

PAPAYA



Papaya, papaw or papita (*Carica papaya L.*) originated from tropical America, has become a popular fruit due to its fast growth, high yield, long fruiting period and high nutrient value as well. In addition it has been use as vegetable, fruit processing, and papain production at immature stage. It can be a highly profitable crop now.

The papaya plant has male, female, hermaphrodite (bisexual flower) and some other complex forms. Male plants do not bear any fruit, Normally the fruit shape from female plant is shorter, but the fruit shape from hermaphrodite (bisexual flower) plant is longer.

The seeds of following varieties we offer in grow in mixture of female plants and hermaphrodite plants.

I. CLIMATE AND SOIL CONDITION

Papaya is a tropical, plant, very sensitive to frost. Optimum temperature is 25 - 30° C and minimum 16° C. The suitable pH value is between 6 and 6.5. The well-drained or sandy loam soil with adequate organic matter is most important for the papaya cultivation. In high rainfall area, if drainage is poor and roots are continuously drenched for 24 to 48 hours, it may cause the death of the plants. Sticky and calcareous soils are not good as rain water may accumulate in the soil even only for a few hours. In this case, higher raised bed and drainage ditch are recommended.

The growing field should be irrigable and kept at suitable soil moisture which is necessary for the growth of papaya plants, although dry climate at the time of ripening is good for the fruit quality. Continuous cropping in the same field may result to poor growth and cause disease problem of papaya trees. Papaya does not like strong, cool, hot, dry or salty wind. It is better to grow in sheltered but full sunshine place. Staking and/or windbreak can decrease the damage to plants under strong wind.

II. RAISING SEEDLINGS

A. Seed Source:

The seed must be from dependable source and sown as soon as possible. The remaining seeds must be sealed tightly and kept at cool (5 -10° C) and dry (under relative humidity 40%) place.

B. Seed requirement:

One gram contains about 50 - 80 seeds, mostly 65 -75 seeds. It needs 50 to 80 g seeds per hectare at one plant per hill average of 80 % seed germination and 80% successful seedlings.

C. Growing season:

The time of sowing depends upon the choice of fruiting season and danger of rain or frost. In northern part of Taiwan, (around N 24) seeds are sown from March to May and transplanted from May to July. IN central and south areas (around N22, 23), seeds are sown almost all year round, but optimum season is from February to March (Spring) or from September to November (Autumn).

D. Seed germination:

The optimum temperature is 21 - 27° C, and of radical emergence is 19 - 29 °C. it take 1 - 4 weeks from sowing to emerge depending on the temperature. The seed may be treated with Thiram (TMTD) W.P. before sowing to control the fungus diseases at young stage.

E. Sowing method:

It may be sown directly, but normally, it is better to be seeded to raise seedlings and transplanted.

1. Plastic bag or soft plastic pot sowing:

Transparent plastic bag in 8 - 9 cm wide and 8 cm wide and 8 cm high or black soft plastic pot is used for raising seedlings. Drainage hole is required. Then fill with the mixture of sandy loam virgin soil and sand at the ratio 3: 1. Sow 1 or 2 seeds each bag (pot) and cover with well fermented compost, then water fully. Cover the bags (pots) with plastic film or thatch such as straw sheets or used jute bags to keep warm and wet till emergence. Meanwhile, keep the air fresh and moist, and then remove the cover gradually for fitting the seedling under the sun shine.

2. Seedling Tray sowing:

The use of plastic seedling tray is new way of seedling culture to obtain the healthy seedlings which are easily for the transporting and transplanting. The Tray size may be 74 to 82 holes at 4.5 cm each in diameter. Fill the prepare media in the holes, sow 1 to 2 seeds in each hole, and cover the layer of media. Other procedures are similar to plastic bag (pot) sowing.

For purposes of controlling aphid, viral infection, rain and wind protection, and maintaining tolerable temperature during seedling stage, it is required to use screen house, greenhouse or tunnel covered with 0.07-0.10 mm plastic film or 32 - mesh net. Black plastic net is also usually used for shading. During the seedling stage, semi-humid environment is preferred. For better aeration, the film may be covered during the cool night or heavy rain period and opened in the warm day time. The site of the bag, pot or tray should be changed if the roots of seedling penetrate into the soil. In this way, it will induce more new roots and healthy seedlings.

III TRANSPLANTING

A. Transplanting stage:

When the seedling is 10 -15 cm tall, it should be transplanted, but 30-40 cm is also all right if it is grown in a larger container.

B. Spacing:

A 40-60 cm high bed is required if the soil is not well drained. Normally, the distance between rows is about 2-2.5 m, and 2 m between plants (or 3m x 3m when grown at sloping land, or 2.7 m of distance between beds for the tractor practice). The total number of plants for each hectare is about 2,000 to 2, 5000. In case of eradication of undesirable sexual or virus infected plants later, the distance between plants at beginning of planting may be 1.2-1.5 m.

C. Pollinator Plants:

Minimum 10-20% hermaphrodite plants are required for pollination.

D. Planting method:

(A) Black-and-white plastic mulching film on the beds can be used to:

- (a) Reduce the loss of water and fertilizer nutrient
 - (b) Control weed
 - (c) Repel the winged aphids
 - (d) Decrease virus infection at young stage
 - (e) Decrease bed soil erosion.

(B) Drill the planting hole about 45 cm in diameter and 30 cm in depth. The soil in the hole is mixed with compost for planting. Then transplant the Seedlings (seedlings should be fully watered one day before transplanting) On a cloudy day or late afternoon to minimize transplanting shock. Take care Not to plant too deep, otherwise collar-rot disease may affect the buried part Of the stem. Then water immediately after planting.

(C) Intercrop with the newly-planted long term fruit trees such as orange. Short term crop such as corns or vegetables may also be considered but not Necessary.

(D) To retard growth, lower the fruit - setting site, resist the wind facilitate Management and harvesting, slant planting is considered as follows:
Plant the seedlings at the angel of 45° C between the stem and surface of Soil and then later cut the leaves, which touch the soil. Fix with rope at two thirds of the stem from the base and adjust the site up when the plant grows higher to prevent the stem from being upright.

Above procedures may be modified to fix the plant with plastic rope down to the side(s) of bed about 1-2 months after transplanting (about 36-40 cm height of the plant).

(E) Screen house cultivation: For reducing virus infection during growing Period, the following cultivation is recommended:
Use 3.0 - 3.6 m long of bamboo stems or concrete stakes as supporters at a distance of 4.5 - 5m, and connect with No.12 iron wire. Then tightly surround with 32- mesh white net, which contains anti-ultra violet material. After the construction is completed, the protected healthy seedlings are planted and the virus-infected plants destroyed and buried immediately once found. Note that hand pollination for female trees is required (the central flower of the cluster on the bisexual plants can be taken as pollen supplier) and control the powdery mildew and mites well. The net may be taken off before the fruit is mature.

IV. Fertilization

The plant needs continuous fertilization, as fruiting is continuous upon maturity. Recommended rate of fertilizers for papaya is as follows:
(it should be modified depending upon the soil conditions)

A. Basal fertilization:

Apply 10 tons of fermented compost per hectare (or 1 kg per square meter) before planting or when forming beds. The same dose should be repeated every year for the adult plants

B. Side dressing: Apply NPK at rate of 4:85 monthly, bimonthly or Seasonally. Following fertilizers in kg is for 100 plants in the period:

Age	N	P	K	Total	Frequency
Within 6 months	5.6	12	2.4	20	2-3
between 6-12 months	25	54	11	90	2-3
between 1-2 years	35	75	15	125	4-6
between 2-3 years	58	134	20	212	4-6

(C) Others: Apply 0.25 - 0.5 kg borax per 100 plants right before dry season In which is boron-deficient. For the young trees, apply compound fertilizers in the trench (10 cm deep and 15 cm wide) around the outer of tree crown, then fill back the soil, or top dress at furrows after irrigation

V. Weed control

Weeds should be removed at the young stage frequently and lightly, but never do deep tillage to the soil since the plant has shallow roots. Growers may apply herbicide once before emergency with 43% lasso E.C. at 1:200 or 80% Kamex W.P. at at 1:400; or mulch the bed with the plastic film before transplanting or with rice / sugarcane straws before or within a few days after transplanting to control the weeds, soil erosion and water loss..

VI. Irrigation

Normally, irrigate every 10 days in winter or every week in summer, but practise varies according to soil, climatic conditions, and irrigation methods. Ring method, furrow or drip irrigation can be done. However, be sure to prevent the water from coming in contact with the stem. Irrigation may prevent the plants from the damage of frost.

VII. Other Management

- A.** Remove the side shoots of the stem as soon as possible.
- B.** Cut the old, dry, or disease leaves and petioles.
- C.** Thin the fruits, which are poorly pollinated, malformed or pest- infected. Nevertheless, avoid transmitting the virus mechanically from infected plant to others through the above practices.
- D.** Support the plant with stakes, which should tie with the rope, especially when bearing heavy fruits and during storm season.
- E.** Pollinate by hand to increase the fruit setting and the percentage of large and normal fruits, especially when growing net house.
- F.** Management after storm
 1. Drain the plantation well.
 2. Apply the fungicide to control phytophthora blight.
 3. Spray 0.5% urea or side dress the fertilizers.
 4. Support the fallen trees to keep them from the surface of the soil.
 5. Cover the fruits with paper to avoid the sun scald.
 6. Thin the small fruits if the trees are severely damaged.

VIII. Harvest

In general, papaya takes six months to flower and another five for harvesting; but it may vary according the climate conditions and management. For shipping to the distant markets the fruits should be harvested when the apical and starts turning yellow and the latex is no longer milky. During the cold months the fruits can be left on the tree to develop deeper color and obtain better flavor.

Step ladder or plumber 's helper with long bamboo pole is usually used by the small growers to pick the fruits if the trees grows too tall. The bin attached to the tractor is used for harvesting in large plantation. The fruits can matcher well by treatment of calcium carbide or ethylene gas.

IX. Pest control and micro - element deficiency management

(Please refer to your local recommendation for chemical control)

- A. Papaya Ring Spot Virus (PRSV) and Papaya Leaf-Distortion Mosaic Virus (PLDMV)**

PRSV induces vein - banding mottling and yellowing spot or distortion of leafs, water soaking streaks on and petioles, and ring spots appear on fruits or even on leaves. It stunts the plants and drastically reduces the size of fruits, sugar content, and taste. Some infected plants will bear fruit or production would decline. It spreads very fast and has become the limiting factor in papaya production in many areas of the world.

PLDMV induces characteristics rosettes of leaves with slender stems on the crown top. The fruit has the same markings as PRSV, but there are bumpy swellings around the ring spots. Both viruses are transmitted by sap (via mechanical means) or aphids. No evidence has been found that they are seed transmitted.

Control:

1. Select to grow the tolerant varieties such as Known You No. 1 and Red Lady.
2. Grow the seedlings and trees under the net house or screen house.
3. Transplant at a time when there are relatively few winged aphids around and protect the seedling with transplant cylindrical plastic film and supports.
4. Inter- crop papaya with barrier crop such as corn, but never host crops such as cucurbit. (May sow the corn seed one month after transplanting)
5. Mulch silver and black plastic film to deter winged aphids from visiting young seedling.
6. Immediately eradicate and burry the whole infected plant once found
7. Do not touch the healthy plants if hand or foot is contaminated with infected plant
8. Control the aphids
9. Practice cross protection with specific mild strain, but it often breaks down after a few months, losing its affectiveness.
10. Papaya tree may be treated as an annual crop and requires replanting every year in order to cut down on virus infection in the area where virus occurs seriously

- B. Damping-off (*Pythium aphanidermatum*, *P. ultimum*, *Phytophthora palmivora* and *Rhizoctonia* sp.) The fungi live in the soil. The disease is favored by high temperature and wet weather, wet soil, poor drainage, deep sowing, thick sowing (crowded), poor soil aeration, high nitrogen in the soil and sunshine shortage. Infected seedlings will wilt, fall and then die.

Control:

1. Use virgin soil or sterilize the soil with steam at 180°F (82.3°C) for 30 minutes or fumigate with methyl bromide (see manufactures recommendations)
2. Improve above mentioned enviornmental conditions to be favorable to the seedlings.
3. Protect with plastic film from rain water.
4. Drench the slution of 35% Etridiazole (Terrazole)

C. *Phytophthora* Fruit Rot (*Phytophthora palmivaro*)

Occurs in the hot and humid season, especially after typhoon attacks. It induces root rot on young and adult plants, and finally wilts or dies. Also it may cause large lesions and white mold appears on the fruit and then fruit drops.

Control:

1. Rotate with other crops.
2. Select well drained soil.
3. Avoid harming the roots.
4. Control the snails and ants.

5. Rogue and deeply bury the diseased fruits.
6. Spray 80% Mancozeb (Dithane M - 45) W.P. at 1:400 weekly.

D. Powdery Mildew (*Oidium caricae*)

White and gray powder-like mold appears on the leaves, petioles, stem and young fruits in early spring season (around 18-22° C). It stunts the plant, induces leaf dropping, or does not set fruit.

Control: Spray one of the following fungicides with the sticker at 10-14 intervals.

1. 50% benomyl (benlate) W.P. 1:3000
2. 70% wettable sulfur at 1:400
3. 10.5% Penconazole E.C.1: 2000 phytotoxic to seedling.
4. 50% Binapacryl W.P 1:2000 phytotoxic to seedling.
5. 18.6% Triforine E.C. 1:1000 phytotoxic to seedling.
6. 19.5% Dinocap W.P.1:1500 phytotoxic to seedling.

Caution should be taken that the above mentioned chemicals may injure papaya at high temperature or/and at high concentration.

E. Anthracnose (*Colletotrichum gloeosporioides*, *Glomerella cingulata*)

It attacks the petioles and fruits. Symptoms mainly appear on the mature fruit and thus shorten its shelf life. The symptoms are usually round, water soaked lesions which if enlarged, will be slightly sunken. The fungus frequently produces light-orange masses of spores in the central lesion.

Control:

1. Weekly spray 80% Mancozeb (Dithane M -45) W.P. 1:400 with spreader/sticker. 2.Treat the harvested fruits with hot water at 49°C for 20 minutes, then dip in the cool water for 20 minutes and then dry it.

F. Black Spot (*Asperisporium caricae*, *Caercoospora papayae*)

The leaf spots are grayish-white, roughly circular to irregular in shape. Heavily infected leaves turn yellow and dry up. The spots on fruit are tiny water-soaked, turning black and corky. Wet and cool place at hill side is more serious.

Control: Please refer to “Anthracnose” control.

G. Root Rot (*Rhizoctonia solani*, *Fusarium* sp.)

It causes root decay, leaf yellowing, and failing plant after raining. It also kill young seedlings in the nursery.

Control:

1. Rotation
2. Good drainage
3. Staking
4. Sterilization of the nursery bed with formaldehyde two weeks before sowing or treating the seeds with thiram (TMTD) or captan.

H. Collar Rot, Foot Rot (*Pythium aphanidermatum*)

Symptoms include swelling, cracking and rotting of the stem, when it comes in contact with water during the rainy season.

Control: Please refer to “ Damping-off” control.

I. Stem-end Rot (*Ascochyta* sp. And other fungi)

A dry, firm, dark rot usually occurs after picking. It starts at the stem-end and extends into the fruit.

Control: Pick the fruits with part of peduncle.

J. Rhizopus Fruit Rot (*Rhizopus stolonifer*)

The fungus invades injured mature fruit only It causes soft rot and produces masses of visible black sporangia; leakage of cell fluids from the rotting fruit will also occur.

Control:

1. Be careful when picking, transporting and packing to avoid bruising or injuring the fruit.
2. Heat treatment to kill the pathogen.
3. Remove and destroy the rotting fruit in the packing sheds.

K. Black Rot (*Erwinia cypripedii*)

The symptom mainly appears on the top of the stem. It primarily causes water-soak, then turns to black and leaves fall. New shoots may be infected and finally the plant dies. Occasionally the symptom of water-soaked lesions are found on the leaves and petioles and will turn to brown angular and necrotic spots. Bacteria also invade the flesh, induce brown spots and decay, producing poor odor.

Control:

1. Eradicate the severely infected plant.
2. Cut the infected portion of the stem under sunny day, then paste with sulfur to develop the new shoot.
3. The seriously infected plantation should be destroyed.

L. Boron Deficiency.

This physiological problem is common in the sandy or gravel soil during dry cool season. The latex could be found on the surface of immature fruits. Gall-like malformation of the fruit is also found in the severe plantation. The fruits are hard and not easy to get ripe, tasteless and having no commercial value.

Control:

1. Use more organic manure
2. Dissolve the Borax in hot water, then spray 0.25% Borax or Boric acid solution on the leaves at the beginning of dry season at 2-3 weeks intervals.
3. Apply 2.5-5g Borax per plant (5-10kg/ha) along with other fertilizers bby side dressing at the beginning of dry season.

M. Nematode Diseases

2. Reniform Nematode (*Rotylenchulus Reniformis*)

The young female nematode penetrates the root, causing stunting of the trees which are stressed and wilt more readily than the healthy ones. Fruits are smaller and may become tasteless as well.

3. Root-knot Nematode (*Meloidogyne* sp.)

It causes swelling or retardation of the root and stunting of the plants.

Control:

1. Rotate after rice crop.
2. Control with nematocide.

N. Mites

1. Spider Mites: Carmine Mite (*Tetranychus cinnabarinus*): It infests widely on many kinds of plants and more seriously on papaya. The leaves become matted with webbing. Citrus Red Mite (*Panonychus citri*) & Texas Citrus Mite (*Eutetranychus banksi*): The outbreaks of both mites occur only periodically, usually during the fall, causing matted but not prominent webbing, and inducing bleached punctures on leaves. The premature leaves drop and the plants become weak. The damage may widely spread rapidly.

2. False Spider Mites: Red and black flat mite (*Brevipalpus phoenicis*): It causes corky scarring of papaya fruit and reduces its market value. The mite is found onto the stem and advances onto the petioles and fruits.

3. Tuckerellid Mites: Twelve-tailed Tuckerellid (*Tuckerella pavoniformis*): It is a minor pest. Injurious symptom is similar to that caused by red and black flat mite.

Control:

1. Fungicide such as Binapacryl, Triforine, Dinocap used for powdery mildew control is also effective on spider or false spider mites. Spray 25% Morestan W.P. at 1:1000~1500 or 50% plictran W.P. at 1:2500~3000 at 10-15 days intervals.

Notice that too high concentration or/and high temperature may cause plant injury. Also, do not use the same chemical continuously because in this way, the mites may become tolerant to pesticide.

3. Tarsonemid Mite

Broad mite (*Hemitarsonemus latus*): It damages the seedlings and young plant greatly, causing stunted and distorted leaves. In a serious situation, the rosette leaves will appear, and the growing tips may be aborted.

Control: Spray 75% wettable sulfur at 1:300 on the top of stem at 10-15 days intervals until normal new leaves occur.

O. Aphids (*Myzus persicae*, *Aphis spp....etc.*)

Aphids suck young leaves which become curled and crinkled, and even defoliate, especially at seedling stage. Some aphids also transmit the virus diseases

P. Red Scale (*Aonideilla inornata*)

It mainly infests stem after flowering and then spreads to the fruits.

Control: Spray one of the following pesticides at 7-10 days intervals.

1. 33% Formothion E.C. at 1:660
2. 50% Malathion E.C. at 1:500-1000
3. 44% Methidation E.C. at 1:1000
4. 40% Methidation E.C. at 1:800

The above pesticides are also effective to control aphids and some other insects of Papaya.

Q. Other Insects:

Scales, thrips, beetles, stink bug, leaf hopper, moths., mealy bug, and white fly are minor insects, but may occasionally cause certain damage to papaya.

Control:

1. Keeping the plantation relatively free of weeds can control aphids, leaf hopper and thrips outbreaks to a large extent.
2. Harvest all the fruits at the mature-green stage, and then pick dispose of all soft ripen and infested fruits promptly to prevent fruit fly infestation and reproduction within the plantation.
3. Select the proper insecticide to control the outbreaks of certain insects.

Biological Control: Apply the eggs of Mallad basalis walker (20-60 eggs/ plant or 100,000 eggs/hectare) to control mites, aphids, white flies if the papaya is grown in the screen house.

R. Snail and Slug: It feeds on young plants, shoots, or flower buds in humid place. Also, it can transmit the pathogen of phytophthora fruit rot.

Control:

1. Grow the seedlings at a safe place.
2. Collect the snails in the evening and at dawn and properly dispose them of.
3. Protect with big plastic cylinder film after transplanting. (This may also protect from virus infection)
4. Apply “Artitox” 10-15 granules each square meter.

Note: The above information is provided based on research and field observation. Variations in local condition may affect the information and suggestions contained above and for which the company should not be held liable. In case of doubt, it is recommended to carry out ordinary trial production in order to test local growing condition in different seasons and area.