General best practices in fruit tree crops

Prevention

- Check the plantation every week for diseases, pests and other problems. Mark problem areas on a map and mention what you found.
- Depending on the season/growing stage, check leaves and branches, axils of leaves, basis of suckers, blossoms, fruit, and from time to time also the roots.
- Check for fruit flies, aphids and their eggs, mealy bugs, thrips, etc. visually and use traps (yellow adhesive/sticky cards for aphids and leafhoppers, yellow-orange for white flies, blue cards for thrips, light traps for noctuides (moths, cutworms, African armyworm, cotton bollworm) or bait traps for fruit flies, e.g. with a plastic bottle with small holes, half-filled with water, fruit flesh and a drop of detergent or soapy water) (1).
- Prune your trees in a way that allows sufficient aeration but at the same time gives birds shelter and protection from their predators so they can feed on the insects in the trees. Apples and pears generally need some more light on the fruits while avocados need shadow from the leaves to avoid sunburn.
- Encourage insect eating birds, micro bats, lizards, frogs, toads by providing living space for them and eventually also place lights in trees, respectively on the ground to attract the night active insects to a certain spot where the bats, lizards and frogs can eat them easily. Also, poultry can be used to control pests, especially grasshoppers and beetles (2).
- Use compost extract or herbal extract to strengthen plants against diseases. Application as foliar application and on the soil.
- Balanced potassium supply contributes to the prevention of fungi and bacterial infections (1)
- Infected fruits/plants should be removed from the field or orchard as soon as possible. If present after harvest, remove residues of infected plants from the field/orchard/plantation.
- Neglected fields or poorly managed surrounding properties can be a constant source for new outbreaks of pest or disease. (3)
- Keep your own orchards/ plantation clean, especially from infected leaves, branches, fruits and weeds. If possible burn or compost the material. However, if you compost it, make sure it gets hot for at least 3 consecutive days inside the pile.
- Use of clean planting material (1) (3)
- Encourage biodiversity and encourage beneficial predators (1) (3) by planting their host plants and avoiding the use of products which harm natural enemies.
- Healthy plants are more resistant against pests and diseases (1). Healthy plants start with healthy soils. Healthy soils are characterized by an active soil life, sufficient organic matter, and nutrient cycling. Especially the active soil life can help reduce soil borne diseases and nematodes. Use compost or other organic manure to increase soil organic matter contents.
- Try to keep the stress level low for your plants (water stress, temperature stress, nutrient deficiency, or abundance) as all stresses increase the susceptibility of a plant for pest and diseases (1)
- Ensure sufficient aeration and plant distances for the plants to dry quickly to hinder fungal disease development (1)
- Do some further research and make a list of the most occurring pests and diseases of your crop and a list of possible control mechanisms (2)
- Against fruit flies: bag the fruits (with old newspaper) to prevent them from laying their eggs at your fruits. Bagging works well with melon, bitter gourd, mango, guava, star fruit, avocados, and banana (plastic bags used).
- Don’t touch wet fruit and harvest only dry fruit. Avoid contact of fruits with soil.
- If applicable, use a push-pull strategy to repel insect pests from your crop, e.g. with desmodium as a repellent plant and napier grass as a trap plant (1)

Citrus

Main diseases/ main problems

- fungal diseases like: Blue mold/ penicillium, sooty mold, peteca, anthracnose, damping off, phaeramularia fruit and leaf spot
- insects (fruit flies, aphids, leaf miner)

Natural methods – preventive/Prevention – curative

Fruit flies:

- remove & destroy ripe, fallen fruit
- regular harvesting cycles because they attack ripe fruits
- install fruit fly traps

Aphids (Toxoptera citricidus and T.aurantii) and Leaf miner (Phyllocnistis citrella):

- promote natural enemies in and around the orchard (4)
- apply neem sprays around young leaves and shoots (4)

Damping off (caused by Rhizoctonia solani, Phytophthora spp. or Pythium spp.):

- avoid planting in infected fields (4)
- treat seeds with hot water before planting (4)
- avoid over-watering of seedbeds; use a mixture of manure/compost and sand as planting media (4)

Greening disease (transmitted by vectors or infected plant material):

- control the vector using Tamarixia radiata or other natural enemies such as Cycloneda sanguinea (4)
- control the vector using neem, tephrosia or pyrethrum mixtures (4)

Sooty mold, blue mold, peteca, anthracnose, phaeoramularia spot:

- Sooty mold: prevent aphids and other sucking insects from feeding on your plants. However, if it is already too late for prevention, neem has been reported to be effective against sooty mold and the pest.
- Blue mold/ penicillium: Yeast (candida oleophila strain O), pseudomonas syringae (bacteria) or sodium (bi)carbonate can be applied after harvest (5) (6)
- To avoid peteca, avoid stress to the fruit. Since it is a physiological disorder, there is no spray to cure it. It seems however, that it is related to calcium and potassium imbalances as well as to weather conditions as mainly fruits grown with low outside temperatures (in late fall or winter) and with high humidity or harvested after rainfall, are affected (7). Further, low storage temperature and maturity seem to play a role as well (8).
- Anthracnose: cut out infected limbs, avoid overhead irrigation
- Phaeoramularia: copper based products (for instance Bordeaux mixture) and strict orchard hygiene (4)

General best practices

- Use clean (=virus and bacteria free) root stocks/ planting material (4)
- Prevent the plants from stress as weakened plants are more susceptible to any kind of disease and pest.
- Use resistant varieties (e.g. resistant against anthracnose)
- Do not use overhead sprinklers for irrigation
- Prune out infected, old, or dead wood yearly.
- Clean the plantation from any infected plant residues.
- Ensure good aeration of the crown and sufficient planting distance (4).

- Encourage good soil fertility. (4)
- Be careful when applying any soap sprays (against insects) as they damage the protective wax of the fruits and thus make them more susceptible for fungal diseases (9)
- Remove any weeds or grass in a circle of 10 cm around the trunk. Possibly work with cover crops.

Avocado

Main diseases/ main problems

- Anthracnose
- Fruit fly
- Root rots
- Mites (avocado mite, avocado brown mite, persea mite)

Natural methods – preventive/Prevention – curative

Against fruit flies:

- Bag the fruits to prevent fruit flies from laying their eggs into the fruits
- regular harvesting cycles because they attack ripe fruits; remove & destroy ripe, fallen fruit

Against anthracnose:

- Several sprays are said to have an effect such as Bordeaux mix, copper-based fungicides, or neem (1) (9) (10) (11). If symptoms are detected, spraying should begin and be continued until the fruits are about 5 cm long (10).
- As postharvest management, savoury and thyme oil have found to be effective (12).

Against mites:

- predatory mites (e.g. Galendromus annectens) (13)
- water-jet washing with insecticidal soap added, but will also kill parts of the beneficial predators (13)
- oil, soap or nicotine applications (please refer to “curative methods”of this document)

General best practices

- Use resistant varieties and rootstocks (resistant against root rots, anthracnose, phytophthora and others)
- Do not use overhead sprinklers for irrigation
- Prune out infected, old or dead wood yearly. Clean the plantation from any infected plant residues.
- Prevent the plants from stress as weakened plants are more susceptible to any kind of disease and pest.
- Quickly cool down after harvest to a minimum of 5°C to hinder the development of anthracnose and other fungi on the ripe fruits and ripen fruits below temperatures of 15,5°C (13).
- Wider spacing of the trees may prevent an epidemic spread of diseases, especially anthracnose (10).
- Avoid wetting tree trunks and water logging of the soil. This already starts with the right choice of planting location. Prevent soil or water movements from invested areas.
- Use mulch layers below the trees to avoid water (loaded with spores of fungi) from splashing onto the plant (13).
- Remove fruits that touched the ground (13).
- Do not plant plants susceptible to verticillium wilt near avocado trees, such as tomato, eggplants, potatoes, peppers, many berries, apricot and several flower crops (13).

Pineapple

Main diseases/ main problems

- Black rot - Ceratocystis (thielaviopsis) paradoxa
- Heart rot - Phytophthora nicotianae var. Parasitica
- Mealybug Wilt (MWP)
- Nematodes
- Symphylids

Natural methods – preventive/Prevention – curative

To prevent mealybug wilt:

- Spread ashes around the plants and on ants to prevent ants from transporting mealy bugs onto the plants (1), or place bands of sticky material around the trunks. However, keep in mind that ants are also predators for other pests.
- Provide living space for ladybugs and small wasps as natural enemies of mealy bugs to prevent the spread of mealybug wilt (14).
- “mealybugs present at the basis of the fruits can be removed by a gentle brushing” (3)
- “All crop residues should be removed and burned. Crop residues and grass roots left in the field may harbour mealybug populations and will infest the new crop” (3)
- Use healthy planting material (without virus disease)
- As a last resort and short-term solution, emulsified vegetable oil or white oil mixed with water and soap can be sprayed onto the mealybugs (14).

To reduce the nematode population:

- Increase soil organic matter contents of the soil through the use of compost or other organic manure (3).
- Use fallow, green manures, or crop rotation with non-host plants (3)

Against symphylids:

- Only use well degraded compost or manure
- Avoid clayey soils

General best practices

- Ideally plant in soils free from nematodes and symphylids as well as bacterial diseases.
- Use clean (= healthy, if available: certified) planting material (3)
- Select plant varieties with resistances. Selecting varieties that are well suited to the local growing conditions will ensure healthy growth and resilience to problems.
- Plant in rows in main wind direction to allow for faster drying after rain
- Use crop rotation
- Infected plants should be completely removed as soon as detected.

Apple and pears

Main diseases/ main problems

- Scab -Venturia inaequalis
- Fire blight/ Cancer
- Penicillium decays and botrytis
- Insects: Plum curculio, Japanese beetle, codling moth, apple maggot

Natural methods – preventive/Prevention – curative

Against scab:

- Use resistant varieties (15) (16)
- Remove (and compost or burry) or accelerate breakdown of fallen autumn leaves as they form the first source of inoculum for the new infection in spring (16)
- Pick up dropped fruits, prune diseased limbs (17)
- Where still allowed, copper, sulphur or lime sulphur products can be sprayed (15) (16) (17)

Against fire blight:

- Sanitation in and around the orchard (16). If possible, plant resistant varieties.
- Cut out infected limbs as soon as possible but close the wounds immediately (16)
- Applications of the competing bacteria Pseudomonas fluorescens at newly opening flowers before the fire blight bacteria (Erwinia amylovora) can colonize there (16)

Against penicillium and botrytis post-harvest decays:

- Yeast (candida oleophila strain O) can be applied after harvest (5) (6)
- Pseudomonas syringae (bacteria) can be applied after harvest (penicillium decay only) (5)

Against insects:

- Neem as a repellent against Japanese beetle (17)
- Against plum curculio, pick up dropped fruit and destroy them to break the life cycle of the pest (17), encourage chicken, ducks or geese to scratch for the larvae and adults by mixing poultry feed into the soil under the trees (16) and/or try to trap the adults with traps in spring to reduce the population and mating possibilities (16). Plum trees can act as early detection, as the plum curculio signs appear earlier on plum then on apple (16).F
- Against codling moth: Mating disruption with pheromones (16) (17), black light traps (16) or the use of trichogramma sp. (16)
- As for other pests and diseases, also against apple maggot, the orchard and surroundings should be kept free of abandoned or neglected apple trees and host plants, in this case hawthorns (16). Additionally, apple maggots can be trapped with sticky traps and are susceptible to pyrethrum, rotenone and diatomaceous earth (16).

General best practices

- Choose varieties that are well adapted to the region and with the most relevant resistances (e.g. scab, fire blight, mildew or others) (15) (17)
- Try to avoid cultivating one variety in large quantities in one area (monocultures) as this speed up the break of resistances (15)
- Encourage beneficial organisms (15) (16) (17)
- Install proper pruning as plants can then dry quicker and sources of inoculum are taken away (16) (17)
- Regularly inspect the orchard and remove fruit mummies and infected shoots to prevent spread of fungal diseases (15) (16) (17) and detect insect pests at an early stage
- Mites and aphids are usually kept under control by natural enemies (17)

- Sooty blotch and fly speck can usually been washed off after harvest (17)
- Sanitation of the orchard and surrounding is key in preventing insect pest from invading (17). Specifically against codling moth, woodpiles, boxes, bins and wooden crates should be removed from the orchard (16)
- Store at the right temperature and humidity and monitor them closely (15)
- Strip mowing in the orchard (leave un-mowed strips with flowering plants as feeding source for the beneficial insects; change strip by next mowing: mow un-mowed strip, leave initially mowed strip to flower) (16)

Curative methods

If all these measures failed, there are some natural sprays against pest and diseases. However, natural sprays decay much faster than synthetic chemicals and do not have the same efficiency, thus might need to be applied more often. And curative methods are never as good as prevention.

But only spray hot spots = areas with highest number of pest, because beneficial organisms might survive in the other areas. And you want them to survive in order to help you reducing the plant attacking pests.

Consult your local certifier for allowed substances before you use them.

List of preventive and curative options

Name	Preventive or curative	Additional information	Reference
Fungicide			
Neem (azadiracta indica) (as a spray, made from neem seed or leaves)	Curative	Sooty mould, and other fungi; It is most effective to use neem in the evening, directly after preparation and under humid conditions, because of its fast decay in sunlight.	(1)
Mexican and African marigold	Preventive	Against fungal diseases, i.a. mildew in potatoes, beans, tomatoes, and peas.	(1)
Bordeaux mixture	Preventive and curative	Fungicidal and bactericidal. Mixture of copper sulphate and lime. Amongst many others against apple scab, powdery mildew, downy mildew, and various anthracnose pathogens.	(1) (16)
Sulphur	Preventive	against powdery mildew, downy mildew, and others. Prevents spore germination. Not compatible with other pesticides. However, more effective in combination with lime.	(1)
(Baking or washing) soda	Preventive	Against mildew and rust diseases. Mix 100 g of baking or washing soda with 50 g of soft soap and 2 l of water. Leave long gaps between	(1)
Milk	Preventive	Against blights, mildew, mosaic virus and other fungal and viral diseases. Spray every 10 days: 1 l milk to 10 - 15 l water.	(1)

Garlic and onion	Preventive	Against many diseases, i.a. mildew, and other fungal and bacterial diseases.	(1)
Plant extracts (e.g. from ivy, rhubarb, giant knotweed, stinging nettle, horsetail, comfrey, clover, seaweed, pawpaw (carica papaya), sweet basil and others)	Preventive	Every 7-10 days to prevent diseases from developing and encourage soil life.	(1)
Compost extracts	Preventive	To induce plant resistance	(1)
Acidic clays (active agents: aluminium oxide or aluminium sulphate)	Preventive	Some fungicidal effect, and often used as alternative to copper, but less effective	(1)
Plant ashes	Preventive and curative	Against soil borne diseases	(1)
Fungi, e.g. Trichoderma sp.	Preventive and curative	Against Rhizoctonia solani and other root rots; (African bollworm, aphids, and others)	(1)
Pest control			
Bats	Preventive and curative	Night flying insect pests like fruit sucking and piercing moths. Put lights in the orchard where control is needed to attract them to hot spots	(2)
Lizards, frogs, toads	Preventive and curative	A wide range of insects, but especially beetle and moth species	(2)
Chicken, ducks, peafowl and guinea fowl	Preventive and curative	Grasshoppers and beetles	(2)
Birds	Preventive and curative	A wide range of insects	(2)
Chili	Preventive and curative	Against insects; aphids, ants, small caterpillars, snails; Grind 200 g chilis to dust, boil in 4 l water, add another 4l and a few drops of soap.	(1)
Garlic	Curative and repellent	Antifeedant, insecticidal, nematicidal and repellent. Against a wide range of insects, e.g. ants, apids, armyworms, diamondback moth, white fly, wireworm, termites. It kills beneficial insects as well.	(1)
Tea tree oil	Preventive	Repellent against insects	
Lavender oil	Preventive	Repellent against insects	
citronella oil (this oil can also attract some species like fruit flies)	Preventive	Repellent against insects	
Cypress pine oil	Preventive	Repellent against insects	
Tobacco, yellow root, fish bean, violet tree, nasturtium.	Preventives, curatives, repellents	Their extracts are known to have insecticidal effects.	(1)
Nicotine (tobacco)	Curative	Very toxic to human and animals. Against aphids, trips and spider mites.	(1)

Anise, chilies, chives, desmodium, garlic, coriander, nasturtium, spearmint, marigold	repellent	Can be grown as border- or intercrops to repel different insects like aphids, moths, root flies, etc. Marigold is especially known to repel root nematodes.	(1)
Oil (with or without mixing with soap)	Preventive and curative	Against mealy bugs, mites, scale, and eggs of some other pests, and various other insect pests, but also harmful to beneficial insects. Can be phytotoxic, especially if applied within 30 days of sulphur application.	(1) (13) (14) (16) (17)
Soap	Preventive and curative	Be careful, the protective waxy layer of fruits can be damaged. For instance: Anthracnose can be especially severe after application of insecticidal soap. Against mealy bugs, mites, aphids and other sucking insects.	(1) (9) (13) (14) (16) (17)
Small parasitic wasps and flies, certain fungi and viruses	Preventive	(avocado) worms	(13)
Fungi – different strains of Beauveria bassiana	curative	Against whitefly, thrips, aphids, mealybugs	(1)
Fungi, e.g. Apoanagyrus lopezi	Preventive and curative	Cassava mealybug (Phenacoccus manihoti)	(1)
Fungi -others	curative	Amongst others against African bollworm, aphids, cassava mealybug	(1)
Virus such as NPV (nuclearpolyhedrosis virus)	curative	Against various caterpillar species, but every species needs their specific NPV-species	(1)
Bacillus thuringiensis (BT)	curative	Caterpillars, beetles, mosquitoes, black fly; African armyworm, African bollworm, avocado worm, bean armyworm, beet armyworm, cabbage webworm, cabbage moth, cabbage looper, cotton leafworm, diamondback moth, giant looper, green looper, spiny bollworm, spotted bollworm, pod borers, tomato looper	(1) (13)
Entomopathogenic nematodes	Curative	Against different weevils species, cutworms	(1)
Trichogramma sp.	Curative + preventive	Amongst others against codling moth	(16)
ladybird beetles, lacewings, hoverflies, and parasitic wasps	Curative + preventive	Against aphids	(4)
Sulphur	Preventive and curative	Amongst others against spider mites (but also against their natural enemies!)	(1)

		Not compatible with other pesticides and the use of oil -> phytotoxicity	
Plant ashes		Against ants, leaf miners, stem borers, termites, potato moths, weevils. Should be dusted directly on the pest or infested plant parts.	(1)
Pyrethrum (chrysanthemum sp.)	Preventive and curative	Strong insecticide against almost all insects with high toxicity also to bees, aquatic life (e.g. fishes) and humans. Should ideally be applied at night. Breaks down in sunlight. Can be applied as powder or spray. As spray, add soap to increase efficiency.	(1)
Rotenone (Derris sp.)	Curative	Amongst others against apple maggot	(16)
Neem (azadiracta indica) (grounded neem seed or kernel powder to be added to the soil before/while planting)	Preventive and curative	Neem cake against nematodes and other root pests; additionally, also a fertilizer. Applied in the planting pit and mixed with substrate.	(1)
Neem (azadiracta indica) (as a spray, made from neem seed or leaves)	Curative	many species of caterpillars, thrips, whitefly, diamondback moth. It is most effective to use neem in the evening, directly after preparation and under humid conditions, because of its fast decay in sunlight.	(1)
Post harvest treatment			
Pseudomonas syringae (bacteria)	preventive	Against penicillium decays in apples, pears and citrus	(5)
Yeast (candida oleophila strain O)	preventive	Against penicillium decays (blue mold) and botrytis (grey mold) in pome fruit (=apple, pears and others) and citrus	(5) (6)
Bacillus subtilis	preventive	In South Africa on avocado	(5)
Sodium (bi) carbonate	Preventive	Against green mould on citrus	(5) (18)
Calcium chloride	Preventive		(5)
Savoury and thyme oil	Preventive	Against anthracnose (in avocado)	(12)
Hot water treatments	Preventive		

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