UWI

# DWARF POMME CYTHERE PRODUCTION MANUAL

*Laura B. Roberts-Nkrumah*

*Department of Food Production, Faculty of Food and Agriculture,*
*The University of the West Indies, St. Augustine, Trinidad and Tobago*
*Tel: (868) 662-2002 ext. 82089/83325; Fax: (868) 645-0479;*
*Email: food.production@sta.uwi.edu;*
*Website: https://sta.uwi.edu/ffa/foodprod/*

# DWARF POMME CYTHERE PRODUCTION MANUAL

***Laura B. Roberts-Nkrumah***

The University of the West Indies,
St. Augustine Campus,
Trinidad and Tobago. 2021

ISBN: 978-976-634-019-3



# DWARF POMME CYTHERE PRODUCTION MANUAL

UWI

## Table of Contents

Page No.

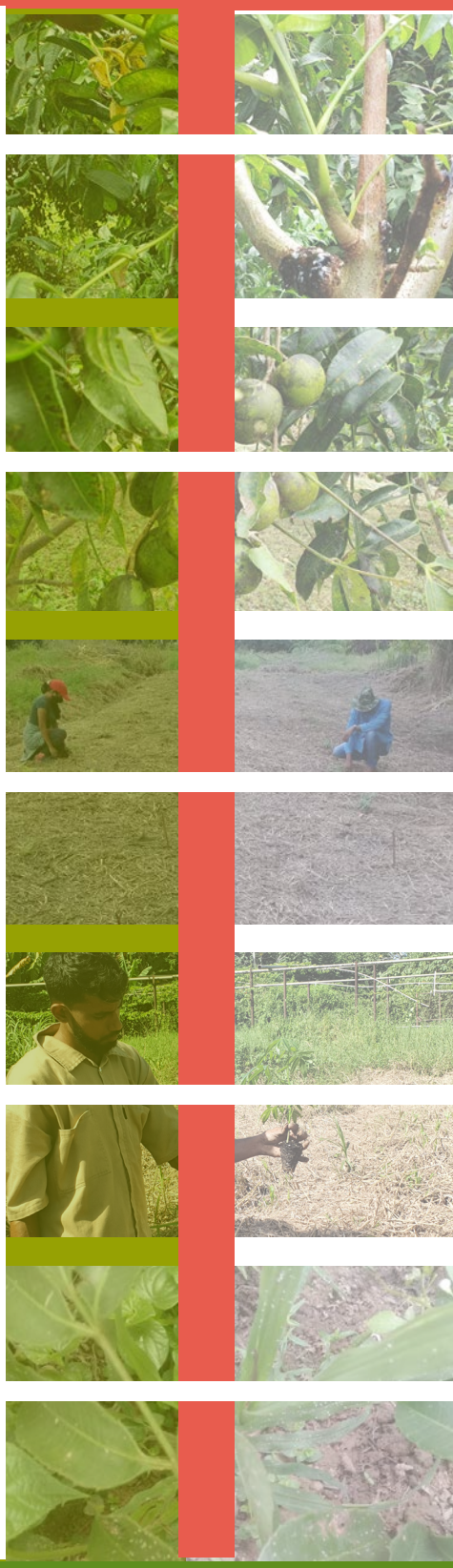



Laura B. Roberts-Nkrumah

Department of Food Production, Faculty of Food and Agriculture,
The University of the West Indies, St. Augustine, Trinidad and Tobago
Tel: (868) 662-2002 ext. 82089/83325; Fax: (868) 645-0479;
Email: food.production@sta.uwi.edu;

# LIST OF PLATES





# PREFACE

The wide range of fruits found throughout the Caribbean contributes to the regions's rich, plant biodiversity. The availability of this diversity offers significant benefits, most importantly to the diets of people in the region. The reality, however, is that fruit consumption is low. Supplies in most local markets consist of imported temperate fruits and fewer than 10 species are produced commercially by the very small fruit crop sector. One serious consequence associated with low levels of fruit consumption is deficiencies in important vitamins and minerals in the diet.

One of the main objectives of the Agricultural Innovation in Fruit Crop Propagation and Production Project, which was jointly funded by The University of the West Indies (UWI) and Nutrien TT (formerly, PCS Nitrogen), was to stimulate fruit crop production in Trinidad and Tobago by addressing some key constraints to the production of species of minor economic importance. One constraint is lack of information, particularly for tree fruit crops that are in demand and that have good potential for sustainable production on small to medium-size farms. We identified the dwarf pomme cythere as a suitable candidate for production on such farms but little information was available.

The demand for dwarf pomme cythere fruits by processors has increased in recent years but supply is inadequate. Apart from the demand, this pomme cythere has several advantages that contribute to commercial viability. The guidelines provided in this manual are based on unpublished data collected at a small orchard that was established at the UWI under the project, observations made at the commercial orchard at the Nutrien Model Farm, one of few in the region, and the limited literature on production elsewhere in the Caribbean and on postharvest aspects.

The objective of this manual is to encourage sustainable commercial production of the dwarf pomme cythere to support expansion of the fruit crop sub-sector for improved levels of consumption of local fruits and to enhance food and nutrition security.

## ACKNOWLEDGEMENTS

*The author gratefully acknowledges the funding for the development of this manual under the Agricultural Innovation in Fruit Crop Production Project that was jointly funded by the Department of Food Production, Faculty of Food and Agriculture and the Office of Graduate Studies and Research of The University of the West Indies (UWI) as well as Nutrien Trinidad. The technical support of the department's staff at the University Field Station, staff of Nutrien Trinidad and the On-the-Job Trainees, Mr Kirby Joseph and Ms Mikella Lall, provided by the Government of Trinidad and Tobago is much appreciated. I am also very grateful for the the suggestions on the draft of the manual provided by Professor Emeritus Julian Duncan of the UWI and Mr. Karl Burgess, Farm Consultant and Educator, which have helped to improve its quality.*

UWI

# DWARF POMME CYTHERE PRODUCTION MANUAL

# INTRODUCTION

## Names

The pomme cythere (*Spondias dulcis* Parkinson or *S. cytherea* Sonnerat) is a widely grown tropical fruit crop species. It was introduced from Tahiti to the Caribbean where it is also known as golden apple, June plum, Jew plum and amberella. This species is a member of the Anacardiaceae family with tropical relatives including mango (*Mangifera indica* L.) from southern Asia and cashew (*Anacardium occidentale* L.), purple and yellow plums (*Spondias purpurea* L.), and hog plum (*S. mombin* L.) from tropical America.


Plate 1.Fruits of the tall and dwarf pomme cythere

## Varieties

Pomme cythere occurs as two basic varieties according to tree size. The more common variety has tall trees with large fruit, whereas the other variety has dwarf trees with small fruit. (Plate 1). These varieties are referred to as lines because they are propagated from seed but maintain their distinct characteristics. The focus of this production guide is on the dwarf variety which is becoming commercially important in some Caribbean countries. This variety has important production advantages such as earlier bearing, year-round production, higher yield potential with higher planting densities and easier harvesting,


Plate 2. Processed dwarf pomme cythere products.

## Utilisation

Similar to the tall variety, the fruit of the dwarf is consumed fresh or processed as juices, jams, chutneys, sweet and sour pickles and preserved fruit. However, the latter variety is easier to process into some products because the flesh is easier to peel and the stone is softer. (Plate 2.)

# BOTANY AND GROWTH

Dwarf pomme cythere trees grow to 1.5 to 3 m in contrast to the trees of the taller variety that typically reach 9 to 18 m in height. Although height variation occurs among trees of the dwarf variety growing at the same location and also according to environmental conditions, they are always shorter that those of the tall variety of similar age. Under good growing conditions, the trees grow upright quickly but canopy width exceeds tree height even at 4 to 5 months old when the width to height ratio is approximately 2:1.

Low-branching (the first branches may arise at 30 cm on the main stem), closely-spaced branches (10 - 15 cm apart) and determinate growth also distinguish the dwarf variety. Growth is determinate because the main and lateral stems do not elongate continuously. Their elongation ends when the terminal bud becomes reproductive, that is, it begins to produce flowers instead of leaves. As fruit develop, their increasing weight causes the stems to bend downward. All of these features contribute to the low-growing stature and compact appearance of mature trees (Plate 3a and 3b).


*Plate 3b. Low-growing branches of the dwarf pomme cythere tree*


Plate 3a. Mature dwarf pomme cythere tree

The stems are greyish brown and 30 cm from the base, the girth of 1-year old main stems is approximately 5 cm. The glossy green, pinnate leaves are arranged spirally and are 25 - 39 cm long with 10 - 13 cm long petioles and 8 to 11 pairs of leaflets each 6.5 - 11 cm long (Plate 4). Between 3 to 5 lateral branches may grow out by the time flowering begins on the main stem.


Plate 4. Dwarf pomme cythere leaves

Numerous small, cream to light yellow flowers are borne on terminal, many branched inflorescences (Plate 5).


Plate 5. Dwarf pomme cythere inflorescence

The flowers are cross-pollinated. The fruit are borne in bunches on long fruit stalks at the tips of the stems (Plate 6).


Plate 6. Bunch of immature dwarf pomme cythere fruit

The mature fruits are oval with a length of 5 - 6 cm and a diameter of 4 - 5 cm. They consist of a thin green skin, greenish white to cream, firm flesh and a single stone surrounded by a softer endocarp with softer fibres that project into the flesh less so than in the tall variety. The endocarp surrounds 1 to 5 ovaries, each with one seed (Plate 7).


Plate 7. Cross-section of dwarf pomme cythere fruit showing pulp, fibrous endocarp and seeds

## ENVIRONMENTAL REQUIREMENTS

The most appropriate sites should be selected for commercial orchards. Dwarf pomme cythere trees thrive well in full sunlight in tropical locations. Well-distributed rainfall promotes tree growth and maintains flowering and fruiting throughout the year. Annual rainfall above 2000 mm is required where irrigation is unavailable. Dry spells cause leaf yellowing and fall, smaller fruit and premature fruit fall while prolonged drought may lead to cessation of flowering and severely stunted plants. Locations that are sheltered from wind are preferred to minimize the risks of low soil moisture and broken branches especially when the trees are bearing. Dwarf pomme cythere trees can grow on a range of soil types provided that the soil is well-drained.

## PROPAGATION

Dwarf pomme cythere trees are propagated commercially by planting the stone which contains the seeds. The stone is extracted from mature to ripe fruits and after removing the pulp, it is planted in moist growing medium in seedling trays with cells at least 10 cm deep or in potting bags (Plate 8). Germination is uneven and may take from 4 to 8 weeks after planting because of physical and physiological factors that prolong dormancy. The stone may be planted either whole, or slightly cracked to speed up seed germination. If more than one seedling per stone arises, they should be separated and replanted singly to reduce competition. The seedlings should be fertilized weekly with a dilute foliar fertilizer (e.g. 20 N-20 P-20 K) and the growing medium kept moist. They are ready for field planting when they are approximately 3.5 to 4 months old and 20 to 25 cm tall (Plate 9); they should not be allowed to become old and root-bound.



Plate 8. Dwarf pomme cythere seedling propagation –
a. stone (planting material) with enclosed seeds
b. seedlings emerging in trays.


Plate 9. Dwarf pomme cythere seedling ready for field planting

## Establishment

A few commercial orchards of 6 ha or less, have been established in Trinidad and Tobago, Grenada, Guyana and Jamaica. Pure stands are preferred to reduce competition for light because the trees are short. The trees are planted in either in rectangular or square arrangements at 1.5 to 4.5 m apart within and between rows (Plate 10). Appendix 1 shows the plant population at different spacings.


Plate 10. Young dwarf pomme cythere trees spaced 1.5 m x 1.5 m

At the closest spacings, yield/ha are higher but management and harvesting are more challenging as the crop canopy closes. Therefore, removal of some of the trees may be necessary after one year in locations with vigorous tree growth. At the widest spacings, weed control is more difficult and yield/ ha is lower. Therefore, the recommended within and between row spacings are 2.5 - 3.5 m.

Flat beds or cambered beds with in-field and main drains may are used depending on the level of drainage that is required. Flat sites are better for shelter and easier management, however, if the land is slightly sloping, it is important to minimize erosion by orienting the beds and drains along the contours.

Before planting, line the beds to according to the chosen row spacing and mark the plant positions with stakes at the desired spacing within each row (Plate 11). The planting holes should be prepared at a suitable size for the root ball of the plant, with the depth of the hole the same or not more than 2 - 4 cm deeper than the length of the root ball, if fertiliser is to be placed in the hole. The objective is that after planting, the surface of the root ball should be level with the surface of the surrounding soil. This ensures that the lower stem is not buried in the hole which will encourage rotting and plant death. If the seedlings were grown in seedling trays, a hole 10 - 12 cm deep and just as wide is adequate. Seedlings raised in potting bags will generally require larger holes to accommodate the larger root ball, and proper hole size can be determined using the same guidelines.


Plate11. Planting seedlings on a lined bed.

Before digging the hole at the plant position, remove the stake then remove the soil. The sides and bottom of the hole should not be slick or smooth, but roughened to ensure good contact between the refilled soil and surrounding soil. If organic matter is to be added, incorporate it into the soil from the hole instead of placing it at the bottom of the hole where it can cause water-logging if planting is taking place during wet weather. Fertilizer should be placed evenly at the bottom of the hole and covered with at least 2 cm of soil to avoid chemical damage to the plant roots.

## Establishment cont'd

The potting bag must be removed before planting , and the sides and base of the root ball slightly roughened to improve root growth into the soil. Then the plant, with the root ball attached, is placed in the centre of the hole and held erect. Replace the soil in the hole, distributing it evenly until the hole is completely filled. Press the soil in the hole gently to fill all gaps and distribute the soil at the surface to make it level with the surrounding soil. Finally, apply water to moisten the root ball and surrounding soil thoroughly and to remove air pockets. If planting takes place during dry periods, irrigation will be required at least 3 times weekly depending on how fast the soil dries out.

Trees may be planted at any time of year provided that adequate soil moisture is consistently available to support establishment and growth to maturity.

## Water Management

Water availability is important during all stages of growth and, unless rainfall is evenly distributed, irrigation should be available. Irrigation systems with microjet sprinklers have been found to be effective (Plate 12).


Plate 12. A microjet sprinkler used in orchards

***Pre-bearing stage –*** Soil moisture levels must be adequate during this stage for steady vegetative growth. Inadequate water supply causes slower growth, and dry periods of three or more weeks can lead to bending of the main shoots, severely shortened internodes, distorted leaves due to impaired expansion and significantly stunted trees (Plate 13. With subsequent rainfall or irrigation, the main shoots can grow erect again, and begin to flower and fruit. However, with the onset of reproductive growth, the trees are unable to attain sufficient size to support good levels of fruit production and full recovery may not occur. Stunted plants are also more susceptible to competition from weeds.


Plate 13. Dwarf pomme cythere tree stunted by drought

***Bearing stage –*** To minimize the adverse effects of prolonged dry weather on tree growth and bearing, irrigation should be applied to maintain adequate soil moisture levels. Prolonged dry spells can also cause bending of the stems, leaf distortion, reduced flowering, smaller fruits and lower yield on mature plants.

## Nutrition Management

***Pre-bearing stage*** - Where it is necessary, nitrogen (N) and phosphorus (P) fertilizer in a (1:2 ratio) should be added to the planting hole to encourage shoot and root growth. About 8 weeks later, prior to the onset of flowering and fruiting, another fertilizer application, with potassium, should be made using a fertilizer with a 1:1:1.5 NPK ratio. The fertilizer should be applied in a ring around the tree at the drip line of the canopy.

***Bearing stage*** – After bearing commences, small amounts (100 g) of a complete fertilizer with NPK ratio of 1:1: 1.5 may be applied to each tree every 3 months.

Ring placement may be used if the canopies of the trees are not touching, otherwise, band placement along the row on both sides of the tree may be more appropriate.

## Pest Management

***Pre-bearing stage*** - Weed control is critical to avoid competition for water, nutrients and light during this stage. Organic or other biodegradable mulch maybe used for this purpose as well as to conserve soil moisture. If herbicides are used, pre-emergent applications before planting are more effective and reduce the risk of damaging young trees. After planting, weeds may be controlled using string trimmers but these must not be used too close to the trees because they can cause debarking or girdling and tree death (Plate 14). If post-emergent herbicides are applied, a shield must be use to avoid damaging the trees. Herbicides that remain active in the soil must be avoided.

Insecticidal baits should be applied early, where necessary, to minimize attacks by insects such as leaf-cutting ants that can completely destroy the shoots in a short time (Plate 15).

***Bearing stage*** – Weed control is usually easier with mature trees because the canopies shade the weeds out especially at the closer spacings. However, weeds should still be controlled if they harbour pests.

Leaf-cutting ants can attack mature trees, therefore, insecticidal baits should be maintained where necessary.


Plate 14. Dwarf pomme cythere tree trunk damaged by string trimmer


Plate15. Use of plastic bottle to contain bait for leaf-cutting ants control on dwarf pomme cythere

## Pest Management cont'd

White flies can become a major problem as heavy infestation may cause severe leaf senescence and fall (Plate 16).


Plate 16. White flies on dwarf pomme cythere leaves

Lady bird beetles are useful predators and with proper weed control, insecticides not required. However, if it becomes necessary, low toxicity chemicals should be selected and applied with a mist blower. Scales suck sap from the stems and the fruits; they are usually associated with ants. Mites and thrips damage the skin and thereby, impair the appearance of the fruits and cause loss of quality.

Diseases on the fruits also reduce fruit quality and increase losses. Round, small (8 mm) and large (1.5 mm) black spots with gumming on the green fruit are associated with fungal pathogens, but these spots are superficial and do not cause fruit rot.

Brown lesions, without gumming, on ripe fruit, are caused by the fungus, *Colletotrichum gloeosporioides*, and lead to rotting. Fungal diseases are more prevalent under high humidity conditions and during the rainy season.Therefore, selecting planting sites in well-drained areas that receive moderate amounts of rainfall, proper tree spacing and maintaining good in-field drainage are useful strategies to reduce the incidence of fungal diseases. Immersion of harvested fruit in water at 46º C for 10 minutes was reported to control anthracnose infection. Sooty mold fungus infects the leaves and skin of the fruit and is commonly associated with infestation by sucking insects such as scales, mealy bug, aphids, and white flies (Plate 17). Its presence is reduced when these pests are controlled.


Plate 17 Sooty mold on dwarf pomme cythere fruit and leaves

Gummosis is the most important disease affecting the dwarf pomme cythere tree which, although more tolerant than the taller varieties, can experience branch and even tree death. Lesions which exude gum appear on the branches or trunk of the tree. The gum becomes dark brown to black and as the lesions expand, more gum is produced (Plate 18). The exact cause of the disease has not been identified. Avoiding physical damage to the trunk and branches and the use of sterilsed secateurs during harvest have been recommended to reduce transmission of pathogens that may cause this disease.


Plate 18. Gummosis on dwarf pomme cythere branch

# TREE MATURITY, FRUIT MATURITY AND YIELD

Dwarf pomme cythere trees can begin to flower as early as three months after planting but most plants flower by 5 months with adequate sunlight and soil moisture levels and, proper management. From first appearance of the inflorescences through to their growth, flower opening and fruit set, takes 3 to 4 weeks, and from fruit set to the green mature stage, approximately 20 weeks. At maturity, the skin colour is bright green and the flesh is cream, firm and suitable for eating fresh. Fruits should be harvested at this stage, unless otherwise specified by the market, because they usually fall before ripening (Plate 19). After removal from the tree, the fruit ripens as indicated by the bright yellow skin and softer flesh. Earlier flowering and fruit maturity are important economic advantages over the tall variety in which tree maturity takes 4 years and 6 to 7 months are required for fruit maturity.


Plate 19. Mature dwarf pomme cythere fruit ready for harvesting

Yield of dwarf pomme cythere is largely determined by fruit number. The number of mature fruits per bunch varies depending on pollination, fruit set and subsequent fruit fall. With good fruit set, initially, there may be approximately 60 to 100 fruits per bunch but only about 25% remain to maturity. The average weight of mature fruits may range from 50 to 70 gm depending on environmental and management factors, and to a less extent, fruit number per bunch.

With continuous branching and flowering, a tree has several bunches of fruit at different stages of development at the same time (Plate 20). Therefore, it may be possible to harvest fruit on a monthly basis. In one small orchard, 2 year old trees produced 230 to 360 fruits that weighed 12.3 - 17.6 kg / tree. At this age, the estimated annual yield from a population of 1600 trees/ha is between 20 to 24 t/ha, while 9-year old trees grown at lower densities have produced annual yields up to 40 t/ha. These yields compare favourably with annual yields of 10 - 20 t/ha from the tall variety.


Plate 20. Dwarf pomme cythere tree with fruit at different stages of maturity

## HARVESTING

Timely harvesting of fruits as they mature is important to avoid fruit loss due to fall or stunting the tree or even death if the tree is carrying too many bunches of mature fruit simultaneously. All fruits in the same bunch are usually harvested together, although they may not be at the same stage of maturity. Harvesting is done manually or by using harvesting shears or secateurs to separate the fruits from the peduncles (Plate 21). Like those of the tall variety, the fruits of the dwarf variety are very dense and firm at maturity and highly susceptible to physical damage such as punctures, cracking and bruising that may not be obvious at first, but will show up and contribute to fruit loss during the post-harvest stage. Therefore, recommendations to reduce such damage are similar and include using gloves during harvesting, avoid dropping the fruits and packing in shallow, well-padded crates which should be filled to the proper level (Plate 22).

Temperature management is also important because the fruits have a high rate of respiration that can also encourage loss of fruit quality. Therefore, beside avoiding physical damage, cool temperatures should be maintained by harvesting during the early morning, placing the harvested fruit in well-ventilated, light-coloured containers, keeping the containers in the shade or using light-coloured tarpaulin covers or banana leaves and transporting from the field as soon as possible after harvesting.


Plate 21. Harvesting fruits with secateurs


Plate 22. A crate of harvested fruit in the field

## POST-HARVEST HANDLING

Similar protocols to those recommended for the tall varieties may be used for the dwarf pomme cythere. During transport and all subsequent post-harvest stages, continued caution should be taken to avoid physical damage and to keep the fruit cool. If the fruits are not being sold soon after harvesting, steps must be taken to prolong their shelf life and maintain their quality.

Hydro-cooling (by submerging the fruit in water at 7 - 10ºC for 1 hour) to remove field heat within 45 minutes of arrival at the packing house is recommended. Washing the fruits in water containing 100 - 120 ppm (parts per million) of sodium hydroxide (bleach) solution disinfects them and improves their appearance by removing dirt, debris and latex stains. Then they should be air-dried. Any unmarketable fruit and those that will increase post-harvest losses should be removed before storage. These include damaged, diseased or over-mature fruit, as well as those that are under the marketable size or weight, which for the dwarf pomme cythere is at least 60 g. They should then be packed in card-board or fibre-board cartons and kept under suitable conditions.

Temperatures as low as 8ºC can cause chilling injury and must be avoided. Instead, after cooling, the fruits should be maintained at 12 - 13ºC and at 85 - 90% relative humidity for the best shelf life and fruit quality.

# *GLOSSARY*

Arrangement – the planting pattern or layout of plants in the field e.g. square, rectangle

Canopy – the entire shoot system of the plant

Canopy width – the width of the canopy

Determinate growth – stem elongation that is not continuous but ends when the terminal bud becomes a reproductive bud that produces flowers and eventually fruits

Density – the number of plants per unit area in the field e.g. the number of plants per hectare

Dormancy – the inability of a seed to germinate under ideal growing conditions

Endocarp – the tissue covering the stone.

Establishment – the period after planting during which the plant begins to grow and adapt to the field environment

Foliar fertilizer – a liquid fertilizer that is applied to the leaves for absorption of nutrients

Fruit maturity – the stage at which the fruit is fully developed and does not increase further in size

Fruit stalk – the stalk that attaches the fruit to the stem or branch

Inflorescence – a collection of flowers borne on the same stalk which may or may not be branched

Lateral branch – a branch that grows out from the side of the main stem

Main stem – the primary or first stem that arises from the germinating seed and forms the trunk of the tree.

Microjet sprinkler – a sprinkler that delivers a low volume of water as a fine spray under low pressure and close to the ground

Pathogen – a microorganism that can cause disease e.g. a bacterium, fungus, virus, nematode

Pre-emergent – effective before germination and emergence of weeds above the soil surface

Pinnate leaf – a leaf in which the blade is divided into smaller segments that are arranged in two rows along the main vein

## *GLOSSARY*

Pollination – the transfer of pollen from the anthers (male part) to the stigmas (female part) of flowers
- cross pollination – transfer of pollen from the anthers of flowers on one plant to the stigmas of flowers on another plant

Post-emergent – effective after germination and emergence of weeds above the soil surface

Root-bound – the plant condition in which the roots grow spirally around the base of the container and may become entangled or stop growing

Predator – with reference to insects, it is an insect that preys on other insects

Respiration – the process by which oxygen is used to breakdown stored carbohydrates and carbon dioxide and heat are released

Spacing – the distances between adjacent plants in the same row and between adjacent rows

Stone – a hard endocarp with enclosed seeds

Terminal bud - the bud at the tip of the main or lateral stem

Tree height – the distance from the base of the tree trunk at the soil surface to the highest point on the tree

Variety – a group of plants that can be distinguished from others in the same species by their naturally occurring variation in traits e.g. tree height, fruit shape

Weed – an unwanted plant species growing among the desired species

## BIBLIOGRAPHY


Andall, R. P. 2001. The effect of fruit and inflorescence pruning on fruit size and yield of dwarf golden apple *(Spondias cytherea Sonn.)*. *Proceedings of the Caribbean Food Crops Society*. 37:116-118.

Bauer, T., Kim, J. and Baldeo, I. 1993. *Preliminary study on the golden apple (Spondias dulcis) production and marketing in Grenada.* Inter-American Institute for Cooperation in Agriculture Office in Grenada. pp. 21.

Fortune, M. and Dilbar, A. 1993. New disease of mango *(Mangifera indica),* passion fruit *(Passiflora edulis var. flavicarpa)* and pomme cythere *(Spondias cytherea)* and their threat to sustainable agriculture. *Proceedings of the Seventh Annual Seminar of Agricultural Research,* NIHERST, 68 – 75.

Graham, O.S., Wickham, L. D. and Mohammed, M. 2004. Growth, development and quality attributes of miniature golden apple fruit *(Spondias cytherea* Sonn). Part I: Fruit growth and development to maturity. *Food, Agriculture & Environment* 2 (1): 90-94.

Paull, R.E. and Duarte, O. 2011. Other tropical Asian and Pacific Fruit. Chapter 11 in *Tropical Fruits,* Vol. 2, 2nd Ed., 255 – 301. Crop Production in Science Horticulture Series, Oxfordshire, CAB International.

Mitchell, J.D. and Daly, D.C. 2015. A revision of *Spondias* L. (Anacardiaceae) in the Neotropics. *PhytoKeys* 55: 1–92. doi: 10.3897/phytokeys.55.8489

Morton, J. F. 1987. Ambarella. In *Fruits of Warm Climates,* Winterville, North Carolina, Creative Resource Systems, Inc.

Mohammed M., Bridgemohan P., Mohamed M.S., Bridgemohan R.S.H. and Mohammed Z. 2017. Postharvest physiology and storage of golden apple *(Spondias cytherea* Sonnerat or *Spondias dulcis* Forst): A review. *Journal of Food Processing and Technology* 8:12. DOI 10.4172/2157-7110.1000707

Souza, P. H. M., Gomes, F. R. , Silva, G. Z., Rocha, D. I., Cruz, S. C. S. and Silva, D. F. P. 2021. Morphological characterization of fruits, endocarp, seed and seedlings of cajá-manga *(Spondias dulcis)*. *Rev. Ceres, Viçosa* 68 (3): 239 – 244.

----------, Ragagnin, A.L.S.L., Ribeiro, R.C., Silva, G.Z., Rocha, D.I. and Silva, D.F.P. 2020. Dormancy overcoming in seeds of cajá-manga *(Spondias dulcis). Comunicata Scientiae,* 11:01-06. doi.org/10.14295/CS.v11i0.3341

Windsborrow, C. 1994. Golden apple production. *Third Regional Workshop on Tropical Fruits,* IICA Office in Trinidad and Tobago, 113- 114.

# APPENDIX 1 – PLANT ARRANGEMENTS, SPACINGS AND PLANT POPULATIONS

| Arrangement | Plant spacing within the row (m) | Plant spacing between rows (m) | Plant Population* | |
|---|---|---|---|---|
| | | | (ha) | (ac) |
| Square | 1.5 | 1.5 | 4,444 | 1,778 |
| Rectangle | 1.5 | 2.5 | 2,666 | 1,066 |
| Square | 2.5 | 2.5 | 1,600 | 640 |
| Rectangle | 2.5 | 3.5 | 1,142 | 456 |
| Square | 3.5 | 3.5 | 816 | 326 |
| Rectangle | 3.5 | 4.5 | 634 | 254 |
| Square | 4.5 | 4.5 | 494 | 198 |

*Plant population indicates the number of plants required at the specified plant spacing. It is recommended that 2 – 3% more seedlings be raised in the nursery or purchased to facilitate selection of the strongest seedlings for planting and also to supply/replace dead seedlings in the field.

***Conversion factors:***

Metre (m) to feet (ft) – 1 m = 3 ft 4 in.

Feet (ft) to metre (m) – 1 ft = 0.3 m

Hectare (ha) to acre (ac) – 1 ha = 2.47 ac;

Acre to hectare - 1 ac = 0.4 ha

# DWARF POMME CYTHERE PRODUCTION MANUAL

**Author:** ***Laura B. Roberts-Nkrumah***
PhD Agric.(UWI), B.Sc.Agric. (UWI), MEd. (UWI)
Professor of Crop Science and Production
Department of Food Production
Faculty of Food and Agriculture
The University of the West Indies

*Department of Food Production, Faculty of Food and Agriculture,*
*The University of the West Indies, St. Augustine, Trinidad and Tobago*
*Tel: (868) 662-2002 ext. 82089/83325; Fax: (868) 645-0479;*
*Email: food.production@sta.uwi.edu;*
*Website: https://sta.uwi.edu/ffa/foodprod/*