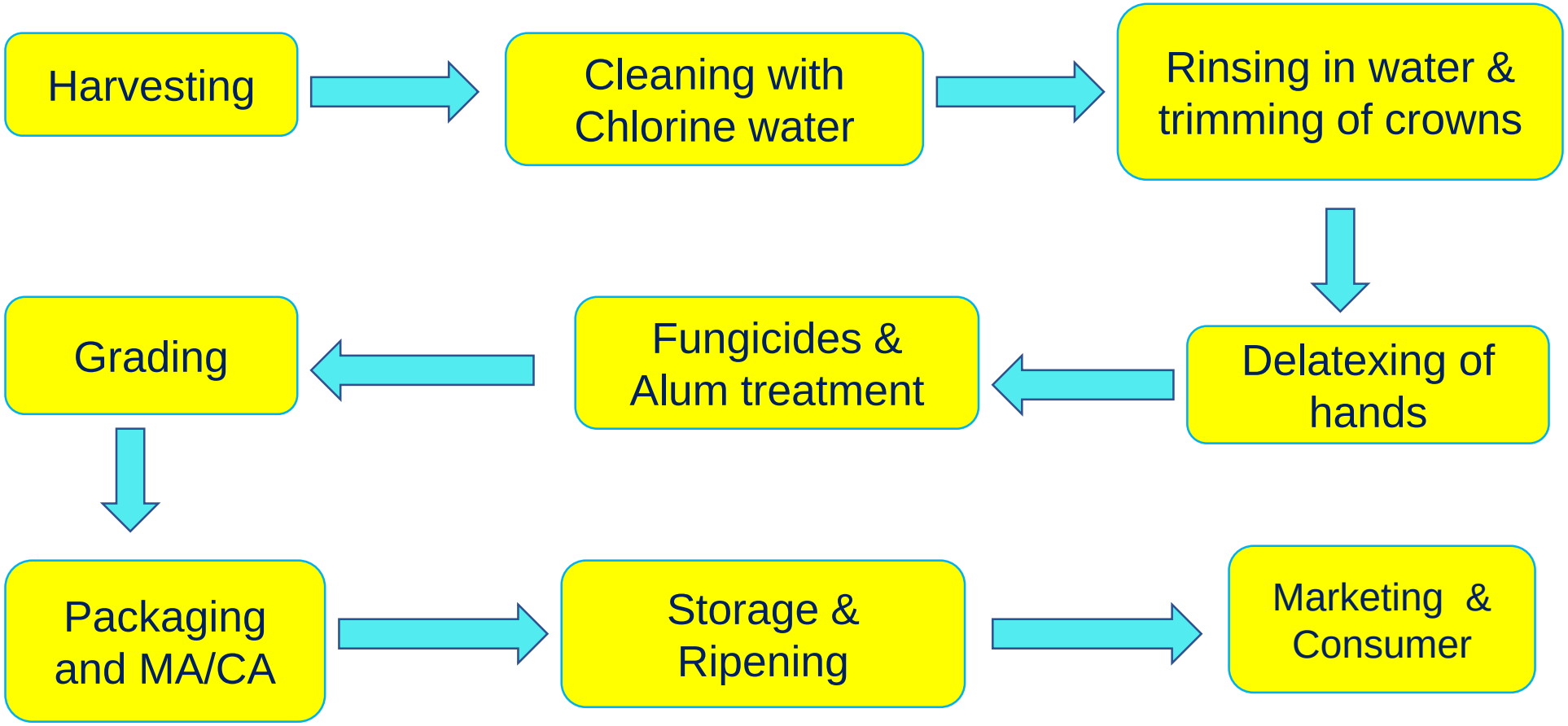


Three-Quarters | Light Full Three-Quarters | **Full** Three-Quarters | Full



# Post-Harvest Handling

# Sequence of postharvest operations



# Transport to packinghouse

- Very important: Avoid physical injury to banana hands






# Ideal Postharvest Preservation Conditions

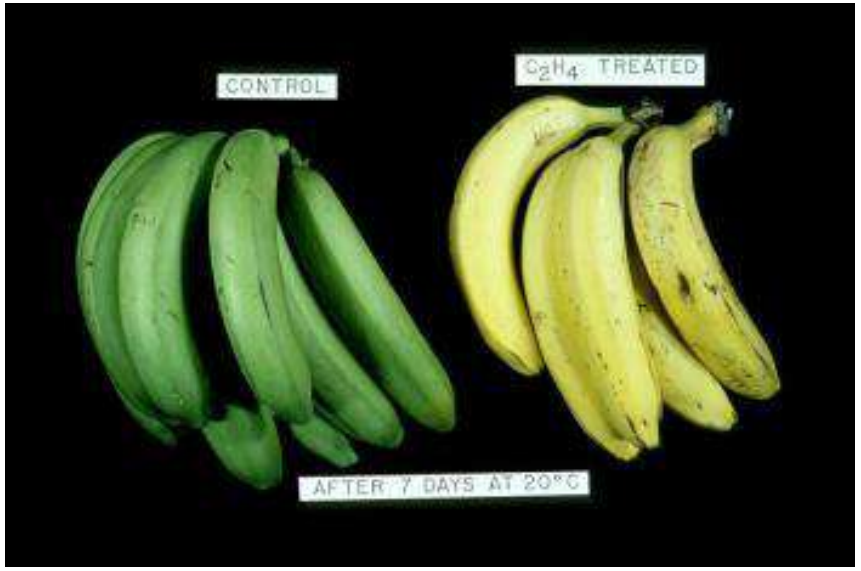
- Precooling: in room cooling to 15ºC
- Temperature: 13-14ºC
- Less than 13ºC: Chilling injury
- Higher than 18ºC: fast ripening
- 15-20°C for ripening
- 90-95% relative humidity:
- Modified atmospheres: 2-3% oxygen + 3-5% carbon dioxide
- Artificial ripening with ethylene on arrival to market
- Postharvest life: 2-6 weeks

# Modified/Controlled Atmospheres

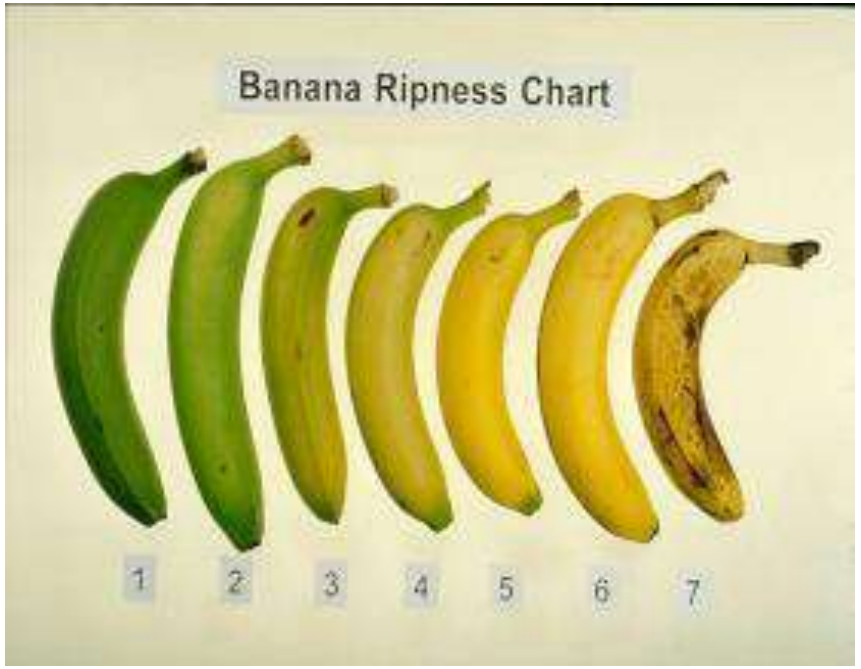
- Commercially used in banana
- Delay ripening and extend postharvest life
- Several systems used: MA or CA

# Artificial ripening

The graded and sorted banana hands are commercially ripened artificially with ethylene on arrival to market




**Banana ripening room**

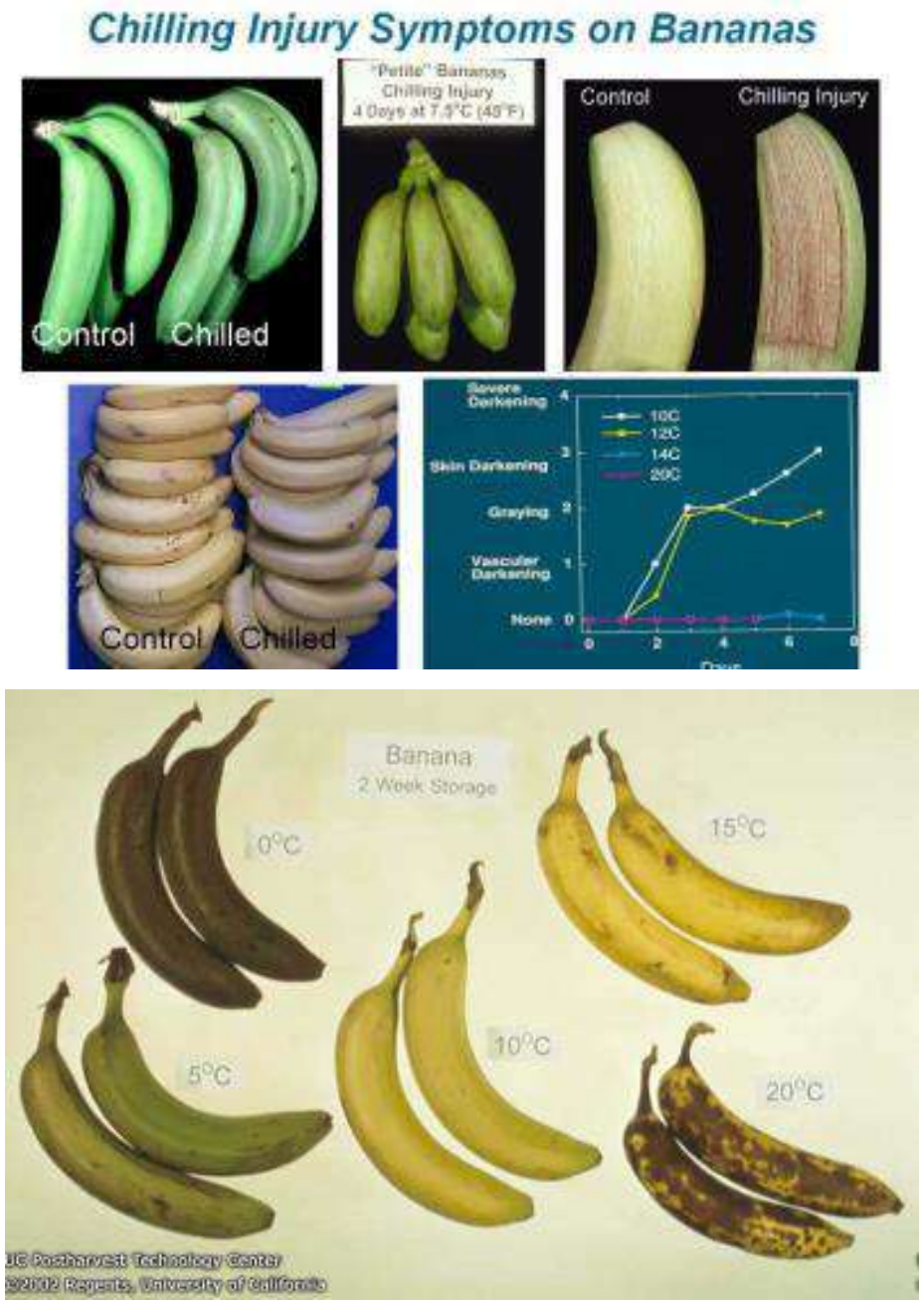


# Important problems

- Fast ripening
  - Use MA or CA at low temperature
- Decay
  - Treatments after harvest, Cold chain, MA/CA

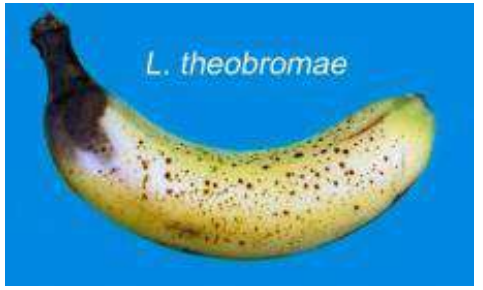
# Chilling Injury

- Banana is sensitive to low temperatures and bruising; Cannot be maintained at very low temperature
- Short life
- Chilling occurs when pre-harvest or post-harvest temperatures fall below 14°C for various time periods.
- The peel of banana become dark and the fruit exhibit uneven ripening. Ripening fingers show dull yellow to smoky yellow colour and watery dark patches are observed on the skin. Brittleness of the fruit and fungal invasion is also observed.
- Appears as skin and pulp darkening, softening, sweetness



# Postharvest Diseases

- Minimizing bruising;
- Prompt cooling to 14°C;
- Proper sanitation of handling facilities;
- Fungicide (such as Imazalil) treatment to control crown rot;
- Hot water treatments [such as 5 minutes in 50°C water] can help.

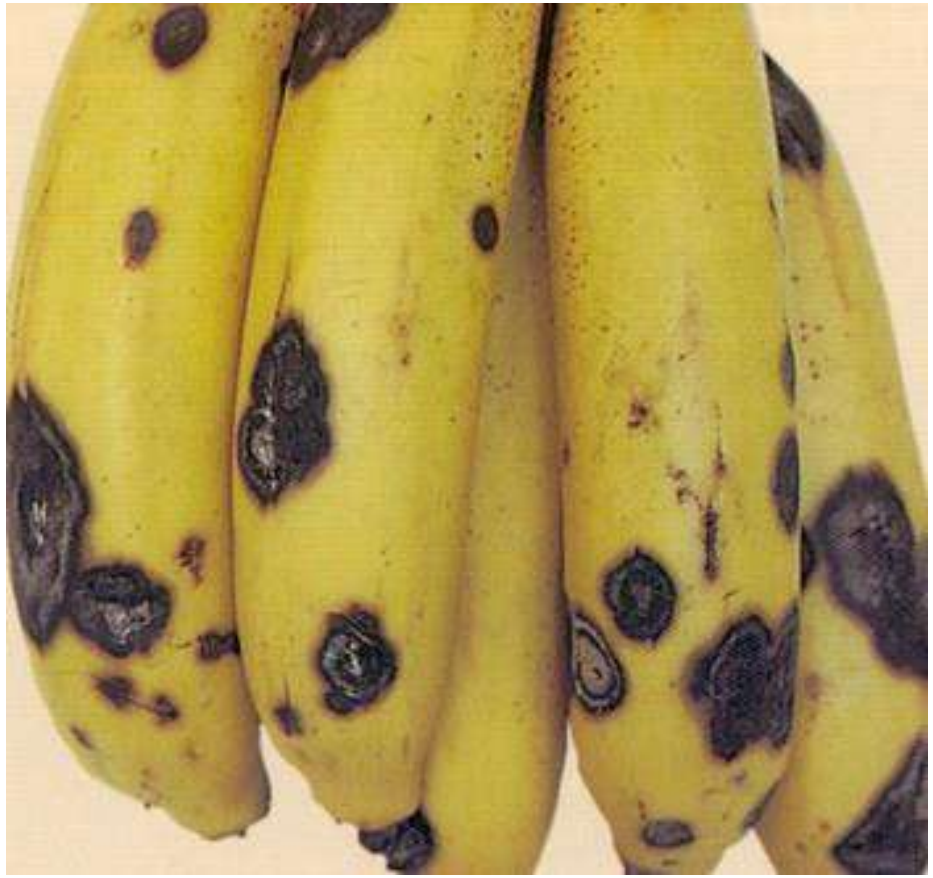




# Anthracnose

**Cultural control:**

- Proper sanitation of handling and prompt cooling to 14° C are essential in minimising the disease in cold storage.



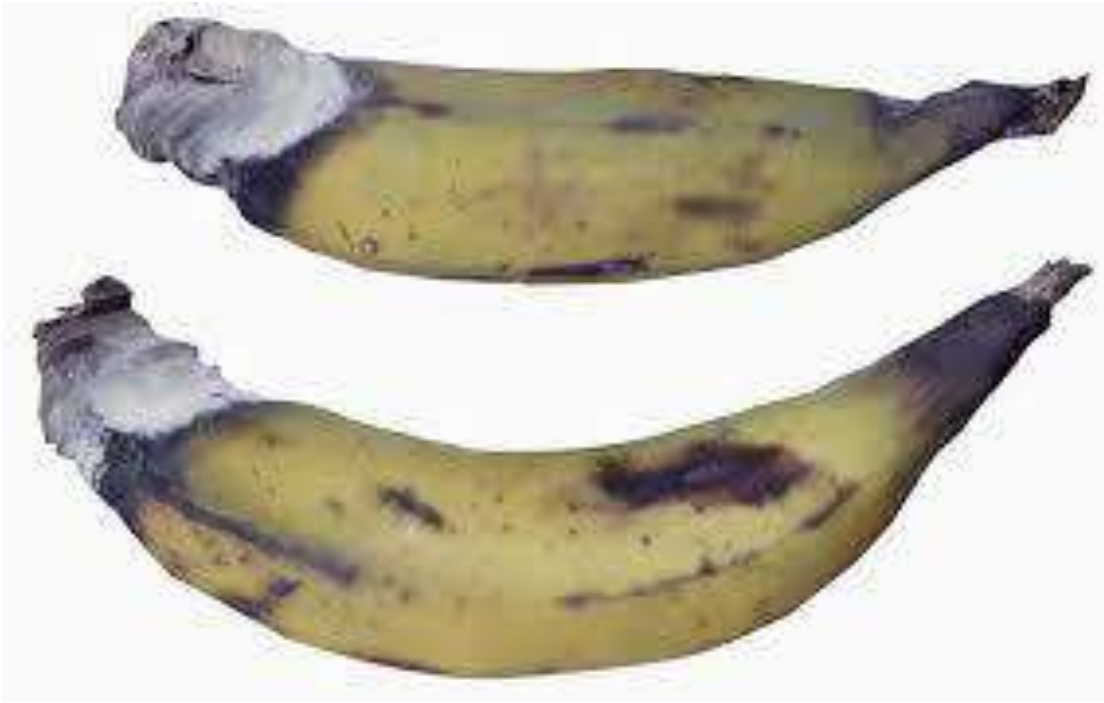
# Cigar end rot

**Cultural control:**

- Prompt cooling to 14° C; proper sanitation of handling facilities reduce the incidence in the cold storage.

Chemical control:

- Mancozeb 75% WP @ 600-800g in 400 l of water/acre



# Packaging Specifications for Banana (Export)

| Corrugated Fibreboard Box | | | | Capacity : 5 Kg |
|---|---|---|---|---|
| **A. Minimum Specifications** | | | | |
| Material of Construction* | Corrugated Fibre Board | Corrugated Fibre Board | Corrugated Fibre Board | Corrugated Fibre Board |
| External Dimensions (mm) | 333 x 300 x 200 | 333 x 300 x 200 | 333 x 300 x 200 | 333 x 300 x 200 |
| Style of Box** | RSC – 0201 | Telescopic - 0300 | Telescopic - 0306 | Telescopic - 0312 |
| No. of Plies | 3.0 | Lid - 3 Tray - 3 | Lid - 3 Tray - 3 | Lid - 3 Tray - 3 |
| Type of Flutes | B (Narrow) | Lid B (Narrow)<br>Tray B (Narrow) | Lid B (Narrow)<br>Tray B (Narrow) | Lid B (Narrow)<br>Tray B (Narrow) |
| Direction of Flutes | Vertical | Vertical | Vertical | Vertical |
| Grammage ($g/m^2$)<br>Outer to Inner (Indicative) | 250 / 150 / 150 | Lid : 250/150/150<br>Tray : 150/150/150 | Lid : 250/150/150<br>Tray : 250/150/150 | Lid : 250/150/150<br>Tray : 250/150/150 |
| Burst Factor of Paper (Kraft) (Minimum) | 20.0 | 20.0 | 20.0 | 20.0 |
| Bursting Strength of Board ($Kg/cm^2$) (Minimum) | 11.0 | Lid : 11.0<br>Tray : 11.0 | Lid : 11.0<br>Tray : 11.0 | Lid : 11.0<br>Tray : 11.0 |
| No. of Pieces per Box | Not more than two | Not more than two | Not more than two | Not more than two |
| Manufacturer's Joint | By gluing | By gluing | By gluing | By gluing |
| Compression Strength of Box (Kgf) (Minimum) | 350 | 350 | 350 | 350 |
| COBB (30 Minutes)*** ($g/m^2$) (Maximum) | 60 | 60 | 60 | 60 |
| No. of Ventilation Holes | 16.0 | 16.0 | 16.0 | 16.0 |
| Diameter (mm) and Position of Holes | 20.0 | 20.0 | 20.0 | 20.0 |
| Two Sides Each | 3 | 3 | 3 | 3 |
| Two Ends Each | 1 | 1 | 1 | 1 |
| Top & Bottom Each | 4 | 4 | 4 | 4 |
| **B. Recommended Specifications** | | | | |
| Edge Crush (Kgf) (Minimum) | 43.00 | 43.00 | 43.00 | 43.00 |

*Outer ply of white duplex board or bleached kraft
**Or any other suitable style which provides equal strength and performance
***Outer ply to be laminated or coated for water proofing

Note:
- Dimensions of the box are modular to Euro pallets. However, any other dimensions or box styles to suit importers requirements could also be used.
- Grammage mentioned is indicative. However, any other grammage which provides equal strength and performance can be used.
- Diameter and no. of holes should be 20mm and 16 nos. respectively. However, sufficient ventilation depending upon the box style could also be used.

| Corrugated Fibreboard Box | | | | Capacity : 7 Kg |
|---|---|---|---|---|
| **A. Minimum Specifications** | | | | |
| Material of Construction* | Corrugated Fibre Board | Corrugated Fibre Board | Corrugated Fibre Board | Corrugated Fibre Board |
| External Dimensions (mm) | 333 x 390 x 250 | 333 x 390 x 250 | 333 x 390 x 250 | 333 x 390 x 250 |
| Style of Box** | RSC - 0201 | Telescopic - 0300 | Telescopic - 0306 | Telescopic - 0312 |
| No. of Plies | 5.0 | Lid - 3 Tray - 3 | Lid - 3 Tray - 3 | Lid - 3 Tray - 5 |
| Type of Flutes | B / B (Narrow) | Lid B (Narrow)<br>Tray B (Narrow) | Lid B (Narrow)<br>Tray B (Narrow) | Lid B (Narrow)<br>Tray B / B (Narrow) |
| Direction of Flutes | Vertical | Vertical | Vertical | Vertical |
| Grammage ($g/m^2$)<br>Outer to Inner (Indicative) | 250 / 120 / 120 /<br>120 / 120 | Lid : 250/150/150<br>Tray : 250/150/150 | Lid : 250/150/150<br>Tray : 250/150/150 | Lid : 250/150/150<br>Tray : 250/120/120/<br>120 / 120 |
| Burst Factor of Paper (Kraft) (Minimum) | 20.0 | 20.0 | 20.0 | 20.0 |
| Bursting Strength of Board ($Kg/cm^2$) (Minimum) | 14.0 | Lid : 11.0<br>Tray : 11.0 | Lid : 11.0<br>Tray : 11.0 | Lid : 11.0<br>Tray : 11.0 |
| No. of Pieces per Box | Not more than two | Not more than two | Not more than two | Not more than two |
| Manufacturer's Joint | By gluing | By gluing | By gluing | By gluing |
| Compression Strength of Box (Kgf) (Minimum) | 450 | 450 | 450 | 450 |
| COBB (30 Minutes)*** ($g/m^2$) (Maximum) | 60 | 60 | 60 | 60 |
| No. of Ventilation Holes | 16.0 | 16.0 | 16.0 | 16.0 |
| Diameter (mm) and Position of Holes | 20.0 | 20.0 | 20.0 | 20.0 |
| Two Sides Each | 3 | 3 | 3 | 3 |
| Two Ends Each | 1 | 1 | 1 | 1 |
| Top & Bottom Each | 4 | 4 | 4 | 4 |
| **B. Recommended Specifications** | | | | |
| Edge Crush (Kgf) (Minimum) | 34.00 | 43.00 | 43.00 | 43.00 |

*Outer ply of white duplex board or bleached kraft
**Or any other suitable style which provides equal strength and performance
***Outer ply to be laminated or coated for water proofing

Note:
- Dimensions of the box are modular to Euro pallets. However, any other dimensions or box styles to suit importers requirements could also be used.
- Grammage mentioned is indicative. However, any other grammage which provides equal strength and performance can be used.
- Diameter and no. of holes should be 20mm and 16 nos. respectively. However, sufficient ventilation depending upon the box style could also be used.

## BANANA Capacity : 13Kg/18kg

### A. Corrugated Fibreboard Box

| A. Minimum Specifications | |
|---|---|
| Material of Construction* | Corrugated Fibre Board |
| External Dimensions (mm) | |
| 13 Kg | 545 x 330 x 255 |
| 18 Kg | 750 x 300 x 200 |
| Style of Box** | TELESCOPIC |
| No. of Plies | Lid :3 Tray : 5 |
| Type of Flutes | Lid :B (Narrow)<br>Tray : B/B (Narrow/ Narrow) |
| Direction of Flutes | Vertical |
| Grammage (g/m²) | Lid : 250 / 150 / 150<br>Tray : 250 / 120 / 120 /120 / 120 |
| Burst Factor of Paper (Kraft) (Minimum) | 20.00 |
| Bursting Strength of Board (Kg/cm²) (Minimum) | Lid :11.0 Tray : 14.0 |
| No. of Pieces per Box | Not more than two |
| Manufacturer's Joint | By gluing |
| Compression Strength of Box (Kgf) (Minimum) | 500 |
| COBB (30 Minutes)*** (g/m²) (Maximum) | 60 |
| No. of Ventilation Holes | 16.0 |
| Diameter (mm) and Position of Holes | 20.0 |
| Two Sides Each | 3 |
| Two Ends Each | 1 |
| Top & Bottom Each | 4 |
| | One slot on each of the ends of the box |
| **B. Recommended Specifications** | |
| Edge Crush (Kgf) (Minimum) | Lid : 37.00 / Tray : 38.00 |

*Outer ply of white duplex board or bleached kraft
**Or any other suitable style which provides equal strength and performance
***Outer ply to be laminated or coated for water proofing

Note:
- Dimensions of the box are modular to Euro pallets. However, any other dimensions or box styles to suit importers requirements could also be used.
- Grammage mentioned is indicative. However, any other grammage which provides equal strength and performance can be used.
- Diameter and no. of holes should be 20mm and 16 nos. respectively. However, sufficient ventilation depending upon the box style could also be used.

### B. Specifications of Bag

| | |
|---|---|
| Material of Construction* | High Molecular High Density Polyethylene (HMHDPE) |
| Weight of the Bag (gms) | 30 |
| Thickness (gauge) | 100 |
| Total Height of the Bag (mm) | 810 |
| Height of the Bag upto Seal (mm) | 780 |
| Length of the Bag (mm) | 570 |
| Total width of the Gusset (mm) | 270 |
| Perforations | Distance between two pinhole perforations should not be more than 25mm. |

### C. Ethylene Absorber Sachet

| | |
|---|---|
| Material | Granules of mixture of potassium permagnate and clay packed in sachets. However, any sachet containing similar material and giving the same performance can also be used. |
| Weight of Material Inside the Sachet (gms) (max) | 7gms |
| Dimension of Sachet (mm) | 70 x 70 |

### D. Specifications of Bubble Film

| | |
|---|---|
| Diameter of Bubble (mm) | 10 |

# Do’s

- Ensure good drainage in the field.
- Prepare pits and fill it with the mixture as recommended.
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning of the orchard.
- Follow fertigation schedule as recommended.
- Compulsorily apply organic manure as per recommendation.
- Apply micronutrient as and when needed.
- Compulsorily weed/ intercultivate, timely operation helps in crop growth.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.
- Keep the farm machineries well-maintained and operative.
- Regular field visit and scouting of the farm should be done.
- Use protective clothing and gloves by field workers/farmers while handling chemicals and fertilizers.

# Don’t’s

- Don’t over irrigate the crop at anytime.
- For fertigation don’t mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don’t use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don’t add solid fertilizer from the gunny bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don’t use metal container.
- Don’t stir the solution with naked / unprotected hand. Use wooden spoon or stick.
- Don’t heat the fertilizer solution to increase solubility.
- Do not spray pesticide under hot sun.

## Important Notice:

The information on performance of recommendations given in this handbook holds good only when used under optimum conditions. Their performance may either change in due course of time due to several factors or can vary under different systems of management. Mishandling/negligence of the user can also result in damage/loss/non reproducibility of results.
The user is advised to contact their nearest KVK and refer to the latest Ad-hoc list for information on banned chemicals and other nationally-issued directives.

## महत्वाची सूचना:

या हँडबुकमध्ये दिलेल्या शिफारशींच्या कामगिरीची माहिती इष्टतम परिस्थितीत वापरली जाते तेव्हाच चांगली राहते. त्यांची कार्यक्षमता एकतर अनेक कारणांमुळे योग्य वेळी बदलू शकते किंवा व्यवस्थापनाच्या वेगवेगळ्या प्रणालींमध्ये बदलू शकते. वापरकर्त्याच्या चुकीच्या हाताळणी / निष्काळजीपणामुळे परिणामांचे नुकसान / पुनरुत्पादन न होणे देखील होऊ शकते. वापरकर्त्यास त्यांच्या जवळच्या केव्हीकेशी संपर्क साधण्याचा आणि प्रतिबंधित रसायने आणि इतर राष्ट्रीय-जारी निर्देशांच्या माहितीसाठी नवीनतम तदर्थ यादीचा संदर्भ घेण्याचा सल्ला देण्यात आला आहे.

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