Guava Production Protocol

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Introduction:

The place of origin for guava (*Psidium Guajava*) is tropical America, between Peru and Mexico, from which it moved to North America and then to India, entered Egypt before spreading to Jordan.
Its cultivation is extended to varying agro-climatic regions owing to wider adaptability to climate and soils (wide range of soils, well-drained, light sandy loam to clay soils).

Common name	Scientific name	Family name	Variety
Guava	*Psidium guajava* L.	Myrtaceae	Local

Since it is a hardy fruit crop, it can be grown on different types of soils and successfully cultivated both under tropical and subtropical conditions. In 2019, 55 million tons of guavas were produced worldwide, led by India with 45% of the total. Guavas also grow in southwestern Europe and Greece where has been commercially grown since the middle of the 20th century. In this time the cultivation was extended also to Jordan and currently is planted in about 3,500 Dunum (350 Ha) with a country production of about 2,900 tons. The great part of the production is concentrated in Irbid Governorate, mainly in Saham area and Jordan Valley. Madaba Governorate comes the next in guava cultivation density in Jordan. The rest of the cultivation areas are distributed to other governorates.

1. Agricultural practices

1.1 Soil management

Guava grows in most types of land from clay soils to poor sandy soils and even in calcareous and acidic soils because its adaptability is very higher, but it is sensitive to waterlogged conditions and its roots can adapt well to the environment in which it grows. It tolerates a wide range of pH from 5.5 to 7.5. In saline soils, guava trees can tolerate salinity up to 3,500 ppm; the size of the fruits and ascorbic acid content will decrease when the salinity rises above 3,500 ppm. It is preferable to grow in fertile, deep soils with good drainage. Buy it can produce high-quality fruits also in poor soils if the soil is well managed.
In preparation for a new plantation, it is important to make soil analysis and determine soil texture, pH and salinity. Ploughing is an essential activity for land preparation before planting. Ploughing should be followed by further tillage such as rotovating or harrowing before planting.

1.2 Flowering and fruiting

Guava bears flowers, singly or in clusters of two or three, on the current season's growth in the axils of leaves. The blooming period varies from 30- 45 days depending on the cultivar, season and region. It is

white in color, with four to five petals. Under Jordan conditions, guava produces flowers once a year in the spring season, and the fruits rip from July to September.

Figure 2: Fruits development stages from flower bud to fruit picking (*Salazar D.M., et al 2006*)

1.3 Water management

Guava trees need regular periodic irrigation and the right amount of water, especially in the summer season, to avoid exposure to water stress. The number of irrigations, right timing and quantity of water depend on the climatic conditions, nature of the soil and its moisture content, age of the trees and variety and method of distribution. Drip irrigation or under-canopy micro-spray irrigation systems have to be preferred. This allows higher irrigation efficiency and lower evaporation losses. Sandy soils require close irrigation periods with less water in each irrigation because of their low ability to retain water; on the opposite, in clay soils, the irrigation periods are far apart, and the amount of irrigation is greater for each irrigation because their water retention capacity is higher.

Figure 3: Drip irrigation system used in guava orchards.

To maintain the appropriate soil moisture care should be taken to irrigate the trees during the flowering period and at the onset of the fruit set. As for the stage of fruit development, which is characterized by rapid cell division and rapid growth, the quantities of water are gradually increased, and the humidity must be properly controlled because water shortage and exposure trees to drought will affect cell division and elongation and, consequently, a water shortage will affect fruit size, which will be reduced.

1.4 Propagation

Guava can be propagated from seeds or by vegetative methods (air layering, budding, grafting). Vegetative propagating orchards will give fruits of the same size, shape aroma, and high yield and good quality.

Figure 4: Guava propagation, seed and vegetative.

1.5 Pruning

Forming guava trees during the first 3 years after planting provide trees with a strong structure and shape which consist of the main stem, 3-5 primary branches by cutting the main stem at 60-70 cm above ground, secondary branches grow from the primary branches bear crop. It is advisable to train guava trees as low-headed trees to facilitate hand pickings.

Flowers and fruits are born on the current season‘s growth in the axils of leaves arising from the old ones; so, annual pruning is considered necessary to encourage new shoots after the harvest.
Pruning is one of the most important practices that influence the vigor, productivity and quality of fruits. Pruning at an early stage is done to develop a strong framework capable of bearing a heavy crop load. The main advantages of pruning on bearing trees include the formation of new shoots, avoiding overcrowding of branches, removal of crossover branches, and diseased branches as well as water sprouts and root suckers (*Lian. H.N., 2019*). Pruning can be done immediately or soon after harvest. Trees are pruned to induce new axillary growth on which flowers will be produced.
As part of their canopy management, guava tree forming and pruning benefits are summarized in the following:

- ✓ Improve plant design and manage plant canopy;
- ✓ Regulate or guide plant growth to achieve the optimal tree canopy;
- ✓ Promote flower and fruit production to increase the amount of high-quality fruit produced per unit area;
- ✓ Make harvesting easier and more effective by maximizing the tree's carrying area and achieving the optimal leaf to-fruit ratio;
- ✓ Increase the amount of sunshine and air circulation in the tree. It is crucial for getting the best yield and fruit quality. The lack of air circulation caused by dense plant canopies encourages the growth of fungal and insect pests within the tree;
- ✓ Rejuvenate the plant by cutting any dying or unnecessary wood or shoots;
- ✓ Improve the effectiveness of spraying and cultural activities.

1.6 Fruit thinning

The Guava tree always bears fruit on new growth from mature wood. To maintain regular fruit bearing, a balance between mature wood and vegetative growth must be ensured. It also ensured production in the following growing season. A huge number of fruit bears on healthy guava trees results in heavy loads of fruits and a chance for the breakage of branches.
Fruits thinning is a needed practice to have high-quality fruit production. With this practice, weight, length, fruit diameter, mesocarp thickness, and sweetness of fruit increase and the number of seeds per fruit decreases as the percentage of fruit thinning. (*Rahman, H. 2017*).

2. Pests and diseases and its control

Based on experience and observation, there are common and widespread pests and diseases which affected guava.

2.1 Common guava diseases in Jordan

Guava wilt

In Jordan wilting seems to be caused by the soil fungus *Fusarium oxysporum*, symptoms at first appear as light-yellow foliage with loss of turgidity. Hard, undeveloped stony fruits, at a later stage, can causes the death of the entire plant within 15 days from full wilting.

The wilting effect is increased in the summer period and this disease affected both young and old guava trees, but older trees are more prone to this disease.

Figure 5: Guava wilt symptoms (*Gangaraj, R., et al. 2022 and Misra, A.K. 2012*).

Anthracnose

It affects flowers and fruits on plants and in postharvest and causes considerable losses for the farmers. The severity of this disease increased with increasing humidity. The symptom started as necrotic lesions on mature fruits, then a small sunken lesion. As the disease progresses, the small sunken lesions form large necrotic corky patches affecting the flesh of the fruit.

Figure 6: Symptoms of anthracnose caused by the fungus *Colletotrichum spp*. Source EPPO

Sooty mold:

It is a secondary disease, and it's a black or grey coating covering the leaves, branches and flowers of guava trees. This disease is weakening the plant by blocking sunlight and affecting photosynthesis efficiency, but it can't penetrate plant l tissues.

Moreover, sooty mold resulted in a secondary fungal infestation growing on honeydew secreted
by some insects like mealy bugs.

Figure 7: Sooty mold on guava leaf.

Phytophthora:

It affected branches, leaves and caused fruit rot. Which also caused fruit rotting at the maturity stage during humid conditions. The fruit surface is covered with white mycelium of fungus, and the fruit skin colour change to dark brown.

It is very important to collect infected leaves and twigs and fruits from previous seasons and get rid of them properly because the pathogen survives in soil and affects leaves and branches near the soil surface. In severe infections, the recommended authorized fungicide has to be applied.

Figure 8: Phytophthora fruit rot symptoms on green and ripen guava fruits (Misra, A.K. 2012).

2.2 Common guava pests in Jordan -

Root knot nematodes (*Meloidogyne spp*.):

It caused plant stunting, premature wilting and nutrient deficiencies symptoms on plants. Moreover, infected plant with nematodes has small root volume. It is important when planting new guava orchards to choose seedlings free from nematodes.

Figure 9: Symptoms caused by Root Knot nematodes on the roots, twigs and on a whole tree (*Kumar, S., et al 2018*).

Mediterranean Fruit fly (*Ceratitis capitata*):

Fruit fly is common in guava, and other many fruits like citrus, stone fruits and pomme fruits; it inserts its eggs inside fruit at the colour break stage. Larva hatched from eggs start to eat the soft pulp of ripe fruits causing serious direct damage and later on indirect damage when fruits start to decay and fall from trees.

Fruit fly management and control can be initiated by monitoring fly activity using yellow sticky traps. When trap fly catches reach a certain number per trap day an integrated control intervention should be applied like bait spraying using a mix of baiting material usually protein hydrolysate mixed with an authorized insecticide. In bait spraying only a small part of the tree is sprayed with the mixture which will lower the cost very much compared with whole tree insecticide spraying. More collecting and destroying or deep burying in soil (0.5 meter) of infested fruits contribute a lot in reducing further infestation of fruits, summer ploughing of the orchard soil can help in exposing fruit fly pupae to sun and kill it. Fruit thinning and bagging can significantly decrease this problem and produce high-quality fruits.

Figure 10: Mediterranean Fruit fly (*Ceratitis capitata*), Adult, eggs and magots infesting citrus fruit.

Mealy bugs:

Mealy bugs suck sap from plant leaves. Shoots, flowers and affect its growth, development and deformed its shape. Moreover, this insect also attacks fruits, and its shape will be uneven. Bugs secret honeydew on which sooty mold fungus can grow as a second infection. The mealy bug identified on guava in Madaba was the Hibiscus Mealybug *Maconellicoccus hirsutus* (Al- Fwaeer, M. 2014). These insects are very difficult to control with insecticides and farmers need to seek other nonchemical control measures like biological control using predators and parasitoids which proved to be very efficient in controlling mealy bugs population in the long run besides its need the government involvement in an area wide control effort.

Figure 11: The mealubug Maconellicoccus hirsutus that infest guava leaves and fruits in Madaba, Jordan (Halaybeh, M. 2010).

Thrips

Nymphs and adults are in the damage stage of thrips and they suck the sap from the leaves. The leaves of the guava plant turn yellow in severe infections and may drop down. In addition, infected fruits will blemish, and may cause the drop of fruits. Control and management of Thrips start with using yellow sticky traps to monitor its population and these traps are very effective in decreasing Thrips number. In severe cases it is important to use effective authorized insecticides.

Figure 13: Thrips infestation symptoms on guava flowers and small fruits.

2.3 Integrated Pest Management

It is defined as the careful consideration of all available methods of plant protection and the subsequent integration of all appropriate measures to discourage the development of pest populations. The use of plant protection products and other forms of intervention are maintained at levels that are economically and ecologically justified while reducing or minimizing risks to human health and the environment.

When using chemical pesticides, the choice of plant protection products must be very careful. First of all, only those approved for the crop and the target must be chosen, then toxicity (for the environment, users and consumers) and residuality of the individual pesticides used must be taken into account in addition to the aspects just mentioned, also in relation to the maximum residue limits imposed in the countries of production and export.

2.4 Pesticides limits in the export countries

Before exporting the product to a foreign country, it is necessary to be aware of the regulations in force concerning the use of chemicals and maximum permitted residues. In particular, a maximum residue limit is set for each plant protection product approved for use on the crop. It is, therefore, necessary to check, by means of multi-residual laboratory analyses, whether or not the production complies with this established limit.

Conversely, if a plant protection product has been withdrawn or not approved in the country to which it is intended to be exported, it will have a predefined maximum limit of 0.01 mg/kg, which is equal to the lower limit of analytical quantification. In practice, there should be no traces of that substance on

the product to be marketed.
Useful information can be checked on the official EU pesticide database, in the case of exports to European countries, or on the FAO pesticide database for all those countries that do not have their own regulations.

Websites:
https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en
https://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/commodities-detail/en/?c_id=254

Codex standard for pesticide maximum residue levels (MRLs) in food and feed which is amended each year by the Codex Committee on Pesticide Residues (CCPR).

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