

Diseases of Custard Apple with their Management

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Annona squamosa Linn. (Annonaceae) is a small, semi-deciduous tree, 3 - 7 m in height, with a broad, open crown or irregularly spreading branches, widely available in India. Different parts of plant like fruit, leaves, bark, and root are used in the treatment of various diseases and famed for its medicinal and nutraceutical values. It is native to the New World Tropics, particularly northern South America - Columbia, Ecuador, and Peru. It was cultivated by natives in the Andes and was first planted in California in 1871. It is believe that it was first introduced into Brazil-“fruta do conds” It is later taken to the Philippines and Asia via West Indies.

In India, there is very large and good commercial importance so considered as native fruit of that country. However, this is a secondary centre of diversity, created during the last 500 years. This fruit has an interesting history attached to it in respect to its name *i.e.* Sitaphal. Mythologically it is said that Sita, wife of Lord Rama during her Vanvaas used to eat this fruit. While some texts says that when Ravana was abducting Sita, at that time the drops of tears from her eyes and nose fell onto the ground and they gave birth to Sitaphal trees in the wilderness. Although, many people believe that sitaphal has nothing to do with Sita. Its origin is in Sanskrit *i.e.* “sheet” in hindi means cold and “phal” is fruit and having excess of it can give you cold and also it has a cooling effect on your body so hence the name is Sitaphal. *Annona* is semi- evergreen shrub specie of *Annona* and native to the tropical America and India. It is a fast growing tree producing compound, 6 - 10 cm diameter fruits with a thick, scaly or knobby skin that gives them a pine-cone appearance, commonly known as ‘Custard apple’ Sharifa or Sitaphal and Krishnaguru in Sanskrit.

It is widely distributed in the tropics and abundantly in the eastern regions of India. It is a terrestrial coarse-gained, woody, deciduous, perennial tree with characteristic odor rough, ash gray colored bark with visible leaf scars and smooth to slightly fissured into plates, inner bark light yellow and slightly bitter, twigs become brown with light brown dots. The leaves are brilliant green above and bluish green below; with petioles 0.7 to 1.5 cm; elliptical ovate to lanceolate; lamina measures about 10 × 5 cm; alternated to spirally arrange with zigzag pattern. Flowers of the plant is 2.0 to 2.5 cm; somewhat fragrant, solitary or in fascicles with 2 to 4 flowers, with three green sepals and six petals arranged in two containers. The flowers have several

conglomerated and spirally arranged stamens below and around an upper globe shaped dome of numerous united carpels. The fruit flesh is fragrant, sweet, and white to light yellow, with the texture. Fruits are divided into 20 - 38 segments, each generally containing a hard, shiny brownish-black, seed, enmeshed in the flesh, although some trees produce seedless fruit.

The fruits are generally eaten fresh, or used to make juice beverages or sorbet, and are a good source of iron, calcium, and phosphorus. Seeds are shiny brownish-black, black color with ovoid shape, numerous scattered over the white pulp. The genus name, *Annona* is from the Latin word 'anon', meaning 'yearly produce', referring to the production of fruits of the various species in this genus. Annonaceae, the custard apple family are a family of flowering plants consisting of trees, shrubs, or rarely lianas. The family is concentrated in the tropics, with few species found in temperate regions. About 900 species are Neo-tropical, 450 are Afro-tropical, and the other species Indo Malayan. Under Annonaceae family 130 genera are available, out of that genera are widely available *Annona*, *Anonidium*, *Rolliania*, *Uvaria*, *Melodorum*, *Asimina*, *Stelechocarpus*. At present, many commercial fruit products are exist in the market hence the present review will probably act as connection between nutraceutical food and industrial pharmaceutical potentials of *Annona squamosa*.

PSEUDOCERCOSPORA SPOT

- Early symptoms consist of a diffuse spot which appear as indentations on the fruit surface. Spots are small (ranging in size up to 15 mm) and dark purple to grey.
- Spots often coalesce to form large disfigured areas. Large necrotic spots are commonly seen as the disease progresses. In advanced cases, superficial cracks appear in the skin, and the hardened skin prevents normal fruit development.



Pseudocercospora spot. Less commonly seen symptom

Causal organism:-

Pseudocercosporaannonicola. This disease organism in custard apple was first reported in Taiwan. It is a different *Pseudocercospora* species that causes husk spot in macadamia.

Occurrence and distribution:-

Pseudocercospora is major problem especially in wet seasons in all production regions. There appears to be a varietal difference in the susceptibility to the disease with cv. African Pride showing greater susceptibility than either cvs. KJ Pinks or Pink's Mammoth.

Chemical control:-

1. In 2010, Cabrio® received a minor use permit for use on custard apple. There is a possible role for applying mancozeb, at least in the early stages of development before disease pressure builds. The need for a companion fungicide to be used with Cabrio® for a resistance management strategy is essential. Only three sprays of Cabrio® per season are recommended.
2. Mancozeb® or copper oxychloride (permit number – PER11943) should be tested in parallel with Cabrio®. The new paraffinic oil formulation Biopest® also gives good control, both alone and in combination with mancozeb. We recommend maintaining a regular protectant spray program using mancozeb, Cabrio®) and Biopest® with frequency determined by prevailing weather conditions. Start spraying early in the fruit growth cycle (see Chapter 8 for regional spray programs).

Orchard management strategies:-

- Spray dormant trees and leaf litter with oil and copper after pruning – several applications may be required. When pruning, open up the trees more to improve spray penetration.
- Dense foliage reduces spray penetration. Prunings which contain carry-over spores and old fruit left on the ground should be removed from the orchard. Prune tree skirts to 50 cm above the ground. This will minimize humidity in canopy and ensure optimum spray coverage.
- Remove prunings from the orchard whenever possible, or mulch them quickly to assist natural breakdown. If dead leaves or prunings are left under trees, cover them with straw mulch 50 mm or more in depth to stop spore movement up into the tree.
- Moisten leaves and mulch to promote leaf breakdown. Regularly monitor fruit for infection during the season so that spraying can start before fruit diseases get too severe. Where fruit diseases are an ongoing problem, regular spraying may be required. Make sure the spray rig is working correctly. Calibrate air blast and other sprayers to ensure that you get good coverage (70-100 or more droplets per square centimeter) to get good leaf and fruit protection.

- Check to see if the fruit are covered with fungicide. Check that the sprayer is operating at the correct pressure, Copper fungicide may also be sprayed onto dead leaves and twigs on the ground under trees when the trees are dormant.

Anthracnose**Disease symptoms:-**

- Infection begins at blossom-end of the fruit and later spreads on entire fruit surface, affected fruits shrivel and they may cling to the tree or fall down.
- Necrotic spots of 2-10 mm in diameter appear on unripe fruits which turn into dark brown to black spots. These spots coalesce later and cover entire fruit.

**Favourable condition:-**

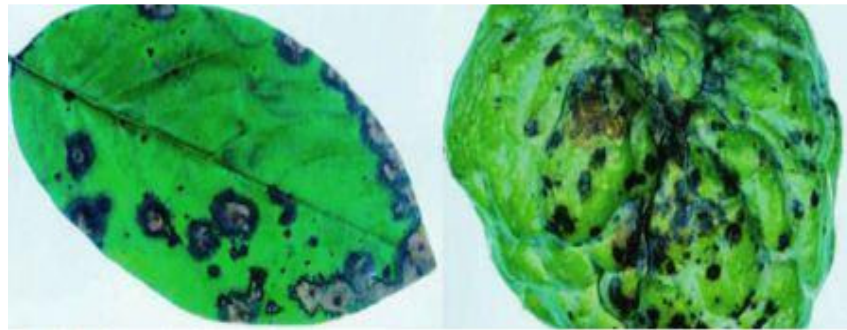
Wet and windy conditions favour the disease.

Chemical control:-

1. Spray dormant trees twice with copper oxychloride fungicide and with Biopest oil®. Ensure that these are high volume sprays. Do not apply copper if buds have broken.
2. Spray every two-three weeks with fungicides such as mancozeb, or Cabrio® or with Biopest®. It is best protectants largely depends on the level of coverage achieved. These sprays also control *Pseudocercospora*, a major problem in cv. African Pride.
3. A minor use permit for Octave (prochloraz) has been issued for control of anthracnose in custard apple (permit number - PER11944). Apply during flowering and early fruit set only. Apply at 21 – 28 day intervals. In prolonged wet weather reduce the interval to 14 days.

Leaf spot**Disease symptoms:-**

- Alternaria leaf spot: Small yellowish spots first appear along the leaf margins, which gradually enlarge and turn into brownish patches with concentric rings. Severe infection leads to drying and defoliation. Dark brown-purplish patches appear on the infected fruits and rachis just below its attachment with the shoots.
- Cylindrocladium leaf spot: Upper: dark purple spots about 1 to 2 mm in diameter develop first on the shoulders of the fruit and then spread down the sides. Spots enlarge and then later dry out and crack. Similar in appearance to spotting bug damage, but spots are irregular in shape whereas spotting bug lesions are round, and damage does not extend very far into the fruit.



Cylindrocladium leaf spot symptoms on leaf and fruit

Chemical control:-

1. Spray dormant trees twice with copper oxychloride fungicide and with Biopest oil®. Ensure that these are high volume sprays. Do not apply copper if buds have broken.
2. Spray every two-three weeks with fungicides such as mancozeb, or Cabrio® or with Biopest®. It is best to rotate each of these fungicides in turn to prevent build-up of resistance. Control with these protectants largely depends on the level of coverage achieved. These sprays also control Pseudocercospora, a major problem in cv. African Pride.
3. A minor use permit for Octave (prochloraz) has been issued for control of anthracnose in custard apple (permit number - PER11944). Apply during flowering and early fruit set only. Apply at 21 – 28 day intervals. In prolonged wet weather reduce the interval to 14 days.

Diplodia rot**Disease symptoms:-**

- Diseased fruits show symptoms of purplish to black spots or blotches confined to the surface of the fruit and eventually covered with white mycelia and black pycnidia.

- Diplodia rot is distinguished by its dark internal discoloration and the extensive corky rotting produces.
- The penetrated flesh eventually softens or hardens and cracks, depending on the presence of secondary microbes.



Favourable condition

- Optimum temperature is 25.9°C to 31.5°C and relative humidity is 80%

Chemical control:-

Chemical control is rarely required in well-managed orchards. Where an outbreak occurs, spray with an appropriate fungicide such as mancozeb.

Orchard management strategies:-

Diplodia is normally a problem in crowded, unpruned trees. Mummified fruit and dead twigs should be removed from the tree before fruiting commences.

Black canker

Disease symptoms:-

- Irregularly shaped spots ranging from small specks to large blotches.
- Spots have an indistinct 'feathered' edge.
- Tissue damage under the spots is no more than 10 mm deep.



Favourable conditions:-

- The disease is favored by extremely wet weather and cool-to-moderate temperatures (15°C to 20°C). When prolonged rainy periods exist in the spring and provide at least six hours of continuous wetness.

Chemical control:-

Chemical control is rarely required in well-managed orchards. Where an outbreak occurs, spray with appropriate chemicals such as copper and mancozeb.

PURPLE BLOTCH**Symptoms:-**

- On small fruit, small purple spots quickly grow to cover the entire fruit surface (Plate 6). On larger fruit, the spots or blotches usually reach 2 cm in diameter before being noticed. The spots quickly expand to 5 cm wide. They have a distinct margin and sometimes a halo around the initial spot.
- The fruit may be covered by white fungal growth, which develops under moist conditions. Affected fruit drop readily.
- Internal discolouration is extensive and may affect all of the flesh. More mature diseased fruit do not become hard as they do with black canker or Diplodia rot. When it occurs on individual farms, it is a very severe problem. A small spot on a harvested fruit quickly spreads to the whole fruit, and if packed can affect the whole tray.

Causal organism:-

- Purple blotch is caused by the soil-borne fungus *Phytophthora capsicii*.

Occurrence and distribution:-

- During dry periods *Phytophthora capsicii* will become mostly inactive and survive in a dormant state as oospores or chlamydospores. These structures are very resilient and can survive in the soil, typically protected within organic matter particles for lengthy periods.
- Oospores in particular have a very thick wall and are very resilient to desiccation and attack from soil microorganisms and survive in the soil for possibly five years or more. When soil moisture and temperatures are favorable these spores will germinate to produce zoosporangia which in turn release zoospores.
- These zoospores have tails that enables them to swim. They have the ability to recognize electro-chemical signals which means they can swim in a purposeful direction towards the targeted host and towards the soil surface. Under heavy rainfall conditions, the zoospores splash from the ground onto the leaves, braches and fruit up to one metre, or slightly more, above the ground.

- The zoospores germinate within 24 hours and start producing infective propagules once they arrive at a suitable host. When you have wind-blown rain the spores become airborne in the water droplets which can include the very fine droplets of windblown spray. It has been found even in the tops of large trees. Once *Phytophthora capsici* is in the soil it is there indefinitely. This disease is usually more of a problem on farms with heavy wet soils and is more prevalent after periods of continuous wet weather.

Chemical control:-

- Mancozeb and copper sprays should be used for control. Fungicide sprays of mancozeb and should be started at fruit set. Phosphonate and Metalaxyl-M (Ridomil® and Ridomil Gold®) are highly effective against Purple Blotch but these fungicides are not currently registered for use on custard apple.
- Ridomil Gold® will probably be more Integrated Pest and Disease Management effective than straight Ridomil® because it provides both the protective properties of copper hydroxide and the curative and systemic properties of Metalaxyl-M. Efficacy data and residue data are required before a permit can be granted.

Orchard management strategies:-

Phytophthora capsici is fairly commonly found in dams and streams. As such, irrigation water can act as a source of inoculum. If micro-sprinklers are throwing water onto the fruit then they are also likely to throwing inoculum onto the fruit. Other strategies are similar to those described for *Pseudocercospora*.

Cylindrocladium fruit rot:-**Symptoms:**

Dark purple spots, about 1 to 2 mm in diameter, develop first on the shoulders of the fruit and then spread down the sides. Spots do not become sunken but enlarge and then later dry out and crack. The symptoms are similar in appearance to spotting bug damage, but spots are irregular in shape whereas spotting bug lesions are round, and damage does not extend very far into the fruit. *Cylindrocladium* also infects leaves and to a lesser extent, roots. On the leaf it produces spots and, when severe, causes leaf drop.

Causal organism:-

- The fungi *Cylindrocladium colhounii* and *Cylindrocladium scoparium*.

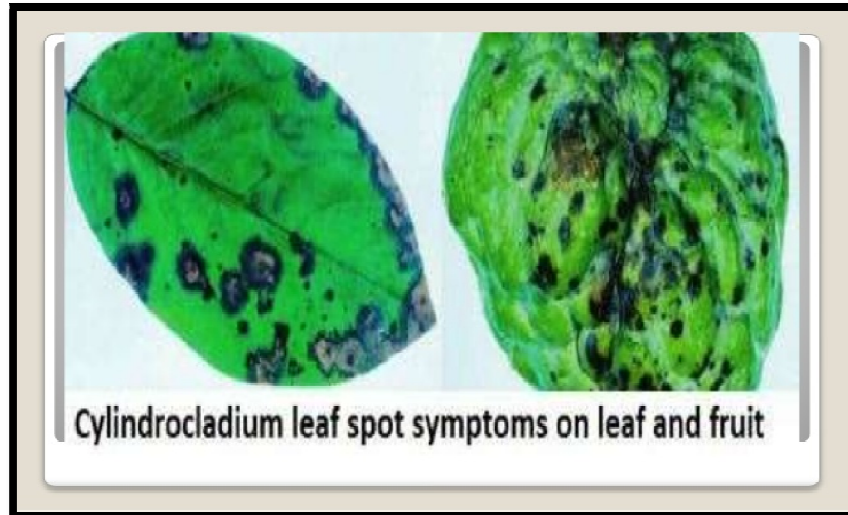
Occurrence and distribution:- The main infection period is from March to June.

Chemical control:-

This disease is serious only after prolonged wet weather in autumn. Where a severe outbreak occurs, regular sprays of fungicide, used for the control of other diseases, should provide adequate control.

Orchard management strategies:-

Orchard management strategies are the same as for *Pseudocercospora* spot. Ants should be controlled to prevent infested soil being carried into the tree canopy.



Cylandrocladium fruit rot damage on shoulder of fruit.

Collar rot:-**Symptoms**

- Young trees Young trees may rapidly wilt and decline, often with severe defoliation. Leaves that stay on the tree are dull green and hang almost vertically.

Older trees:-

In older trees, a slow decline occurs over about two years, generally with little or no yellowing of the leaves. On affected limbs, mature leaves are shed and the expanding juvenile leaves appear less vigorous, pale green and smaller in size. Branches become sparsely foliated and subject to sunburn. The subsequent spring and summer flushes are unthrifty, but flowering and fruit set may be prolific. However, these fruit remain small and fail to reach marketable size.

Root symptoms:-

Affected trees have a dark discoloration of the water-conducting tissues in the basal trunk and large roots. A transverse and longitudinal section of the trunk at ground level will show extensive discoloration of the outer growth rings. Dark streaking of the wood is rarely seen in the branches above the graft union. Roots may also be severely diseased. Wilting is most common in late summer.

Causal organism:-

The bacterium *Pseudomonas solanacearum*.

Occurrence and distribution:-

Wilting is most common in late summer or early autumn when the fruit are approaching maturity. We suspect that the fruit crop load reduces root growth so that susceptible rootstocks cannot escape the disease pathogens quickly enough. Due to the genetic variability in rootstocks, only some rootstock trees are susceptible.

Pink disease**Symptoms:-**

Patches of pale pink or white fungal growth form on branches. The bark and outer sapwood in infected limbs is killed by the fungus and the bark consequently cracks and exudes gum.



(Pink disease of custard apple)

Causal organism:-*Corticiumsalmonicolor*.

Occurrence and distribution:-

Generally occurs in very old trees under stress. This disease is more common after prolonged wet weather in high-density orchards and in shaded areas of the tree canopy. Only a few trees in the orchard will be affected.

Chemical control:-

The disease does not warrant special preventative measures. Where the problem is persistent, remove and burn infected limbs and treat affected areas with a slurry of copper oxychloride and water.

Orchard management strategies:-

Prune trees to open up the canopy and allow better air circulation.

Armillaria root rot**Symptoms:-**

The fungus causes a slow decline of trees with dieback of twigs and leaves. The disease can be diagnosed by the white plaques of fungal growth under the bark of the trunk, and the black 'shoestrings' of the fungus on the major roots. After wet weather, honey-coloured mushrooms of the fungus may be found growing at the base of affected trees. These have a distinct mushroom smell.

Causal organism:-Armillarialuteobubalina.

Occurrence and distribution:-

Losses are most likely when custard apples are planted into land recently cleared of trees susceptible to the disease. Yellow box (*Eucalyptus melliodora*) is a common tree host.

Chemical control: - None available.

Orchard management strategies:-

Before planting, remove as many roots as possible of previous trees. This requires stick raking, deep ripping and tining. The cultivation of cover crops after clearing further reduces the survival of the fungus. Individual replant tree sites may also be fumigated before planting new trees.