

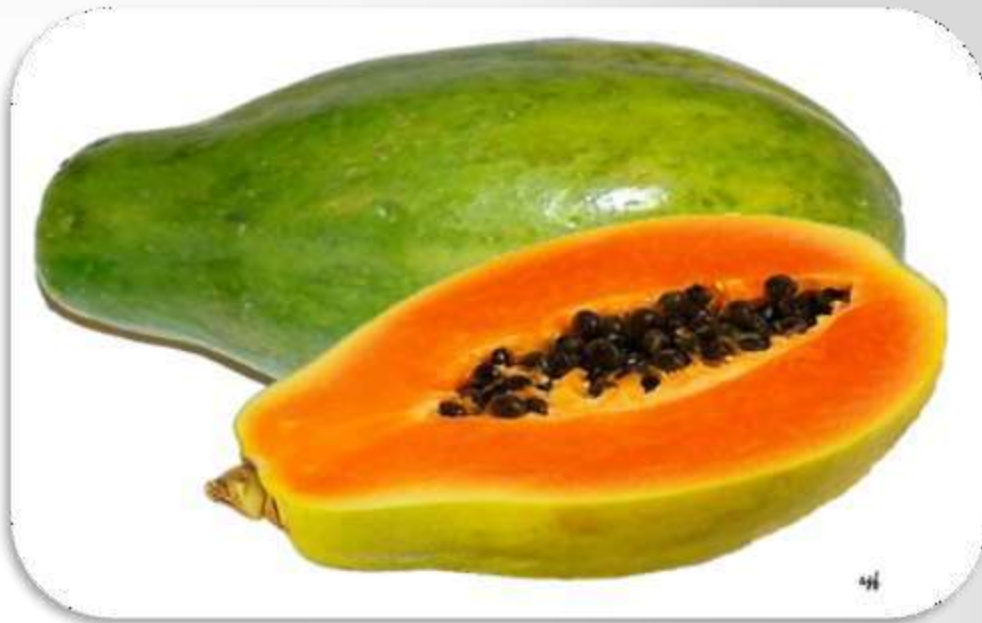
PAPAYA

Botanical name : *Carica papaya*

Family: Caricaceae

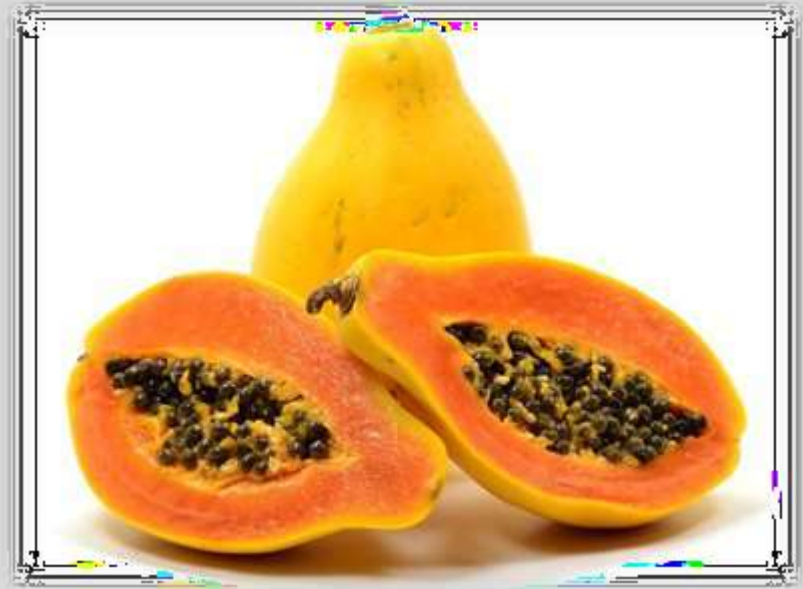
Chromosome no. : $2n=2X=18$

Origin : Tropical America
(Mexico)



Taxonomic classification

- Phylum : Angiospermae
- Sub Phylum : Dicotyledons
- Division : Lignosae
- Order : Cucurbitales
- Family: Caricaceae
- Species : *Carica papaya* L.
- Chromosome no. : $2n=2X=18$
- *Carica*-22 spp., *Jacarita*-6pp., *Jarilla*-1spp., *Cylicomorpha*-2spp.



BOTANY

- Papaya has **4 genera and 22 species**. It is naturally a **dioecious** plant, but **gynodioecious** cultivars have been developed in papaya through breeding.



- Papaya is quick growing **herbaceous perennial single stemmed**, unbranched plant. The **leaves are palm** like with long stalks. **Flowers are borne in axillary position** and solitary and fragrant with variety of sex forms.

FLORAL BIOLOGY

- ✓ Dioecious papaya produces male and female flowers separately on different plants while gynodioecious produces both male and female flowers on the same plant.
- ✓ Anther dehiscence was completed within 18-36 hours before the flowers opened and the stigma becomes receptive a day before the flowers opened remaining receptive for 6 days.
- ✓ The peak anthesis observed between **5-6 am**. The receptivity of stigma was found on day of anthesis and remains **receptive for 6 days**.
- Three types of flowers ;
 - Female
 - Male
 - Hermaphrodite

Staminate- show sex reversal in different Environmental conditions

Hermaphrodite- show sex reversal in different Environmental conditions

Pistillate- highly stable.

Storey (1958) reported 8 categories of flowers in papaya(morphological/sex forms).

- Staminate- produced by male plant.
- Tetralogical staminate- produced by sex reversing male plants.
- Reduced elongata-produced by hermophodite plants.
- Elongata- produced by hermoprodite plants(referred to as normal bisexual flower)
- Carpelloid elongata- produced by hermophodite plants.
- Pentandria- produced by hermophodite plants.
- Carpelloid pentandria- produced by hermophodite plants.
- Pistillate- produced by female plants.





Fig. : Papaya male plant with fruits



Fig. : Papaya female plant with fruits



Fig. : Papaya hermaphrodite plant with fruits

Area-1,32,000 Ha

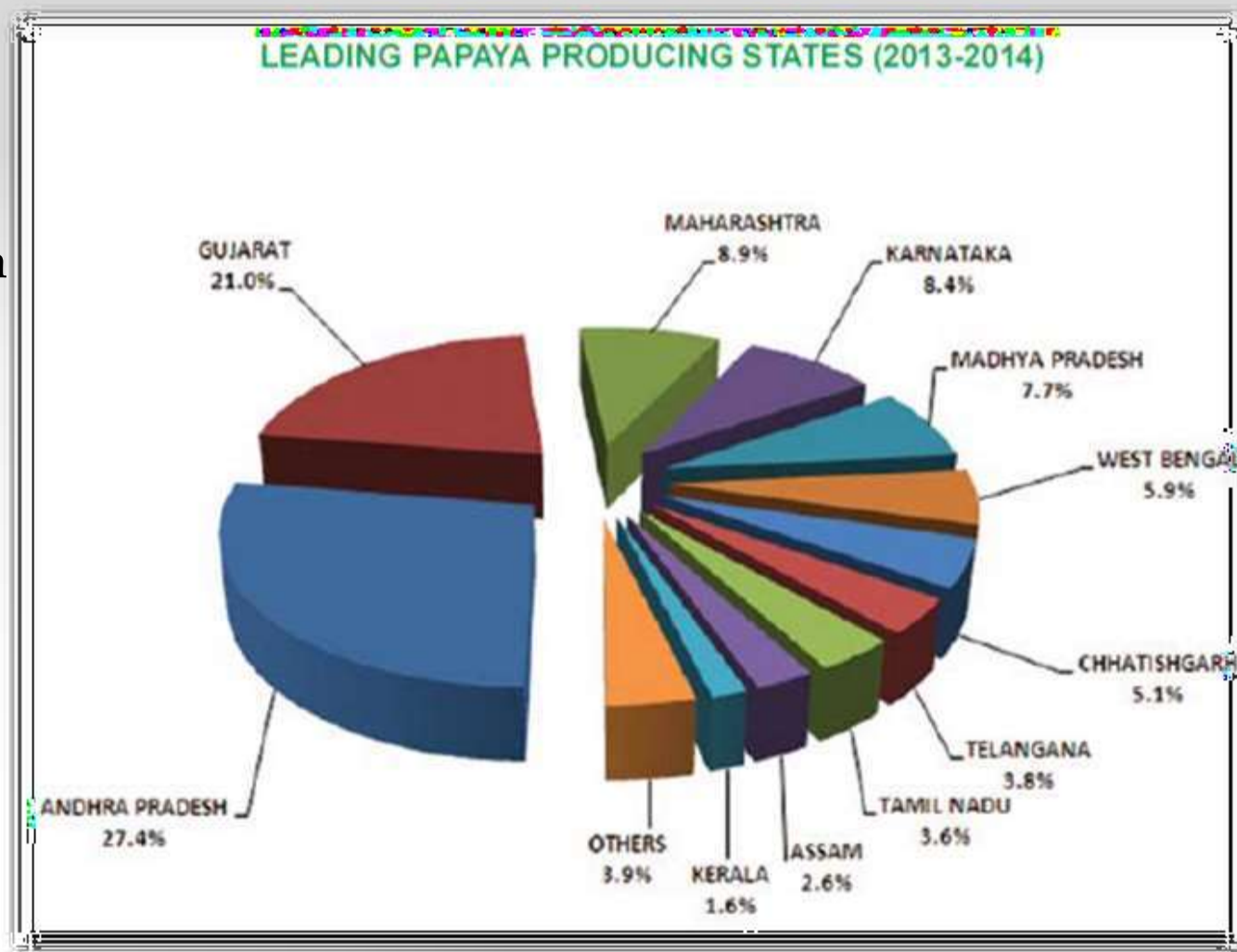
Production- 56,67,000 MT

Productivity- 42.93 MT

NHB, 2016-17

Major producers:

- Andhra pradesh
- Gujarath
- Maharashtra
- Karnataka
- Madhya pradesh



Nutritional value

- ✓ Vitamin A (2020IU/100g)
- ✓ Moisture- 90.8%
- ✓ Protein- 0.6%
- ✓ Carbohydrates- 7.2%
- ✓ Fat- 0.1%
- ✓ Potassium- 69mg/100g
- ✓ Calcium- 17mg/100g
- ✓ Vitamin C- 57mg/100g



Health Benefits of Papaya

- Papaya contain **212 amino acids** and several enzymes, including papain, a proteolytic enzyme that has an anti-inflammatory effect on the stomach, including swelling and fever that can develop post-surgery.

Climate

- It is a tropical fruit plant best grown in warm areas, plenty of sunlight.
- It needs adequate moisture and even distribution of rainfall throughout the year and cannot withstand strong winds.
- Temperature range of **21°C** to **33°C** is ideal for sturdy growth.
- It grows well at altitude 1200m MSL.
- Very much sensitive to frost.

Soil

- Papaya grows best in light, well-drained soil rich in organic matter.
- Deep clayey soils that are prone to water-logging should be avoided.
- Papaya grows best at pH 6.0 to 6.5 but can tolerate pH up to 5.8 to 7.0.



Varieties

1. **Solo:** It is a table purpose variety. The fruits are small with deep pink pulp and a sweet taste. Excellent for kitchen garden.
2. **Ranchi:** It is a variety from **Bihar** and popular in **south India**. The fruits are oblong with dark yellow pulp and **sweet taste**.
3. **Pusa Delicious:** It is a **gynodioecious** variety with 100% productive plants with good fruit yield and quality having excellent taste and good **flavor**.
4. **Pusa Majesty:** This is also **gynodioecious** variety with high productivity and better **keeping** quality of fruits. This is also one of the **highest papain** yielders.
5. **Pusa Giant:** This is a vigorous variety and is **dioecious** in nature. The fruits are suitable for **tooty-fruity** and **candies** like *petha*.

6. Pusa Nanha- An extremely dwarf variety. It is suitable for kitchen gardens, pot and roof cultivation. It is developed through mutation breeding.

7. Coorg Honey Dew: A selection from Honey Dew, it is a **gynodioecious**.

8. Pink Flesh Sweet: It is a selection with excellent-quality fruits. Fruits are medium sized with pink flesh, The TSS is **12-14° Brix**. It is a good dessert variety.

9. CO-1 (1972): It is developed by sib mating Ranchi type over a period of eight years. The plants are dwarf in stature and **dioecious**. There is no papain in the fruit. It is a good table variety with good keeping quality.

10. CO-2 (1979): It is **pureline** selection from a local type. A dioecious type with good Papain yield (4-6g per fruit).

11.CO-3 (1983): It is a hybrid derivative of the cross between **CO-2** (female parent) and **Sunrise Solo** (male parent). It is a gynodioecious variety.

12.CO-5 (1985): It is a **selection** from **Washington type**. It is a **dioecious** type suitable exclusively for papain production giving **14.45g of dry papain per fruit**.

13.CO-6 (1986): It is a **selection** from a **giant papaya**. The plants are dwarf. First harvest can be had in **8 months** of planting. It is suitable for papain (7.5 to 8.0g of dry papain/fruit) and also for table purpose. Plants are dioecious.

14.CO-7 (1997): This variety (culture CP81) is **gynodioecious** in nature developed through multiple crosses. The parents are Pusa Delicious, CO-3, CP.75 and Coorg Honey Dew.

15.Washington: It is a table purpose variety. Male and female plants are separate.

16.Taiwan: This variety is cultivated for table as well as processing purpose. This is gynodioecious variety with blood-red coloured flesh and good taste.

17.Sunrise solo: This is gynodioecious variety having pink flesh and good taste. This variety does not has male parents.

18. Pusa Dwarf: It is dwarf statured dioecious variety with good yield.

19.Pusa delicious: Gynodioecious line, heavy yield, fruit very sweet with good flavour, medium tall plant.

20.Surya: Scientists at IIHR, Bangalore have developed a new **hybrid** which is cross between **Sunrise Solo** and **Pink Flesh**. It is good for distant market.

21. Pink flesh sweet: It is selection with excellent quality fruits with good dessert quality.

22.CO.4 (1983): It is **hybrid** derivative of the cross between **CO.1** (female parent) and **Washington** (male parent). It is dioecious variety.

23. Sun up: red fleshed.

24. Rainbow: Sun up was crossed with yellow fleshed **Kapoha** to produce **Rainbow** and which was the **1st commercial transgenic papaya**.

Gynodioecious cultivars:

Pusa delicious, Coorg Honey Dew, Pusa majesty, Taiwan, sunrise solo, Surya, CO-3, CO-7.

Dioecious cultivars:

Pusa giant, CO-5, Pusa dwarf, CO-6, CO-1, CO-2, Pant 1

Different varieties of papaya



CO 1



CO 2



CO 3



CO 4



CO 5



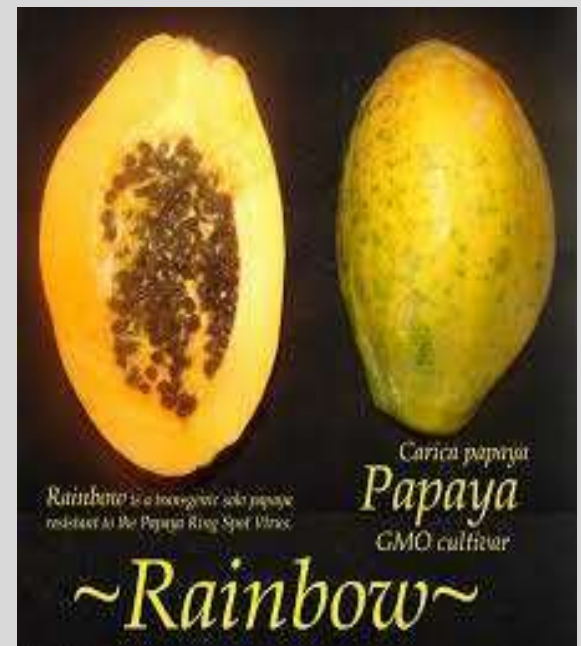
CO 6



CO 7



CO 8



Propagation

Sexual Method -propagated by **seeds**.

- Wash the seeds and remove then gelatinous covering as this can inhibit germination.
- Seed treated with **Thiourea** (100-200 ppm) and **Gibberellic acid** (GA3 at 200 ppm) for better germination.
- Seed germinates in **2 weeks**.
- Seedlings transplanted after 45-60 days .

Seed rate :

250-300g/h(Gynodioecious) and 400-500g/h(Dioecious) (20 seeds/g).

Asexual method:

- **tissue culture technique** using MS media supplemented with NAA.
- Shoot tip culture from seedling and laterals buds from female plants of Coorg Honey Dew variety was successful.

Land preparation

- Organic fertilizer and manure should be spread and incorporated in the soil during land preparation.
- Land should be free from weeds before planting.

Planting density

- ✓ 1.8 m x 1.8 m = 3086 plants/ha for normally followed in most places.
- ✓ 1.25 m x 1.25 m = 6400 plants/ha for Pusa Nanha is best for HDP.
- ✓ 1.6 m x 1.6 m = 3906 plants/ha suitable for papain production.
- ✓ A triangular **2 x 2** planting design can be adopted for non mechanized cultivation, and **2 x 2 x 4** in double rows **for mechanized cultivation.**



Irrigation

- After transplanting, make sure the plants get adequate water every 2-3 days until they are well established.
- Water the papaya plants regularly especially when the climate is hot or dry to
- prevent growth retardation, flower abortion and dropping of young fruits.
- We can use method of **drip irrigation** for efficient use of water.
- Papaya requires 12 gals of water per day.

Manuring and fertiliser application

- ✓ The nutrition for papaya differs from other fruit crops because of its quick growth, continuous fruiting habit and higher yield.
- ✓ NPK:: 250:250:500 g/plant, FYM 10 Kg/plant (UHS, Bagalkot).
- ✓ Apply 20 g in each of *Azospirillum* and *Phosphobacterium* at planting and again after six months of planting.
- ✓ Deficiency of lime, zinc and boron has often been observed in papaya orchards. Spraying of 0.5% Zinc sulphate and one spray of Borax (0.1%) may be done depending upon the nutrient status of soil.

Weed control

- ✓ weeds can reduce by 25% production.
- ✓ Deep hoeing is recommended during first year to check weed growth.
- ✓ Application of Fluchloralin or Alachlorin or Butachlorine (2kg/ha) as pre-emergence 2 months after transplanting can control all weeds for 4 months.

Intercropping

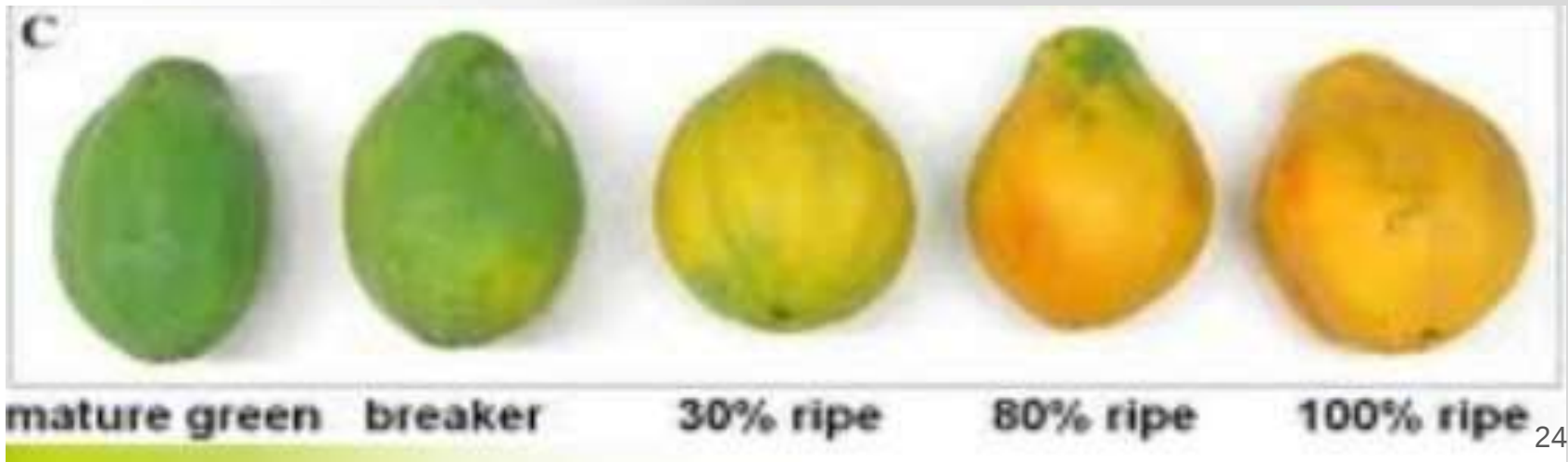
- Low-growing vegetables of short duration may be taken as inter-crops.
- An occasional thinning of fruits necessary to prevent overcrowding .
- Papaya also grows as filler or in plantations of other crops where spacing is wide enough.

Removal of male plants

About 10% of the male plants are kept in the orchards for good pollination where dioecious varieties are cultivated.

Maturity indices

- It is a climacteric fruit, so it should be harvested at mature stage.
- Usually fruits are harvested when they are of full size, **light green tinge of yellow** at epical end.
- We should harvest yellow green fruits as dark green fruits are not ripen.
- When the latex ceases to be milky and become **watery**, the fruits are suitable for harvesting.



Harvesting and yield

- ✓ While picking fruits from the tree, care must be taken that they are not scratched, and are free from blemishes, otherwise these are attacked by fungus and start decaying during marketing.
- ✓ On an average each plant of improved varieties bears **30-45 fruits**, weighing **40-75 kg** in one fruiting season.
- ✓ Average yield of **60-75 tons/ha** may be expected in a season.



STORAGE

- **Storage at** : 10°C-13° C with Relative humidity 85-90% for 1-3 weeks with proper handling.
- **Ethaphon treatment 1000 ppm** increase ripening



DISEASES

1. Stem rot / Foot rot:

Cause- It is caused by group of fungi but *Pythium aphanidermatum* is mainly responsible for it.

Symptoms- Rotting of stem near collar region.

Control- Kavach/Rovral (2ml/litre) and Metalxyl/Mencozeb (2g/litre) as and when required.



2. Powdery mildew:

Cause- *Oidium caricae/ Laveilulla taurica*

Symptoms- White mealy growth on leaves, petioles and young shoots.

Control- Apply wettable sulphur (1g/litre) during September-January.



3. Anthracnose:

Cause- *Colletotrichum gleosporioides*

Symptoms- Dark brown depressed spots of chocolate colour.

Control- Apply Carbendazim (1g/litre) and Mencozeb (2g/litre) 15 days before harvesting.



4. Damping off:

Cause- Complex of organisms responsible but mainly *Pythium* spp.

Symptoms- Causes drooping of seedlings which ultimately die off.

Control- Treat seeds with Captan (2g/kg).



5. Leaf curl

Cause- Papaya leaf curl virus (Vector-White fly, *Bemisia tabbaci*)

Symptoms- Curling, crinkling and distortion of leaves, reduction of leaf lamina, rolling of leaf margins inward and downward, thickening of veins.

Control- Uproot affected plants. Avoid growing **tomato, tobacco** near papaya. Spraying with systemic insecticides to control the vector.



6. Papaya mosaic

Cause- Potex virus (Vector- Aphid).

Symptoms- Plants stunted. Yellowing, mottling & distortion of leaves, bending of petiole.

Control- Control vector aphid. Remove affected plant. Spray **phosphomidon** 3ml in 10 litre water 36



7. Papaya Ring Spot:

Cause- Papaya ring spot virus (Vector- Aphid)

Symptoms- Vein clearing, puckering and chlorophyll leaf tissues lobbing in. Margin and distal parts of leaves roll downward and inwards, mosaic mottling, dark green blisters, leaf distortion which result in shoe string system and stunting of plants. On fruits circular concentric rings are produced. If affected earlier no fruit formation.

Control- Raise papaya seedlings under insect proof conditions. Plant disease free seedlings.

Raise **sorghum** / **maize** as barrier crop before planting papaya. Rogue out affected plants immediately on noticing symptom. Do not raise **cucurbits** around the field. Select to grow the tolerant varieties such as **Red Lady**.



INSECT- PESTS

1. **White fly-** *Bemisia tabbaci*

Symptoms of damage-Nymphs and adults suck the sap from under surface of the leaves. Cause yellowing of leaves.

Control- Installation of yellow sticky traps. Spraying Imidachloprid 200SL at 0.01% or triazophos 40EC at 0.06% during heavy infestation.

Release of **predators** viz., Coccinellid predator, *Cryptolaemus montrouzieri*. Release of **parasitoids** viz., *Encarsia haitierrsis* and *E.guadeloupae*.



2. Fruit flies- *Bactrocera dorsalis*

Symptoms of damage- Maggots puncture into semi-ripe fruits with decayed spots. Oozing of fluid and brownish rotten patches on fruits. Dropping of fruits.

Control- Monitor the activity of flies with methyl Eugenol sex lure traps. Spray Malathion 50 EC 2ml/litre.



3. Ash weevil- *Mytiloderus* spp.

Symptom of damage- Grub feed on the roots. Wilting of young sapling notching of leaf margin by adults.

Control- Dust Lindane 1.3 D at 25 kg/ha to kill grubs. Spray Carbaryl 50 WP at 2g/litre.



4. Aphid- *Myzus persicae*

Symptom of damage- Nymphs and adults suck the sap from leaves, petioles and fruits. Leaf curling and falling. Premature fruit drop.

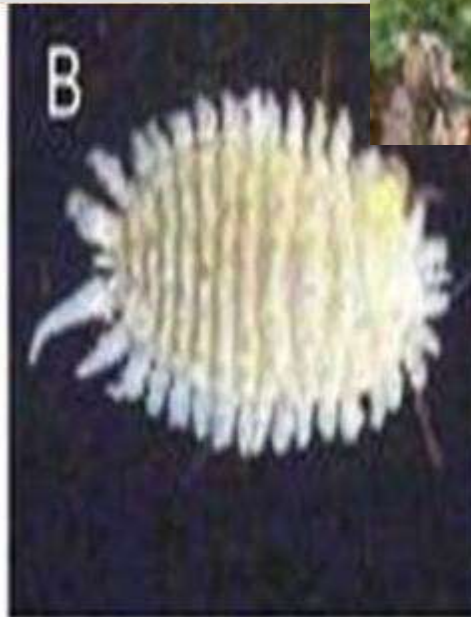
Control- Spray Dimethoate 0.03% or Methyl demeton 0.025%.



5. Mealy bugs-

Symptom of damage- Flatten oval insects (1-4 mm long). They can transmit a viral disease known as **leaf drop** and will cause a reduced yield.

Control- Spraying Malathion at the rate of 1.5 to 3.0 tbs. per 16 liter knapsack sprayer.



PAPAIN EXTRACTION

- The immature papaya fruit contains a milky latex.
- The dried latex called papain is in great demand in the international markets.
- Papain is used for detecting stomach and intestinal cancers and also in correcting diphtheria.
- Papain Uses: Proteolytic enzyme extracted from latex, Meat tenderizer, Cosmetics, Leather industry, Medicinal uses.



- Papain production is influenced by several factors :
1) Fruit size 2. Fruit maturity 3. Season 4. Cultivars (CO-5best) 5. Effect of PGRs
- The papain content of fruit decreases rapidly as it ripens.
- Papain extracted from the unripe fruit can fetch another Rs.35000 per hectare.
- Papaya fruits, which are about 90-100 days old (fully mature but not ripe), are selected for tapping. Tapping should be done in the morning hours before 10.00 am.
- The latex should be collected in suitable containers (arecanut spathes, aluminium trays or glass vessels).
- **Papain yield:** Crude papain from a plant yield **250-300 kg/ha**.

THANK YOU



M.VISWANTH
CUTM