Management of Fruit Drop in Citrus

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MANAGEMENT OF FRUIT DROP IN CITRUS

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First edition: January 2019

ISBN: 9789386267757

Published by: Additional Director of Communication for
Punjab Agricultural University, Ludhiana.

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FRUIT DROP IN CITRUS

The agro-ecological conditions of Punjab are best suited for the production of citrus fruits. Citrus cultivation has proved a boon for the farmers due to its higher economic productivity as compared to other fruit crops. Citrus fruits have emerged as number one, both in area and production and has brought the "Golden Revolution" in the Punjab state. However, a heavy shedding of flowers and fruits, right from the flowering stage upto the time of harvest is a serious problem in citrus fruits.

In general, citrus trees bloom profusely in spring, but only a small number of flowers become fruit that stay on the tree and reach maturity till harvest. In Kinnow, for example, less than 1 per cent of flowers turn into harvestable mature fruit. The actual percentage of flowers till harvestable fruit vary from year to year, with heavy-blooming years setting less flower to fruit than in years with lighter bloom. The low percentage of flowers turning to fruit can be attributed to fruit drop during different stages of growth and development. All the fruits do not drop at one time but at different times. There are more or less definite periods or stages when extensive dropping occurs. The loss comes in a series of waves varying in the different citrus fruits in length of time between them. In citrus, the shedding of flowers and fruits comes more or less in three distinct waves known which are also known as post-bloom drop, June drop and pre-harvest drop.

First wave (Post-bloom drop):

This fruit drop starts soon after flowering and lead to falling of very small fruits. This drop is due to natural over-production and is not of much concern to the grower. This fruit drop lead to reduction of excess fruit load on tree.

Second wave (summer or June drop):

This wave of fruit drop commences approximately one to two months after bloom, young developing fruit abscise from trees with excessive fruit set in June (often happens in May in Punjab), consisting of about 10 per cent of the total dropped fruits. In Kinnow, fruits dropped at this stage are of marble sized (about 1

cm diameter). The drop during this stage mainly results from the competition among young fruit for energy (carbohydrates) for growth and development. Although June drop of citrus fruit is typically considered a natural event during the course of fruit development, water-deficit in addition to high temperatures in early summer can exacerbate fruit drop.

Third wave (comprise pre-mature and pre-harvest fruit drop)

The third wave, comprising pre-mature and pre-harvest fruit drop, is the dropping of almost mature to harvestable fruits. It starts from August as pre-mature fruit drop and continue till harvest as pre-harvest fruit drop. Drop occurs at the peduncle and calyx junction, leading to fruit drop without the peduncle attached. This drop is of economic importance to the grower as in this drop nearly completely grown fruits are shed causing heavy losses to the grower. Most of pre-mature fruit drop occurs due to spread of disease and attack of fruit fly. Whereas, pre-harvest fruit drop in December–January is caused due to low-temperature and foggy weather.

Dropping of fruits in citrus depends upon many factors both internal and external. These factors include imbalance of growth regulators, disease, insect pest attack, extreme temperatures, water stress, high humidity, flooding, etc.

Physiological fruit drop

The physiological process of fruit drop is called abscission. Physiological drop occurs due to exposure of plant to environmental or physiological stress.

Causes of physiological fruit drop

The main cause of physiological fruit drop are

- Water stress
- High temperature
- Nutrient deficiencies
- Frost for long period of time
- Poor health of tree

When the plant is in stress due to any of the above mentioned

POST-BLOOM DROP

Shortly after bloom, a number of flowers and fruitlets of citrus abscise due to poor pollination or due to nutrient shortages or because of environmental stress. Flowers and fruitlets dropped at this stage have peduncles.

JUNE DROP

One to two months after bloom, young developing fruit drop from trees. Fruits dropped at this stage are without peduncle.

Pre-mature fruit drop in Kinnow

Pre-harvest fruit drop in Kinnow

reason, plant body produce ethylene. Production of ethylene lead to weakening of abscission layer between branch and fruit, ultimately resulting in the dropping of fruits. So it is very important to maintain tree in optimum health and protect the plant from stressful conditions like excess or shortage of moisture, yellowing of leaves due to nutrient deficiencies, timely control of diseases and insect-pests.

The citrus trees require a good balance of macronutrients and micronutrients to develop sufficient foliage to support the developing fruits. So apply the recommended fertilizers and to maintain the healthy and vigorous growth of the trees. Proper drainage arrangement should be made to avoid water stagnation.

Citrus trees should not be water stressed during fruiting period as water stress accelerates the synthesis of abscissic acid which fastens the abscission of fruits.

Besides physiological causes, fruit drop is also caused by diseases (pathological fruit drop) and insect-pests (entomological fruit drop).

Pathological Fruit Drop

Pathological fruit drop is a major bottleneck causing reduction in yield and quality of harvested produce. In this fruit drop, the pre-mature fruits fall down and give a painful sight to the growers. Such fruits become unfit for marketing. This drop is of much economic importance and if left uncontrolled it can seriously reduce yield and returns. Therefore, it is imperative to adopt integrated approaches to effectively manage fruit drop in a sustainable way. Pathological fruit drop usually starts during August and continues till harvest with its peak in mid-September to mid-October. The drop in the months of September-October is the most detrimental, as the fruits are near maturity and have drawn nourishment from the tree. Pathological fruit drop is caused by different plant pathogens, most common of these are *Colletotrichum gloeosporioides*, *Diplodia natalensis* and *Alternaria citri*

Symptoms

- Above mentioned pathogens, besides causing fruit drop are also responsible for die-back of twigs. The disease initiates on tree as

Stem end rot is the main cause of fruit drop in citrus in Punjab

drying of twigs from tip downwards and numerous black dot like fruiting bodies of the fungus can be seen on the dead twigs.

- The stalk-end infection of immature fruits/pathological fruit drop is recognized by the appearance of small, circular, light brown lesions around the stalk end of the fruit.
- As the area enlarges, a soft dark brown pliable rot develops. The affected area around the fruit rots resulting into pre-mature fruit drop.
- The dropped fruits are deep yellow to brown colour and show dark brown coin like rotting around the stalk end.
- In some fruits, lesions are present on both stalk-end as well as stylar-end of fruits. The affected area around the fruit rots resulting into pre-mature fruit drop.
- *Alternaria citri* causing stylar-end rot infects the fruit in its early stages of development and being a weak parasite, it remains quiescent and express symptoms later on. As the fruit approaches maturity, the fungus becomes active and exerts a stimulus resulting in abscission.
- Sometimes diseased fruits shrink due to late infection, become black, light in weight, mummified and remain hanging to the stalks for a longer period.
- The stalks of the diseased fruits turn grey and numerous black dot like fruiting bodies of the fungus appear on the stalks.

Factors favouring disease development

Presence of dead wood on tree is the most important factor favouring fruit drop in Kinnow. The fungus survives on the dead twigs, leaves and fruit stalks as black dot like fruiting bodies which become primary source of inoculum for initiation of die-back and fruit drop in the coming fruiting season. The disease initiates from diseased twigs during spring season (February-March) and stops its development during April-June in hot summer days and further frequent rains from July onwards coupled with high temperature and humidity favour the development and rapid spread of the disease causing maximum fruit drop in mid-September to mid-October.

Die back of twigs in Kinnow

Black dot like fruiting bodies of the fungus on the dead twigs

Mumified fruits on the tree

Brown discolouration around the stalk-end and complete rotting of ‘Kinnow’ fruits

Brown discolouration around the stalk-end of ‘Mosami’ fruits

Brown discolouration around the stalk-end of ‘Valencia Late’ fruits

Control of pathological fruit drop

Pathological fruit drop of citrus can be managed by adopting the following integrated management strategies:

Prune citrus trees to remove twigs which are diseased, dead, decaying or in danger of harming other twigs. The best time for pruning of citrus trees is during the months of January-February after the fruit harvest to reduce the primary source of inoculum. Pruning should be followed by spraying of Bordeaux mixture (2:2:250) or copper oxychloride 50 WP (3 g/litre of water). Repeat spray in the months of March, July and September to reduce die-back of twigs. Do not pile the pruned wood near the orchard as it acts as source of infection. All the prune wood should be collected and destroyed by burning. Collect and destroy the mummified fruits on the trees as well as the fallen fruits by deep burying. Do not keep heaps of dropped fruits anywhere in the orchard as they act as carrier for diseases.

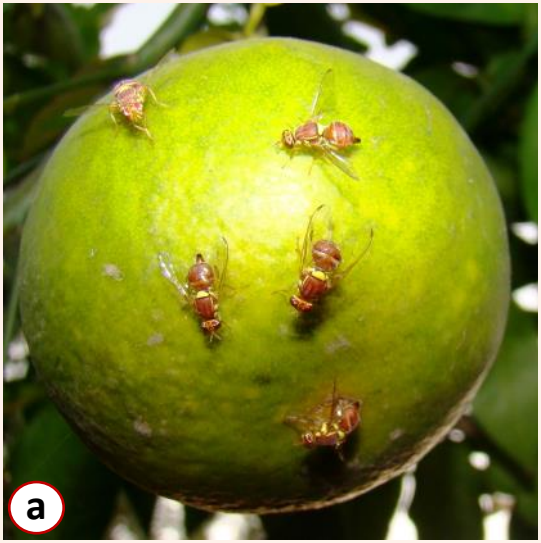
Entomological Fruit Drop

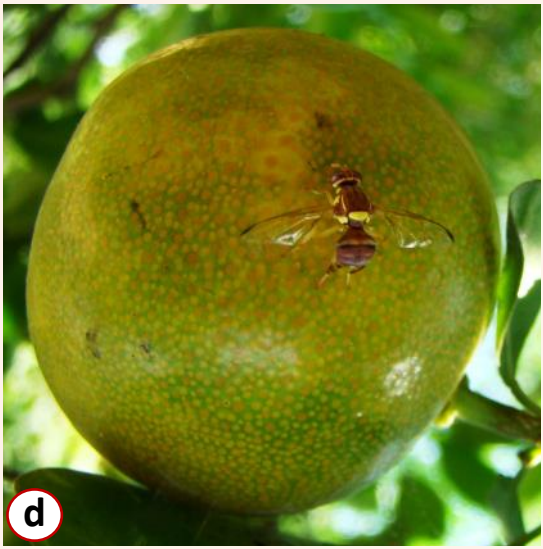
Fruits flies and fruit sucking moths are most important insect-pests responsible for fruit drop in citrus.

Fruit Flies

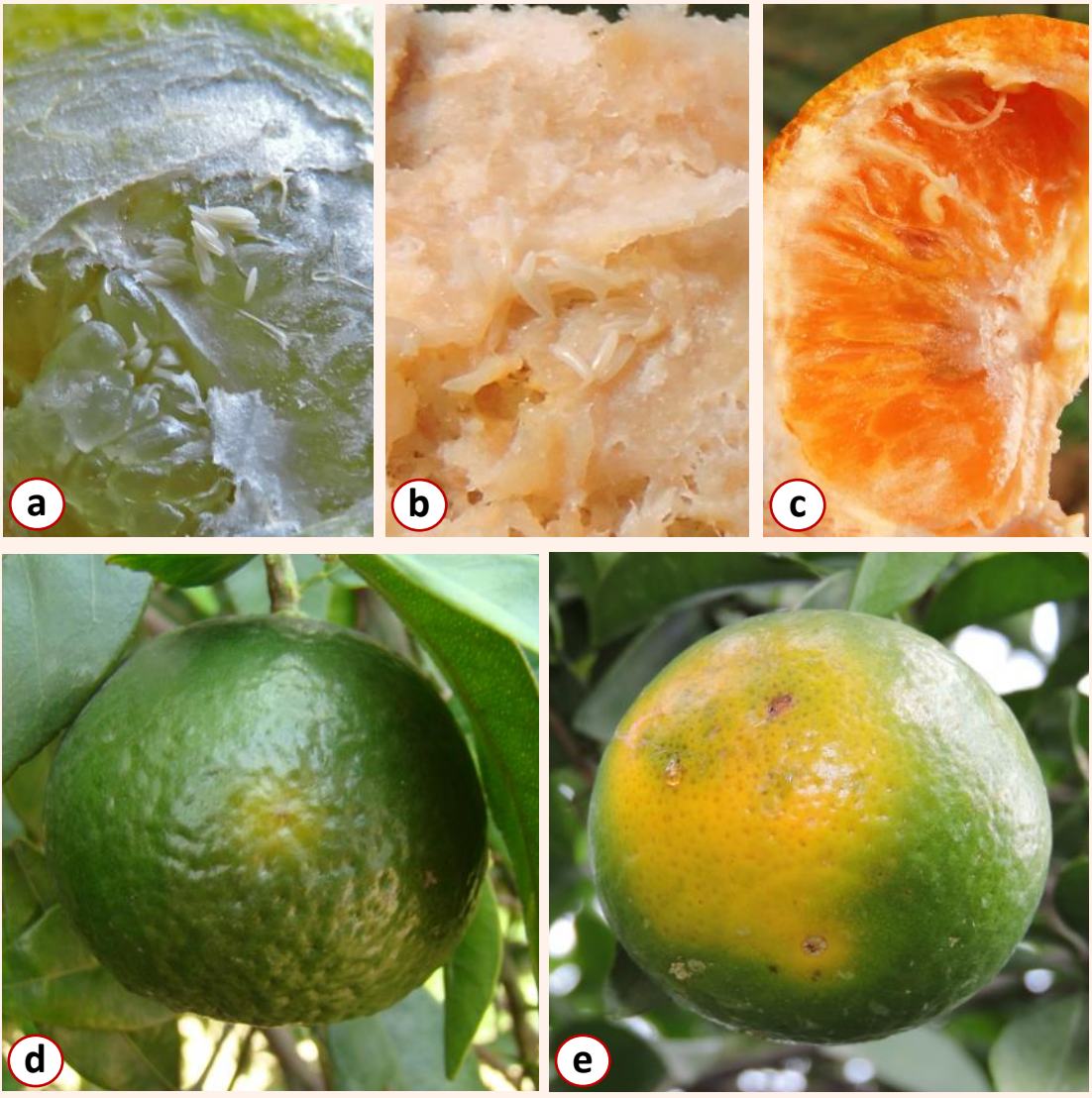
In Punjab, Oriental fruit fly, *Bactrocera dorsalis* (Hendel) and peach fruit fly, *Bactrocera zonata* (Saunders) are important in citrus fruits.

Damage to fruits is caused by female flies and maggots. Male fruit flies don't cause any damage. The female adult fruit fly punctures the ripening fruits by penetrating its needle like ovipositor and lays the eggs inside. On hatching, the maggots feed on pulp. Fruits at colour break stage are more prone to its damage. Infested fruit shows many dark green depressions due to punctures caused by insertion of ovipositor by female fly. Later on, the damaged area around the punctures becomes enlarged and yellow. On squeezing the infested fruit, a number of jets of juice come out, as there are many holes on a single fruit. Rotting of the fruit occurs due to fungal and bacterial infection through the puncture hole and due to feeding by maggots, resulting in premature fruit fall. Apart





Fruit flies: a. fruit flies laying eggs in Kinnow fruit, **b.** female fruit fly, **c.** extended ovipositor of female fruit fly for laying eggs inside Kinnow fruit, **d & e.** fruit flies laying eggs inside Kinnow fruits.



Fruit fly: a. fruit fly eggs on lemon fruit, **b.** eggs in Kinnow fruit, **c.** maggot feeding inside Kinnow fruit, **d & e.** damage of fruit fly on Kinnow fruits.

FRUIT FLY DAMAGE

Fruit fly damage in mandarin variety ‘W. Murcott’

Fruit fly damage in Pummelo fruits

PAU FRUIT FLY TRAP

from Kinnow, fruits of other citrus species like grapefruits, sweet oranges and lemons have also been observed to be damaged by fruit flies. The damage is more prevalent in sub-montaneous zone and central zone as compared to arid irrigated zone of Punjab. Damage on citrus fruits is increasing due to carryover from other crops as this is a very polyphagous pest. Peak activity period of fruit flies is from August to November.

Management of fruit flies

Fruit flies are difficult to manage, because they infests large number of host plants, have many generations in a year, adults have high mobility and have long life span as they can live for more than three months. Besides, a single female can lay more than 1000 eggs. All developmental stages are unexposed as eggs and maggots are inside the fruits, pupae are in soil, and adults are usually flying.

Orchard sanitation

Clean culture, orchard sanitation or removal and destruction of the fruit fly infested fruits either by burning or deep burying and ploughing around the trees have been proved to be an effective tool in the management of fruit flies. One of the most vulnerable stages in the life-history of the fruit flies is when maggots are inside the fruit. It is therefore, very important that as many as maggots as possible should be destroyed at this stage. This will prevent the build-up of large populations later in the season. These practices reduce the infestation or carryover of the pest or expose the pupae/ maggots to sun's heat and other predators. Deep burying of the fruit fly infested fruits in 60 cm deep pits has been found to check fruit fly emergence from soil. Precaution should be taken to press the soil properly so that maggots may not come out of loosely kept soil. This step is very essential for management of fruit flies in orchards, otherwise smell of fallen fruits attracts flies from a distance and this increases the chances of more infestation. This operation should be regularly followed every year in every orchard and in every host fruit crop of fruit flies.

Fruit growers must take precaution that all the under-sized fruits which are left over on the trees after fruit harvesting must be picked up and destroyed. This will help in reducing the population

of flies developing in off-season.

Fix 16 PAU fruit fly traps per acre in the second week of August for area wide management of fruit flies and recharge the same after 30 days, if required.

Fruit sucking moths

Eudocima materna, *Eudocima fullonia* and *Acanthodelta janata* are the most important fruit sucking moths causing damage to Kinnow fruits in Punjab. Apart from these, *Calyptra minuticornis* and *Oraesia emerginata* have also been recorded as new fruit sucking moths from Ghardiwala in district Hoshiarpur during September-October 2017.

Its semilooper larvae are leaf defoliators and feed on other host plants, usually wild plants and creepers like *Tinospora cardifolia*, commonly known as Giloe.

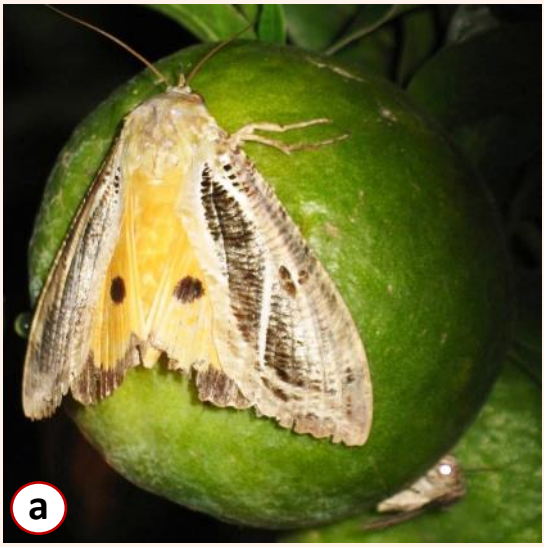
Only adult moth causes damage. Adult moth sucks the juice of ripening fruits after dusk (sun set) during the rainy season. The moths have a strong proboscis with sharp spines with which they pierce the ripening fruits. A circular pinhole like spot appears at the feeding site. Later on, the area around the damaged portion turns yellowish-brown. As many as 16 holes have been recorded on a single fruit of Kinnow. On squeezing such fruits, jet of fermented juice comes out from each hole. The punctured fruits are easily infected with bacteria and fungi. As a result, the fruit rot and falls prematurely.

Peak activity period is July to October and this insect is active mainly in the sub-montaneous zone of Punjab, particularly in the Kandi belt of Hoshiarpur and Pathankot districts, near the forest areas.

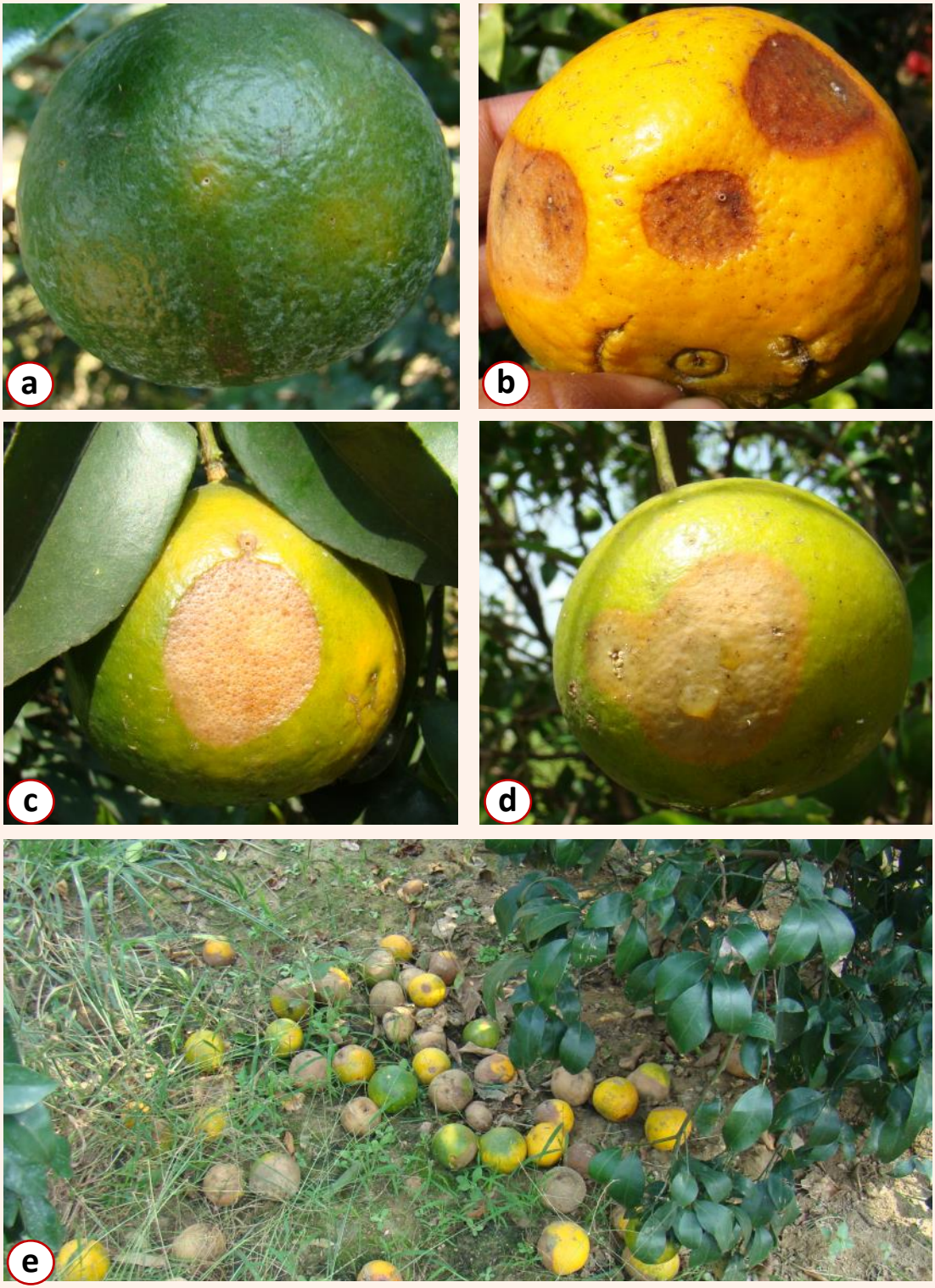
Management

This insect is difficult to control as its caterpillar feeds on weeds and other plants around the orchards. Moreover, moths cause damage after sunset. For effective management destruction of other hosts like wild weeds and creepers, especially *T. cardifolia*, around the citrus orchards is very important. Fallen fruits should be properly disposed as they attract the moths to groove. Insects can

FRUIT SUCKING MOTHS



Fruit sucking moths: a. *Eudocima materna* adult sucking juice from Kinnow fruit, **b.** *Achaea janata* adult sucking juice from Kinnow fruit, **c.** Fruit sucking moth specie *Eudocima fullonia,* **d.** Fruit sucking moth specie *Calyptra minuticornis,* **e.** *Oraesia emarginata.*



Symptoms of fruit sucking moth: a. holes caused by fruit sucking moths, **b.** severe damage caused by moth, **c & d.** typical symptoms of fruit sucking moth damage, **e.** fruits fallen due to damage by fruit sucking moth.

be repelled by creating smoke in the orchards after sunset. At Kitchen garden scale bagging of fruits is effective.

Never throw fallen fruits in open. These fruits act as source of disease inoculum and breeding place for fruit-flies.