# *TECHNICAL OPERATIONAL MANUAL*

# *SOURSOP*

**AGRICULTURAL SECTOR MODERNIZATION PROJECT**
**(ASMP)**

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## Contents

## *Figures*

## *Tables*

## *INTRODUCTION*

The Soursop tree, scientifically known as Annona muricata, is native to the tropical regions of the Americas, particularly the Caribbean and parts of Central and South America. It thrives in warm climates and is often found in rainforests and coastal areas. The tree is believed to have been cultivated for centuries, with its fruit being valued for its unique flavor and potential health benefits. Over time, the Soursop has spread to other tropical regions around the world, including Southeast Asia and the Pacific Islands, where it continues to be a popular fruit in local diets and traditional medicine.

The fruit of the Soursop tree, also known as Graviola or guanabana, is a tropical fruit known for its unique flavor and potential health benefits. The fruit is commonly used in beverages, desserts, and traditional medicine due to its high nutritional value and reported medicinal properties.

Soursop is not only enjoyed for its delicious taste but also for its numerous health benefits, including its high vitamin C content and potential anti-inflammatory properties. In Sri Lanka, Soursop is cultivated in home gardens and commercial farms, contributing to both local diets and the economy. The fruit is often sold fresh in markets or processed into various products, such as juices and ice creams, showcasing its versatility and popularity among consumers.

### Optimal Ecological Requirements

To ensure optimal soursop production, it is essential to understand the agro-ecological conditions that are conducive to its growth:

#### Temperature Requirements

Soursop is a tropical fruit that thrives in warm, humid climates. It is sensitive to cold temperatures and frost, which can damage or kill the plant. The optimal temperature range for Soursop cultivation is between 25°C and 35°C (77°F to 95°F).

#### Water Requirements

The fruit requires a consistent supply of moisture, making it well-suited to regions with high average annual rainfall. However, it is important to note that the plant cannot tolerate waterlogged soils, and good drainage is essential to prevent root rot.

The optimal rainfall and water requirements for the Soursop, also known as Graviola, depend on various factors such as the stage of growth, climate, and soil conditions. Generally, Soursop thrives in tropical and subtropical regions with well-distributed rainfall of about 1000-2000 mm annually. During the initial stages of growth, the plant requires regular watering to establish a strong root system, after which it can tolerate short periods of drought. However, Soursop trees benefit from consistent soil moisture, especially during flowering and fruiting

periods, to support healthy fruit development. Proper drainage is essential to prevent waterlogged conditions that can lead to root rot. Overall, providing adequate irrigation based on local climate and soil conditions is crucial for optimal growth and fruit production of Soursop.

Altitude and Sunlight

Soursop is typically cultivated at altitudes ranging from sea level to 1,200 meters (3,937 feet) above sea level. While the plant prefers full sunlight for optimal growth and fruit production, it can tolerate partial shade, especially during its early stages of development. However, to achieve maximum yields, Soursop trees should ideally be planted in locations with ample sunlight exposure.

Soil Requirements

Soursop grows best in well-drained, fertile soils with a slightly acidic to neutral pH level (6.0 to 6.5). Sandy loam or loamy soils are preferred, as they provide good aeration and drainage, which is crucial for the development of a healthy root system. The presence of organic matter in the soil is also beneficial for Soursop cultivation, as it enhances soil structure, moisture retention, and nutrient availability.

## *LAND PREPARATION*

### Primary Land Preparation

1. Deep ploughing using a disk or mouldboard plough as large as possible, from 30 cm to 60 cm (12” to 24”) in diameter.
2. Incorporation organic matter, commercial compost (12 MT per hectare or 5 MT per acre) and other soil amendments as required by broadcasting all over the plot surface.
3. Deep plough again perpendicular to the first pass.

### Secondary Land Preparation

1. Heavy Soil Textures
   a. Disk harrow using a disk harrow implement with disks having a diameter from 18 cm to 24 cm (7” to 10”).
   b. Two passes perpendicular to each other are required.
2. Light Soil Textures
   a. Cultivate using a tine tiller implement.
   b. Two passes may be required in sandy clay loam soils.

**Tractor**

1. A tractor size 75 to 99 HP (75 to 85 POT), four-wheel drive, is best to pull large ploughing equipment.

**Drainage**

Drainage is of particular importance for the Soursop as the crop is susceptible to several root diseases. Good internal drainage provided by a network of drainage ditches to quickly evacuate high amounts of rainfall are very important practices to prevent Fusarium Wilt, Phytophthora root rot and other soil borne diseases affecting Soursop.

Evacuation Drainage

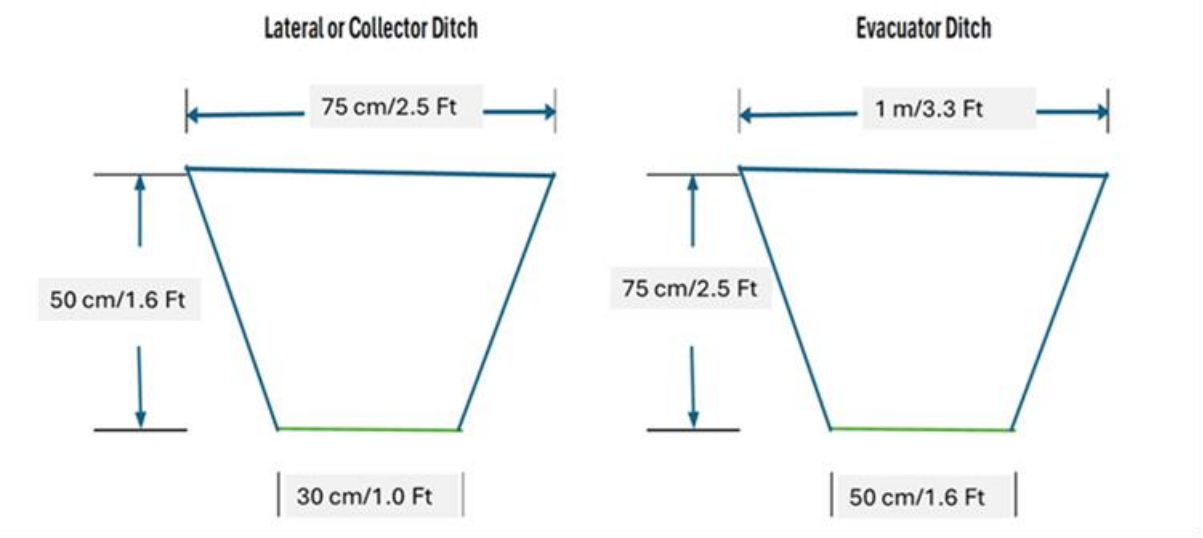


*Figure 1: Size of Drainage Ditches*

For small plots, a "U" type drainage design is recommended. This system is made up of two lateral drainage ditches (collectors) at the extreme ends of the plot that drain into a primary drainage canal (evacuator) that evacuates the water away from the plot into a safe area, avoiding damage to property or goods. All drainage ditches must be trapezoidal in shape to avoid the collapse of the walls into the ditch and subsequent loss of depth by sedimentation. Grass or small plants can be promoted on the walls of the ditches to keep them stable. The size of the laterals and evacuator should be as shown below:

All ditches must have a slope or gradient of at least 0.1% which is equivalent to a drop of 1 m in 1,000 m. This slope is also expressed as 0.001

This on-farm simple drainage system can evacuate 4 mm of rain per hour or 96 mm per day. Catastrophic conditions such as flooding can occur with rainfall greater than 100 mm per day. These conditions will cause damage to crops and can only be mitigated with macro drainage work done by the Government.

Before making the ditches, it is necessary to observe the slope of the plot. It is recommended to place the large evacuator ditch cutting across the terrain and along the lowest section of the plot. Then, the lateral ditches are placed perpendicular to the evacuator. The planting beds should drain into the laterals or collectors, which, in turn, drain into the large evacuator

If necessary, for crops that are planted in the East-West direction such as the double row planting of fruit trees, the laterals can be made to cut across the double rows to force them to drain into the large evacuator placed along the lowest section of the plot.

Surface Drainage

After a heavy rain, wet spots often remain in different locations, especially if the field has not been levelled or does not have a slope gradient sufficient to force the water out of the plot by gravity. In these cases, it is recommended for the farmers to drain all the wet spots by manually guiding the water out of each spot into a nearby drainage ditch or canal using a hoe type tool. Two or more wet spots can be connected to be finally drained into a drainage ditch or canal.

*Figure 2: Draining Wet Spots Using Surface Drainage*

***VARIETIES***

In Sri Lanka, soursop (Annona muricata) is a popular fruit known for its unique flavor and health benefits. Some of the most common varieties found in the country are:

1. Hawaiian Soursop: This variety is notable for its large size and a smooth, creamy texture. The fruit is typically sweet with a hint of tartness, making it a favorite for juices, smoothies, and desserts. The Hawaiian soursop is often praised for its rich flavor and high yield, attracting both local farmers and consumers.

2. Local Soursop: The local variety of soursop in Sri Lanka is generally smaller than the Hawaiian type. It tends to be more fibrous, with a slightly more pronounced tartness that complements its sweetness. This variety is often enjoyed fresh, and its unique flavor profile makes it a staple in local cuisine, where it is used in traditional dishes and beverages.

3. Bali Soursop: Known for its aromatic qualities, the Bali soursop has a creamy texture that is highly sought after. This variety is often used in desserts and is valued for its balance of sweetness and slight acidity. The Bali soursop is also appreciated for its fragrant aroma, which enhances its appeal in culinary applications.

4. Cherimoya Soursop: While less common, this variety is recognized for its sweet, custard-like flesh. It has a distinctive flavor profile that combines hints of banana, pineapple, and strawberry, making it an exotic choice among soursop varieties.

5. Mexican Soursop: This variety is characterized by its slightly smaller fruit and a flavor that is less sweet compared to others. It is often used in traditional remedies and is valued for its nutritional benefits.

***PLANTING MATERIAL***

To cultivate soursop (Annona muricata) on a large scale, selecting the best planting material is essential for ensuring healthy growth and high yields. Here's a detailed overview of the best planting materials and the methods for large-scale production.

### Best Planting Material

1. Seeds:

- Quality: Use seeds from ripe, healthy soursop fruits. Ensure the fruit is from a high-quality variety known for good taste and yield.
- Preparation: Clean the seeds to remove any pulp and let them dry before planting. Fresh seeds germinate better.

2. Cuttings:

- Selection: Use semi-hardwood cuttings from healthy, fruit-bearing trees. Cuttings should be around 15-20 cm long with several leaf nodes.
- Rooting Hormone: Treat cuttings with rooting hormone to enhance rooting success.

3.Grafting:

- Method: Grafting involves joining a scion (cutting from a desirable variety) to a rootstock (seedling). This can result in a tree that has desirable traits from both plants.
- Benefits: Grafted plants may grow faster and bear fruit sooner than seed-grown plants.

**Large-Scale Production**

1. Propagation via Seeds:
    - Germination: Sow seeds in seed trays or pots filled with a well-draining mix. Maintain humidity and warmth (around 25-30°C) for optimal germination.
    - Transplanting: Once seedlings have 4-5 true leaves and are about 15-20 cm tall, transplant them into larger pots or directly into the field.

2. Vegetative Propagation (Cuttings):
    - Rooting Environment: Place cuttings in a humidity-controlled environment (e.g., a mist chamber) to promote root development.
    - Transplanting: Once sufficient roots have developed, transplant the cuttings into the field.

3. Grafting:
    - Technique: Use either the cleft grafting or side-veneer grafting method. Ensure that the graft union is properly secured and protected.
    - Aftercare: Keep the grafted plants in a shaded, humid environment until they establish.

***HIGH DENSITY DOUBLE ROW PLANTING***

**Procedure**

For planting purposes, all distances are carefully measured and staked out in the field in order to achieve the population density as precisely as possible. An East-West orientation of the double rows is recommended to maximize the sunlight exposure of the fruit trees in the double rows throughout the day.

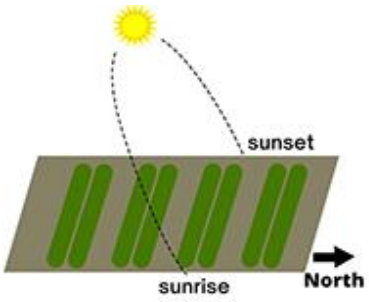

*Figure 3: East to West orientation of rows*

At the beginning, an origin or initial point is chosen at one end of the field making sure that there are no obstacles and no shading in either direction that can affect the development of the crop. A base line facing East or West is then laid out at one end of the plot from the origin. A second base line perpendicular to the first base line is drawn as well.

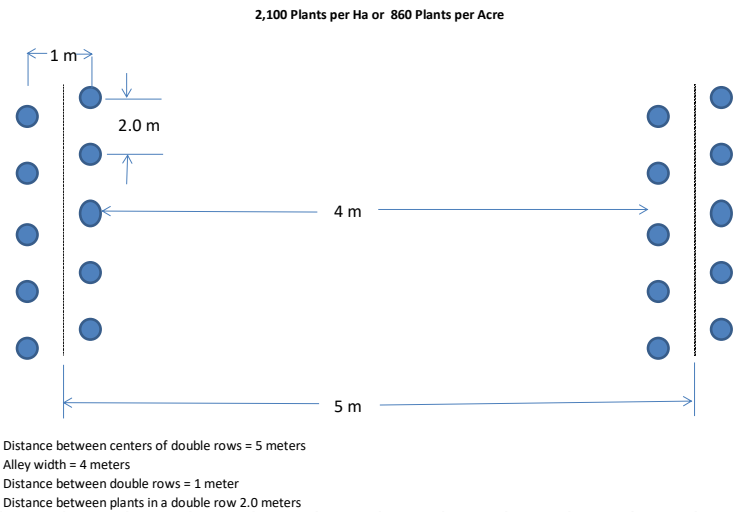


*Figure 4: High-Density Double-Row Planting of Soursop*

The first double row is measured at 1 m on the East-West base line and layout by measuring 1m at 5 steps intervals down the row from the base line. The 4 m width of the first double row alley is then measured from the second row of the first double row. The alley is then laid out by measuring 4 m width at 5 steps intervals down the row. The rest of the double rows and alleys are measured, and layout based on this initial double row and alley way using 1 m and 4 m widths.

The planting distances are measured on each double row laid out making sure a triangular or zig zag pattern is achieved within the double row. To achieve the zig zag pattern, the planting distances in the second double row begin being measured at half the planting distance from the origin of the base line.

Once the double rows and alleys are laid out and planting distances marked with wooden stakes, planting begins in the first double row established at the base line. All other double rows are planted as laid out from the first double row on the chosen base line.

Once the planting distances in the double rows are measured and delineated, planting holes are excavated of sufficient size and depth to accommodate the size of the bags containing the planting material coming from the nursery. The small plants are then placed in the planting holes without the plastic bags, but with the potting mix still attached to minimize transplant shock. The soil is then firmed around the new transplant to increase the anchorage of the new plant in its new environment. It is important to flatten out the soil around the newly planted meristem to avoid basins that may cause waterlogging around the new plant.

Water must be applied as soon as possible after the transplanting operation is completed. Water must continue to be applied throughout the growing period of the Apple Soursop plant as required depending on rain fall.

**Plant Spacings Within the Double Rows**

| | |
|---|---|
| Soursop | 2.00 m |

**Planting Aids**

1. Construction twine (preferably white colored)
2. A good number of wooden stakes to layout base lines and double rows

3. Right angle template made of a non-stretching rope with marks at 3 m, 4 m and 5 m
4. Template of 1 m in length to confirm width of the double rows, made out of a non-stretching rope.
5. Template of 4 m in length to confirm width of the alleyways, made out of a non-stretching rope.
6. Planting stakes to mark planting holes (good quantity)
7. Spade type shovels to make planting hole size 30 cm x 30 cm x 30 cm or one cubic foot

## *IRRIGATION AND FERTIGATION*

### Irrigation

#### Water Requirements

The irrigation requirements for soursop (Annona muricata) can vary significantly based on the tree's growth stage, local climate, and soil conditions. In general, a mature soursop tree may require about 20-40 liters of water per day under typical conditions. This is equivalent to a range from 4.3 mm/day to 8.6 mm/day, with a media of 6.45 mm/day. However, this is highly dependent on the rate of evapotranspiration (ET), which is the sum of evaporation from the soil surface and transpiration from the plant. The ET rate is influenced by temperature, humidity, wind speed, and solar radiation.

In areas with high temperatures and low humidity, evapotranspiration rates will be higher, potentially increasing the water requirements of the tree. For instance, during peak summer months, a soursop tree might experience an ET rate of 4 mm/day to 6 mm/day, which would necessitate more irrigation to compensate for the increased water loss.

*Figure 5: Mini Sprinkler Irrigation*

In addition to the evapotranspiration rate and for a more effective watering schedule, it is advisable to use soil moisture sensors or tensiometers to monitor the water content around the tree's root zone. This ensures the tree receives adequate water without over-irrigating. Weekly water needs can range from 140-280 liters per week for an established tree, but this is again a rough estimate and must be adjusted based on real-time environmental data and the soil's ability to retain water. It is important to allow the soil to dry slightly below field capacity between waterings to prevent waterlogging and ensure proper root aeration. Farmers can learn to monitor the field capacity moisture level of the soil by feeling the soil with their hands, making sure excess water does not drip as they squeeze a handful of soil.

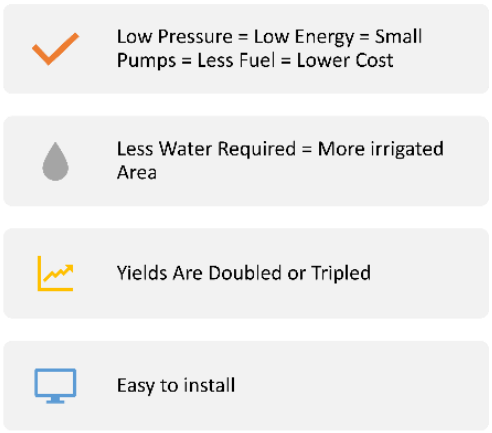


*Figure 6: Advantages of Low-Pressure Irrigation*

Regularly adjusting the irrigation strategy to accommodate changing weather patterns and the tree's lifecycle phases will help maintain the right moisture balance for optimal soursop growth and productivity.

Low pressure irrigation is the best method of applying uniform and precise amounts of water directly to the root zone of the plants, as per their above requirement, through emitters at frequent intervals over a period, via a pipe network comprising of mains, submains, and laterals. In this system, water is applied drop by drop or by micro jet (micro sprinkler), on the soil surface or below it (sub-surface), at a rate lower than the infiltration rate of the soil.

Micro sprinkler systems (micro jets) are preferred for fruit trees because the hydraulic head created by their height and discharge rates will push the waterfront downward in the soil profile to reach their deeper root systems of fruit trees.

## New Irrigation Concepts

- Net Area Irrigation – Water for Cultivated Area Only
- Evapotranspiration for irrigation scheduling rather than soil moisture content
- Consumptive Water Use by Crops: Different Crops Different Amounts of Water
- Water Amounts Are Adjusted to The Physiological Development of the Crops (Kc Constants per Crop)

## Water Application

Low pressure irrigation systems are designed to keep the soil moisture level at field capacity which is the optimal soil moisture level for root growth and development. At this level, the soil provides ample and sufficient amounts of Oxygen and water to the roots of the different crops.

*Figure 7: Mini weather Station*

At constant field capacity soil moisture, the amount of water to be applied through irrigation is the water loss by evapotranspiration, adjusted for rainfall. In other words, low pressure irrigation must provide the amount of water necessary to cover the water deficit of the crop on a daily basis to prevent the crop from suffering from water stress and losing yield potential. Modern weather stations provide evapotranspiration rates on a daily basis for farmers to properly irrigate their crops. To facilitate this modern technology process, ASMP has installed mini weather stations in 21 Clusters in different Districts of the Country.

As a minimum, and on a daily basis, crops must receive the amount of water required for optimum growth, development and yield, defined as consumptive water use. The Soursop tree consumptive water use is a median of 6.4 mm of water per day, equivalent to 44.8 mm per week. This weekly amount can be applied in three cycles of irrigation. As an illustration, the charts below show the recommended irrigation times per cycle to deliver the weekly consumptive water use of Soursop using the micro sprinkler system in the first year of establishment and production:

*Table 1:Consumptive Water Use Irrigation Time For First Year Crop*

| Irrigation Schedule | Veg. Growth | | Flowering | | Fruiting | |
|---|---|---|---|---|---|---|
| Irrigation Time (Hours/Minutes) | 0 | 57 | 1 | 28 | 1 | 13 |

**Recommended irrigation Times Should Be Adjusted Further to Allow for Larger/Deeper Wetting Front**

For the second year of production, the recommended irrigation time is as follows:

*Table 2: Consumptive Water Use Irrigation Time for Second Year Crop*

| Irrigation Schedule | Veg. Growth | | Flowering | | Fruiting | |
|---|---|---|---|---|---|---|
| Irrigation Time (Hours/Minutes) | 1 | 5 | 1 | 41 | 1 | 23 |

**Recommended irrigation Times Should Be Adjusted Further to Allow for Larger/Deeper Wetting Front**

However, it is important to note that crops may need more water than the consumptive water use on a daily basis to prevent water stress and loss of yield potential brought about by water deficits that are determined by evapotranspiration, rainfall, etc. On a practical basis, and for the sake of simplicity, more water would need to be applied on very hot and dry days and less on cloudy and rainy days. The weather stations can tell us exactly how much to apply.

## Fertigation

### Nutritional Requirements

Soursop trees, also known as graviola, have specific nutrient requirements like any other plant. They generally require a balanced supply of essential nutrients to grow and produce healthy fruit. Some of the key nutrients that soursop trees require include nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, copper, manganese, and boron.

Nitrogen is important for leaf and stem growth, phosphorus is essential for root development and flower and fruit production, and potassium is crucial for overall plant vigor and disease resistance. Calcium and magnesium are important for cell structure and enzyme function, while sulfur is necessary for amino acid production. Iron, zinc, copper, manganese, and boron are micronutrients that play various roles in plant metabolism and growth.

It's important to provide soursop trees with a balanced fertilizer that contains these essential nutrients to ensure healthy growth and fruit production. Soil testing and consultation with local agricultural extension services can help determine the specific nutrient requirements for soursop trees in a particular area.

A fertilizer with a formulation of 10-10-10 or 20-10-10 are often recommended for soursop trees, but the specific needs may vary depending on soil conditions and the tree's growth stage. When the tree is young, a higher ratio of nitrogen promotes healthy growth, while a lower nitrogen content and increased phosphorus and potassium support flowering and fruit development in mature trees. Additionally, incorporating organic matter, such as compost or well-rotted manure, into the soil can improve its fertility and structure, ensuring that soursop trees receive the necessary nutrients for robust growth and bountiful fruit production. Regular soil testing can help determine the specific fertilizer needs of soursop trees, allowing for targeted and effective fertilization.

### Fertigation Recommendations

The fertilizer application in the ASMP Clusters is based on soil test results. Annex 3 contains all the soil tests and the global fertilizer recommendations for the Soursop Cluster.

The results of the Ampara Soursop Cluster area soil tests indicated the following:

*Table 3: Interpretation of Soil Test Results for Soursop in Ampara District*

| |
|---|
| Low Organic matter in 3 samples |
| Low Magnesium in 3 samples |
| Low Potassium |
| Low liquid Nitrogen |
| Low Phosphorous |
| Low micronutrients except Boron, Iron in 3 samples and Manganese in 2 samples |
| Cation Ratios not balanced |
| Low Ca Saturation |

Therefore, the recommendations for the application of fertilizers for this soil test are as follows:

*Table 4: Fertilizers Recommendation for Soursop in Ampara District Based on Soil Test Results*

| |
|---|
| Urea as required by the crop |
| TSP |
| MOP |
| MgSO4 |
| CaCO3 Lime |
| Foliar micronutrients |

Based on the above considerations, the recommended amounts of nutrients to be applied through fertigation for a second-year Soursop crop are shown in elemental and oxide form below:

| Recommendation | N | P | K | Mg |
|---|---|---|---|---|
| Kg/Ha | 150.0 | 75.0 | 150.0 | 75.0 |
| Lb/acre | 150.0 | 75.0 | 150.0 | 75.0 |
| Kg/Acre | 68.2 | 34.1 | 68.2 | 34.1 |

| | |
|---|---|
| Phosphoric Acid P (Kg/Ha | 25.0 |

| Recommendation | Urea | P2O5 | K2O | MgO | P2O5 |
|---|---|---|---|---|---|
| Kg/Ha | 326.1 | 171.8 | 180.8 | 124.3 | 57.3 |
| Lb/acre | 326.1 | 171.8 | 180.8 | 124.3 | 57.3 |
| Kg/Acre | 148.2 | 78.1 | 82.2 | 56.5 | 26.0 |

Phosphoric Acid is applied to prevent clogging of the irrigation mini sprinklers

The elemental quantities of nutrients need to be converted to fertilizer materials to make up the fertigation recommendation for the whole cropping season in Kg/Acre:

| Kg/Acre | Urea | TSP | MOP | MgSO4 | P.Acid |
|---|---|---|---|---|---|
| Fertilizer per Season | 322 | 170 | 137 | 377 | 42 |

Each of these amounts of fertilizer materials is then adjusted according to the phenological development of the crop. The FAO Irrigation Crop Coefficients (Kc) for a second year Soursop tree are used for this purpose:

| Ratio | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|
| Kc | 0.80 | 1.20 | 1.00 |

This means the crop will receive 80% of the recommended amounts of fertilizer during the initial stages of physiological development, 120% during the development or active growth phase and 100% during the production phase.

These amounts of fertilizers are then distributed on a per week basis according to the duration of each phenological stage of the crop cycle. These calculations result in amounts of fertilizer materials per Acre and per week (Kg/acre/Week):

| Crop Cycle (Days) | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|
| Weeks | 4 | 11 | 3 |

| Kg/Acre/Week | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|
| Urea | 64.44 | 35.15 | 107.41 |
| TSP | 33.96 | 18.52 | 56.60 |
| MOP | 27.39 | 14.94 | 45.65 |
| MgSO4 | 75.35 | 41.10 | 125.59 |
| P.Acid | 10.47 | 10.47 | 10.47 |

The weekly amounts of fertilizers are then converted to amounts per application using 2 applications per week:

| Applications per Week | 2 |
|---|---|

| Kg/Acre/Application | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|
| Urea | 32.222 | 17.576 | 53.703 |
| TSP | 16.979 | 9.261 | 28.298 |
| MOP | 13.694 | 7.470 | 22.824 |
| MgSO4 | 37.677 | 20.551 | 62.795 |
| P.Acid | 10.466 | 10.466 | 10.466 |

Finally, the amounts per Acre per application are adjusted to the size of the net production area of the plot which for the ASMP Project is half an Acre (50 m x 40 m):

| Bed Width (m) | Bed Length (m) | Bed Net Area (m2) | Number of Beds | Plot Net Area (Acres) |
|---|---|---|---|---|
| 1 | 40 | 40 | 11 | 0.11 |

In other words, in a production area of 0.5 Acre, only 0.11 Acres will be receiving fertilizer as follows:

| Plot/Application | Unit | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|---|
| Urea | Kg | 3.5 | 1.9 | 5.9 |
| TSP | Kg | 1.9 | 1.0 | 3.1 |
| MOP | Kg | 1.5 | 0.8 | 2.5 |
| MgSO4 | Kg | 4.1 | 2.3 | 6.9 |

2 Applications per Week

| Plot/Application | Unit | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|---|
| Phosphoric Acid (ml) | Ml | 300 | 300 | 300 |

Application every two weeks

The fertigation recommendation is complemented by the recommended application of other required fertilizer materials as indicated below:

| |
|---|
| Apply Calcium in the form of CaCO3 at a rate of 200 Kg/Half Acre or 40 gm/Tree per month all around the plant<br>Foliar Applications of Micronutrients (T-Flush 100 ml/16 L) or Similar Are also Recommended weekly. Very important |

***WEED CONTROL***

The best weed control practice for the double row planting is intercropping. Not only will it control undesired weeds in the aisle space, but it will also generate income for the farmers. In the absence of intercropping, only mechanical weed control practices are to be used, including within the narrow width of the double rows. Herbicides are not allowed because of their toxicity.

The most common mechanical weed control practices are:

1. Cultivation with a tractor using a rotavator implement.
2. Motorized weed cutters that use plastic cords to cut weeds (weed eaters)
3. Workers using bush knives or any other cutting or chopping tool

An additional option are biodegradable and recyclable plastic weed control soil mats that allow mini sprinkler irrigation water to penetrate into the soil. They have been in use for some time, particularly in fruit orchards to manage weeds within the narrow width of the high-density double rows.

They are indeed a popular solution for weed control, offering several benefits for managing vegetation around trees. The following are some key features and advantages:

*Figure 8: Plastic Soil Mat for Fruit Trees*

1. Material and Design: These mats are typically made from durable, UV-resistant plastic that can withstand various environmental conditions. They come in various sizes and thicknesses to suit different orchard layouts and tree spacing.
2. Weed Suppression: The primary function of plastic soil mats is to suppress weed growth by blocking sunlight and preventing weeds from germinating. This reduces competition for nutrients and water that trees need to thrive.
3. Soil Temperature Regulation: By covering the soil, plastic mats can help regulate soil temperature, promoting optimal conditions for tree roots, especially during extreme weather.
4. Moisture Retention: These mats can help retain soil moisture, reducing the need for frequent irrigation. This is particularly beneficial in drier climates where water conservation is crucial.

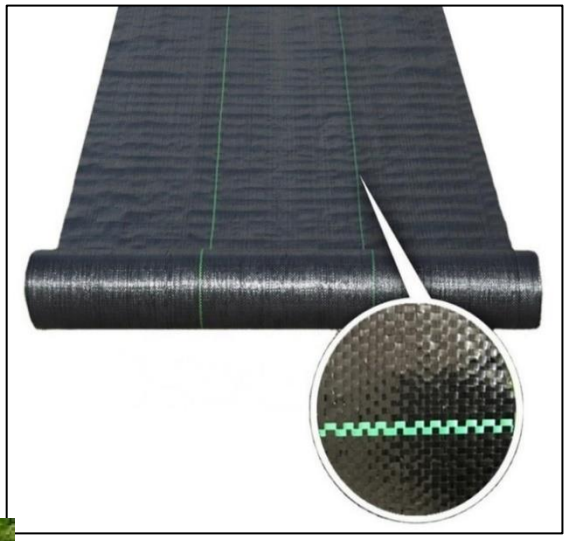

*Figure 9: Soil Mat for Weed Control*

*Figure 10: Fruit TreesPprotected from Weeds with Plastic Soil Mats*

5. Erosion Control: In addition to weed suppression, plastic soil mats can help prevent soil erosion, particularly on slopes or in areas with heavy rainfall.
6. Ease of Installation: They are relatively easy to install, often requiring minimal tools. Mats can be laid directly on the soil around the base of trees, and they can be cut to fit specific shapes and sizes.
7. Longevity: High-quality plastic mats can last several years, providing long-term weed control and reducing the need for ongoing maintenance.

8. Environmental Considerations: While effective, it's important to consider the environmental impact of plastic use. Some orchardists opt for biodegradable alternatives or incorporate practices that minimize plastic pollution.

Overall, plastic soil mats are an effective, low-maintenance option for weed control in orchards, contributing to healthier trees and improved fruit production.

***PEST AND DISEASE MANAGEMENT***

IPM concepts and practices must be applied to manage Soursop pests and diseases. The Quantity/Intensity factor is a practical and easy to apply IMP concept in deciding whether to apply pesticides:

| **Quantity** | **Coverage** |
|---|---|
| **Intensity** | **Severity** |

| | **Quantity** | | |
|---|---|---|---|
| **Intensity** | **Low** | **Medium** | **High** |
| **Low** | Observation | Observation | Localized |
| **Medium** | Spot Treatment | Localized | Full Treatment |
| **High** | Localized Treatment | Full Treatment | Full Treatment |

**Most Common Pests in Sri Lanka**

Soursop crops in Sri Lanka are affected by various pests that can significantly reduce yield and quality. Here are some of the most common pests:

| **Pest** | **Description** | **Symptoms** | **Management** |
|---|---|---|---|
| Aphids | Small, soft-bodied insects that feed on sap. | Yellowing leaves, stunted growth, sticky residue. | Use insecticidal soap, ladybugs for biological control. |
| Fruit Fly | Small flies that lay eggs in the fruit. | Larvae inside fruit, premature fruit drop. | Use traps, remove and destroy infested fruits. |
| Mealybugs | White cottony insects are found on stems and leaves. | Sticky honeydew, yellowing leaves, sooty mold. | Apply neem oil, insecticidal soap, or remove by hand. |
| Scale Insects | Small, immobile insects that suck plant juices. | Yellowing leaves, leaves drop, overall decline. | Use horticultural oils, introduce natural predators. |
| Spider Mites | Tiny arachnids that thrive in hot, dry conditions. | Fine webbing, speckled leaves, leaf drop. | Increase humidity, use miticides or neem oil. |
| Caterpillars | Larvae of moths and butterflies that feed on foliage. | Chewed leaves, visible caterpillars on plants. | Handpick, use Bacillus thuringiensis (Bt). |
| Whiteflies | Small, white, moth-like insects that feed on sap. | Yellowing leaves, sticky residue, sooty mold. | Use yellow sticky traps, insecticidal soap. |

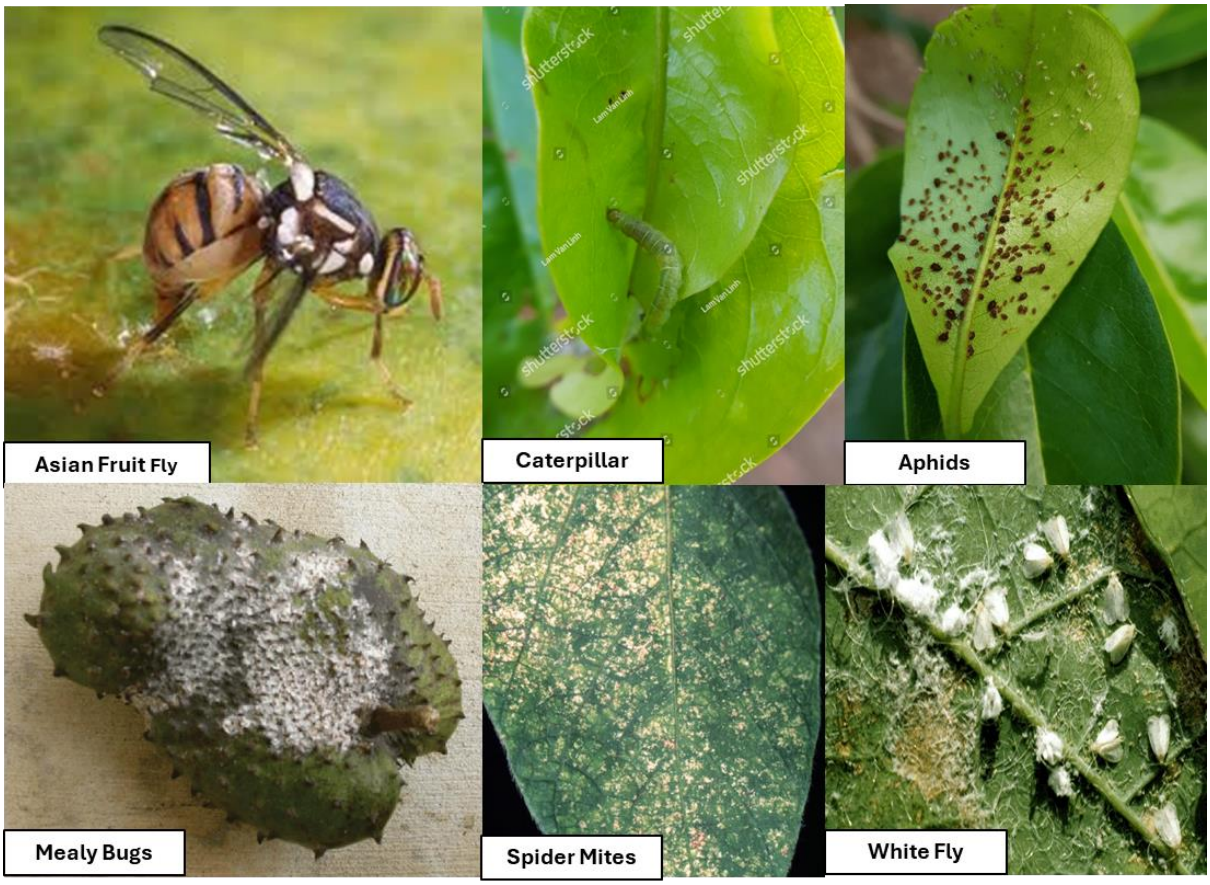


*Figure 11: Most Common Pests of Soursop in Sri Lanka*

Integrated pest management strategies, including cultural practices, biological controls, and targeted chemical applications, are essential for effectively managing these pests in Soursop cultivation in Sri Lanka. Regular monitoring or vigilance and timely interventions by the farmers can help minimize pest damage and improve crop health.

When chemical control is practiced, only pesticides that are registered in Sri Lanka should be used at DOA recommended amounts.

### Most Common Diseases in Sri Lanka

In Sri Lanka, Soursop is susceptible to several common diseases, which can significantly impact yield and quality. Here are some of the most prevalent diseases:

| Disease | Description | Symptoms | Management |
|---|---|---|---|
| Anthracnose | Fungal disease is caused by Colletotrichum gloeosporioides. | Dark lesions on leaves, fruits, and stems. | Remove infected parts, apply fungicides, and ensure good air circulation. |

| | | | |
|---|---|---|---|
| Leaf Spot | Caused by various fungal pathogens. | Small, dark spots on leaves, leading to leaf drop. | Fungicide application and maintaining proper spacing for airflow. |
| Root Rot | Fungal infection typically from poor drainage and overwatering. | Wilting, yellowing of leaves, and root decay. | Improve drainage, avoid overwatering, and treat with appropriate fungicides. |
| Bacterial Wilt | It is caused by bacteria like Ralstonia solanacearum. | Sudden wilting, yellowing of leaves, and decay of stems. | Remove infected plants, practice crop rotation, and use resistant varieties if available. |
| Powdery Mildew | Fungal disease is characterized by white powdery spots. | White powdery patches on leaves and stems. | Apply fungicides, improve air circulation, and avoid overhead watering. |

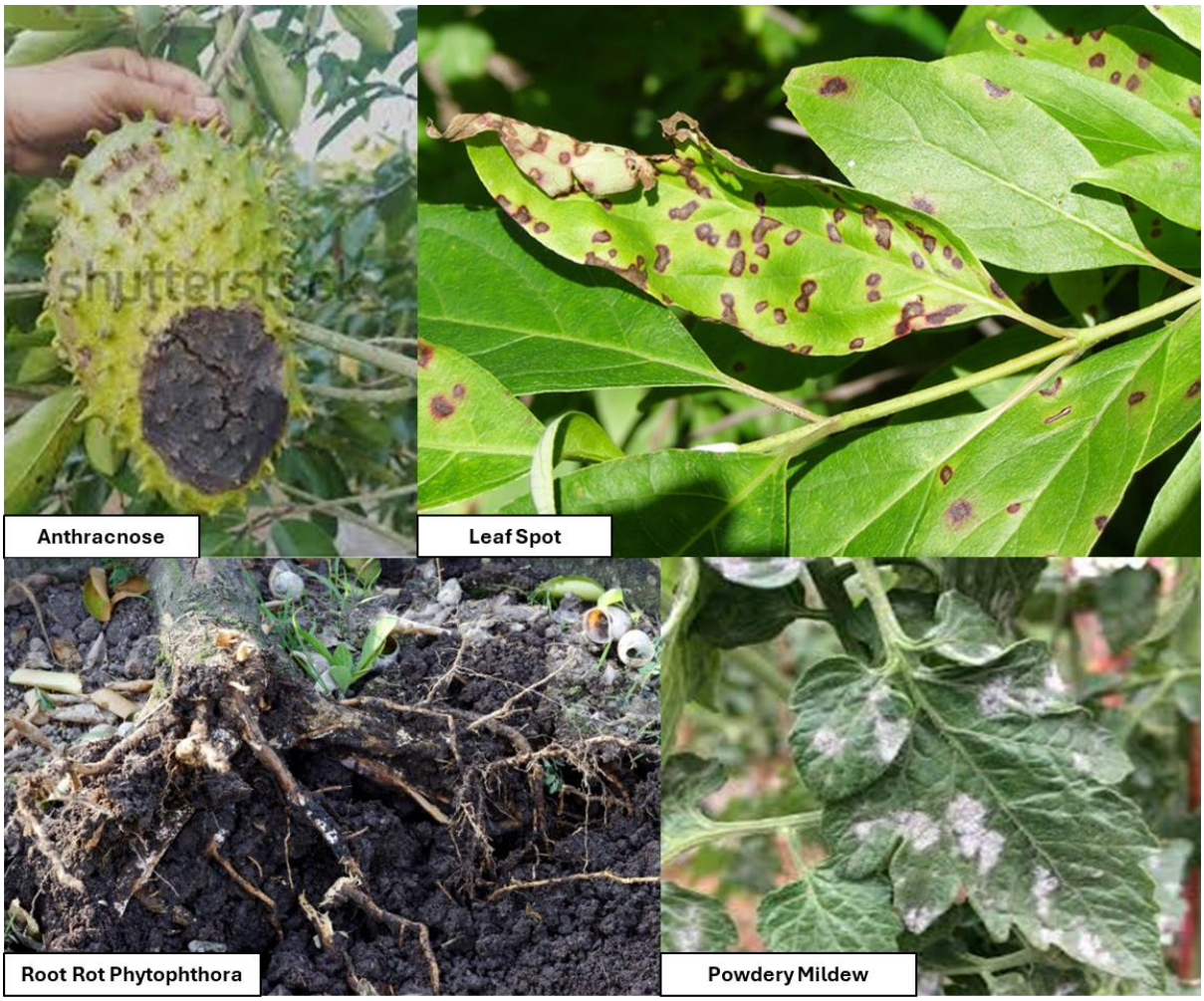


*Figure 12: Most Common Diseases of Soursop in Sri Lanka*

Effective management practices involve a combination of cultural practices, resistant varieties, and chemical controls tailored to specific diseases and local conditions. Regular monitoring or vigilance and timely intervention by the farmers are crucial to minimizing disease impact on Soursop crops in Sri Lanka.

When chemical control is practiced, only pesticides that are registered in Sri Lanka should be used at DOA recommended amounts.

**Chemical Control of Pests and Diseases**

Pests Chemical Control

This table provides a broader range of pest management options for soursop. Always consult local agricultural extension services for region-specific pest control advice.

| Pest | Insecticide | Dosage and Management |
|---|---|---|
| Soursop Borer | Carbaryl | Apply 1-2 lbs/acre; repeat every 7-10 days as needed. Prune and destroy infested branches to reduce the population. Monitor regularly. |
| Aphids | Imidacloprid | Apply 0.5-1 oz per 100 gallons of water. Use at first sign of infestation. Rotate with other insecticides to prevent resistance buildup. |
| | Neem Oil | Mix 2-3 tbsp per gallon of water; spray thoroughly. Use as a preventive measure and apply weekly during infestations. |
| Fruit Flies | Malathion | Apply 1-2 quarts per acre; combine with bait traps to reduce adult populations. Spray fruits directly before they ripen. |
| | Spinosad + Protein Bait | Mix 4-6 oz of Spinosad with bait per acre; apply as a spot treatment on leaves or fruits. Reapply after heavy rains. |
| Leafhoppers | Spinosad | Apply 3-4 oz per acre; target low populations early in the season. Can be used in organic systems. |
| | Lambda-Cyhalothrin | Apply 2-3 oz per acre; avoid usage during flowering to protect pollinators. Monitor for reinfestation. |
| Scale Insects | Horticultural Oil | Use a 2-3% solution; apply early morning or late evening to avoid harming beneficial insects. Reapply every 2 weeks if infestation persists. |
| | Buprofezin | Apply 10-12 oz per acre; use when nymphs are abundant. Avoid overuse to prevent resistance. |
| Thrips | Pyrethrin | Apply 1-2 pints per acre. Use early when thrips populations are low. Combine with integrated pest management practices for best results. |
| | Spinosad | Mix 4 oz per 100 gallons of water; spray thoroughly on flowers and leaves. Safe for use in organic farming. |
| Mealybugs | Chlorpyrifos | Apply 1-2 pints per acre. Direct application to infested areas. Avoid application during fruiting to reduce residue risks. |
| | Neem Oil | Mix 2-4 tbsp per gallon of water; spray directly on affected areas. Repeat every 7-14 days as needed. |

| Pest | Insecticide | Dosage and Management |
|---|---|---|
| Caterpillars | Bacillus thuringiensis (Bt) | Mix 1-2 tsp per gallon of water; apply to leaves where caterpillars are feeding. Effective for young larvae. |
| | Spinosad | Apply 4-6 oz per acre; target caterpillars in the early larval stage. Can be used in organic systems. |
| Whiteflies | Buprofezin | Apply 10-12 oz per acre; use during early stages of infestation. Combine with cultural practices like removing weeds. |
| | Imidacloprid | Apply 0.5-1 oz per 100 gallons of water. Avoid overuse to prevent resistance. Use systemic application for long-term control. |
| Beetles (Defoliators) | Cypermethrin | Apply 2-3 oz per acre; spray directly on foliage. Monitor for reinfestation and avoid overuse to prevent resistance. |
| | Carbaryl | Apply 1-2 lbs/acre; repeat every 7-10 days if defoliation persists. Ensure proper coverage of leaves. |

Notes:

- Integrated Pest Management (IPM): Always combine chemical control with cultural practices such as pruning, removing infested fruits, and encouraging natural enemies like lady beetles and parasitic wasps.
- Safety Guidelines: Follow label recommendations for safe application, pre-harvest intervals (PHI), and re-entry intervals (REI).
- Resistance Management: Rotate insecticides with different modes of action to prevent resistance development in pest populations.

Diseases Chemical Control

This table provides a comprehensive overview of agrochemicals for managing diseases affecting soursop. Always consult local agricultural extension services for region-specific recommendations and practices.

| Disease | Chemical | Dosage and Management |
|---|---|---|
| Anthracnose | Copper Oxychloride | Apply 2-3 lbs per 100 gallons of water; spray every 7-14 days during wet conditions. Ensure thorough coverage on leaves and fruits. |
| | Mancozeb | Use 2-3 lbs per acre; apply at the first sign of disease and repeat every 10-14 days. Rotate with other fungicides to prevent resistance. |
| Powdery Mildew | Sulfur | Apply 3-5 lbs per acre; use when humidity is high. Avoid application during hot weather to prevent phytotoxicity. |
| | Myclobutanil | Apply 10-15 oz per acre; target early in the disease cycle. Use in rotation with other fungicides to manage resistance. |
| Phytophthora Root Rot | Metalaxyl | Apply 1-2 quarts per acre; incorporate into soil before planting or as a drench around the root zone. Monitor soil moisture levels. |
| | Fosetyl-Al | Use 1-2 quarts per acre; apply as a soil drench or foliar spray. Reapply every 14-21 days as needed. |
| Leaf Spot | Chlorothalonil | Apply 2-4 lbs per acre; start applications at the first sign of leaf spot. Repeat every 7-10 days during wet weather. |
| | Azoxystrobin | Use 6-12 oz per acre; apply at 14-day intervals. Rotate with other fungicides to prevent resistance. |
| Black Spot | Propiconazole | Apply 10-14 oz per acre; target early symptoms. Avoid applying during flowering to protect pollinators. |
| | Tebuconazole | Use 4-8 oz per acre; apply every 14 days under high disease pressure. Ensure proper coverage of foliage. |
| Root Knot Nematodes | Nematicides (e.g., Oxamyl) | Apply 5-10 lbs per acre; incorporate into the soil before planting. Use in conjunction with resistant varieties if available. |
| | Bio-nematicides (e.g., Bacillus spp.) | Apply according to product label; may require multiple applications for effective control. |
| Citrus Canker | Copper Hydroxide | Apply 2-3 lbs per 100 gallons of water; spray on affected areas every 14 days. Monitor for symptoms and adjust frequency as needed. |
| | Kocide | Use 1-2 lbs per 100 gallons; apply as a preventive measure during the growing season. |

| Disease | Chemical | Dosage and Management |
|---|---|---|
| Downy Mildew | Mefenoxam | Apply 2-4 oz per acre; targeted application during early disease appearance. Follow with regular monitoring and reapplication. |
| | Dimethomorph | Use 5-10 oz per acre; apply in combination with other fungicides for enhanced efficacy. |

Notes:

- Integrated Disease Management (IDM): Combine chemical controls with cultural practices such as proper spacing, pruning, and maintaining soil health to minimize disease incidence.
- Safety Guidelines: Always follow the label instructions for safe application, including personal protective equipment (PPE), pre-harvest intervals (PHI), and re-entry intervals (REI).
- Resistance Management: To prevent resistance, rotate chemicals with different modes of action and avoid repeated use of the same product.

***PRUNING THE SOURSOP TREE***

The criterion for the pruning of the Soursop tree can be summarized in two statements:

- ✓ More wood, more fruit
- ✓ Less cutting, more flowering, more fruit

This criterion is the opposite to the one used for pruning trees that produce fruit in terminal branches such as Soursop and Soursop trees.

In Soursop, pruning must optimize the Leaf Area Index (LAI) to make sure the photosynthetic capacity of the tree is not reduced and promote the development of strong lateral branches that produce fruit.

**Leaf Area Index**

Leaf Area Index (LAI) is a dimensionless measure that describes the total leaf area of a plant or canopy per unit ground area. It is an important parameter in plant ecology, agriculture, and forestry, as it provides insights into plant growth, light interception, and photosynthetic capacity.

By understanding and measuring LAI, researchers and farmers can make informed decisions regarding plant health, yield potential, and resource management. An LAI of 4 means that there is four times the leaf area than the area of the ground beneath it.

The Leaf Area Index (LAI) is a critical factor in determining the productivity of many fruit crops, including Soursop. The minimum leaf area index (LAI) required soursop to produce good yields typically range from 3.0 to 4.0. A LAI within this range helps ensure adequate light interception, which is crucial for photosynthesis and fruit development. However, optimal conditions can vary based on environmental factors and specific cultivation practices.

Maintaining an optimal LAI involves proper pruning and management practices to ensure that the canopy remains open enough to allow adequate light penetration and air flow while still supporting high photosynthetic activity. Regular monitoring and adjustments are important to sustain productivity and ensure the health of the Soursop trees.

**Branching**

Soursop tends to produce fruit more effectively on mature, woody branches rather than solely on terminal branches. The following are some key points regarding fruit production:

1. Mature Woody Branches: Soursop trees typically yield better fruit from branches that are older and more established. These branches have stronger structural integrity and reserves to support fruit development.

2. Terminal Branches: While Soursop can produce fruit on terminal branches, these younger branches may not be as fruitful as older ones. Terminal branches may still flower and set fruit, but the overall yield can be lower compared to more mature, woody branches.

3. Light and Airflow: Fruit production is generally more successful on branches that receive full sunlight and good airflow. This is often found on outer branches rather than shaded inner ones.

4. Pruning Impact: Regular pruning can encourage growth on more productive branches, facilitating better fruiting.

**Box Pruning**

The preferred tree architecture for Soursop trees in high-density double-row production systems is a rectangular box.

- For such architecture, the optimum tree size is 2 m wide, 1 m deep and 3 m tall. Additional height, width and depth (branching) must be restricted by pruning.

- The development of the width of the tree must be along the double row and the depth inside the double row.
- With proper pruning and training, Soursop trees should develop into strong and well-shaped trees within the first 2 to 3 years after planting.
- Tree architecture or formative pruning begins when the saplings are about 0.9 m high (waist high).

*Figure 13: Soursop Tree Architecture*

- At that time, the top of the young central leader trunk is cut off to encourage the lateral growth of branches.

*Figure 14: Strong Lateral Branches that Promote Fruiting*

- Two lateral branches are left on both sides of the main trunk to freely grow and extend horizontally. This practice encourages the production of wood that, in turn, encourages Soursop fruiting. These branches are then tipped off once they reach the proper length, according to the tree architecture, to produce a flush of vegetative growth for photosynthesis purposes.
- The third branch developed from initially tipping off the main young trunk is trained upward to form a second floor of strong lateral branches extending outward horizontally close to the main trunk.
- This training and pruning practice is repeated until the tree reaches the maximum allowed height of 3 m according to the tree architecture. As the tree grows, the centre portion of the canopy is maintained open to increase sunlight exposure that encourages fruiting and aeration that prevents the incidence of pests and diseases.
- After tree maturity, selective pruning of branches may be required to encourage the growth of strong lateral branches, on both sides of the main trunk, to better support fruit production, maintaining, at all costs, the box architecture of the tree. However, tertiary and subsequent branching, to encourage the development of the optimum Leaf Area Index for photosynthesis purposes, must be promoted as well at the end of the strong lateral branches.

*Figure 15: Fruit Produced on Lateral Branches*

**Espalier Trellis Pruning**

*Figure 16: Example of Espalier Trellis Pruning System in General*

- The espalier trellis allows for the total control of the architecture and growth of the Soursop tree to make it easier to manage i.e., spraying, pruning, harvesting, and other practices are made much easier to manage.
- The espalier trellis production system is made up of one dominant central trunk of the tree and strong lateral branches tied along a wire which is secured to wooden posts. Both the main trunk and the lateral branches produce fruit with priority.
- Third tier and even fourth tier branches are allowed to grow from lateral branches along the wire only to optimize the LAI to maintain the photosynthetic capacity of the tree.
- The Espalier Trellis applies the criterions “more wood, more fruit” and “less cuts, more fruit”.
- To build the trellis, 4”- 5” diameter wooden posts are placed 6 meters apart inside the Soursop tree rows (middle of double row).
- Posts should be placed 3 m tall above ground and 0.5 m below ground.
- Wire lines, spaced at 0.5 m, are laid out and held by the posts to form the trellis. The wires must not be permanently fixed to the posts to facilitate their tensing over time.
- Wires must be tensed tightly at all times to be able to support tree branches.
- Post placement can be mechanized.
- Wires are tightly passed through the posts, not fixed to them.

*Figure 17: Espalier Trellis System for Soursop*

- The wire gauge should be at least #14
- Tools, plastic ties twine and other accessories are required to tie Soursop branches to the trellis.

- Water suckers and very low branches are removed before trellising the tree.
- Small trees must be taller than the first wire on the trellis which is at least 0.5 m high from the ground level.
- When the tree height is at least 10 cm above the next wire, the top is cut off or clipped off to induce the formation of branches that will be promoted to lateral branches along the wire.
- At least three leaf whorls must remain above the wire.
- All cuts for clipping the tree top off must be in the middle of a leaf node.
- It is important to always make cuts at the internodes.
- Avoid pruning immediately above a whorl of leaves. This weakens the tree.
- Avoid working with very new and young branches (flush) developed after just clipping the tree off.
- Once the wood of the newly formed branches is matured enough, they can be bent and tied along the wire.
- Do not tie too tightly to allow the lateral branches to grow in diameter.
- These secondary branches are trained along the wire to increase the width of the Soursop tree along the wire on the trellis.
- Completely cut off the tied lateral branches to a length of 30 cm - 40 cm to produce a flush of tertiary branches to optimize the LAI for photosynthesis purposes.
- Tie the branch chosen to continue to form the central trunk of the tree to the next wire to train it to grow straight up.
- The treetop must be secured to the wire after it grows past the wire as required.
- One of the tertiary branches developed from cutting off the tied lateral branches must be tied along the wire to extend the width of the tree over the wire.
- A ladder is used to work on high trees.
- After harvesting the trellised Soursop, the pruning of tertiary branches must be done close to the fruiting lateral branches to prepare the tree for the next harvest.

***PHENOLOGY***

**First Year**

| **Stage** | **Weeks** | **Description** |
|---|---|---|
| Seedling Development | 0-4 weeks | After transplanting, seedlings establish roots and begin to grow leaves. |
| Vegetative Growth | 4-12 weeks | Rapid leaf growth occurs; the plant focuses on developing a strong structure. |
| Early Flowering | 12-20 weeks | Flower buds start to form; the tree begins to transition to the reproductive stage. |
| Full Flowering | 20-30 weeks | The tree produces flowers, which attract pollinators for fertilization. |

| Stage | Weeks | Description |
|---|---|---|
| Fruit Development | 30-40 weeks | After successful pollination, fruit begins to develop and grow on the tree. |
| Maturation of Fruit | 40-52 weeks | Fruits mature over several weeks, changing in color and size; ready for harvest. |
| Harvesting | 52+ weeks | Fruits are harvested when they reach the desired ripeness and size. |

**Second Year**

| Stage | Weeks | Description |
|---|---|---|
| Dormancy | 0-4 weeks | After the last harvest, the tree may enter a period of dormancy or slow growth. |
| Leaf Emergence | 4-8 weeks | New leaves begin to emerge as the tree starts to prepare for the growing season. |
| Vegetative Growth | 8-16 weeks | The tree experiences rapid growth, developing new branches and foliage. |
| Flower Initiation | 16-24 weeks | Flower buds form as the tree transitions to reproductive growth. |
| Full Flowering | 24-32 weeks | Flowers bloom, attracting pollinators; the tree is in full reproductive mode. |
| Fruit Set | 32-40 weeks | Successful pollination leads to the formation of fruit on the tree. |
| Fruit Development | 40-52 weeks | Fruits grow and mature, increasing in size and changing color. |
| Harvesting | 52+ weeks | Fruits are harvested when fully mature, marking the end of the production cycle for the year. |

***FLOWERING***

The soursop tree (Annona muricata) possesses specific biological and physiological characteristics that enable it to grow in tropical climates:

**Biology of the Soursop Flower**

Structure:

- Flower Composition: Soursop flowers are large, with three outer petals and three inner petals that are fleshy and can be greenish-yellow or creamy white.

*Figure 18: Biology of the Soursop Flower*

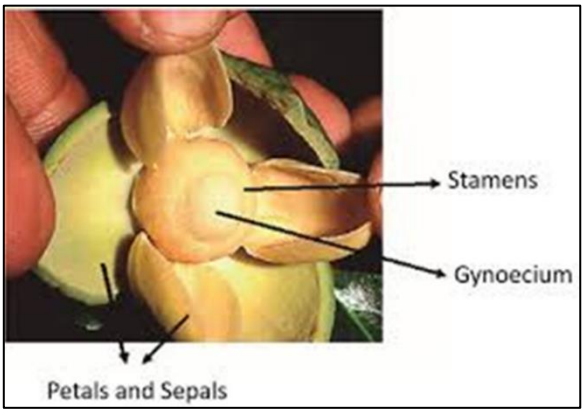

*Figure 19: Makeup of the Soursop Flower*

- Reproductive Parts: The flowers are hermaphroditic, containing both male (stamens) and female (ovary) reproductive structures. Numerous stamens surround a central ovary, which develops into the fruit after fertilization.

Flower Types:

- Soursop produces solitary flowers that emerge from leaf axils or directly from the trunk and branches, which helps in attracting pollinators.
- Flowering Phenology:
- The tree can flower throughout the year, particularly in response to temperature and moisture conditions. Flowering often peaks during the rainy season, enhancing pollination success.

**Physiology of the Soursop Flower**

Pollination Mechanism:

- Pollinators: The flowers are primarily pollinated by insects, including bees and beetles. They open in the late afternoon or evening, coinciding with nocturnal pollinator activity.
- Self-Pollination: While capable of self-pollination, cross-pollination tends to result in better fruit quality and yield.

Growth and Development:

- Following pollination, the fertilized ovary develops into the fruit through cell division and expansion, leading to the growth of the spiny soursop fruit.
- Essential physiological processes include the uptake of water and nutrients from the soil, which are crucial for fruit development.

***POLLINATION***

**Key Aspects of Pollination**

The Challenge:

- Hermaphroditic Flowers, Not Self-Pollinating: Soursop flowers contain both male (stamens) and female (pistil) reproductive parts, classifying them as hermaphroditic. However, they are dichogamous, meaning the maturation of the male and female parts occurs at different times. Typically, pollen is shed before the stigma becomes receptive, preventing self-pollination.
- Limited Pollinators: Soursop flowers do not attract common pollinators such as bees or butterflies. Their primary pollinators are small beetles, specifically those within the Nitidulidae family, which may not always be abundant or reliable.

The Process:

- Flower Opening: Soursop flowers open early in the morning, displaying their creamy white petals.
- Pollen Shedding: Stamens release pollen shortly after the flower opens, marking the optimal time for pollen collection for hand-pollination.
- Stigma Receptivity: The stigma becomes receptive a day or two post-flower opening.
- Beetle Activity: Ideally, small beetles visit the flowers, attracted by the scent. As they navigate inside the flower, they inadvertently transfer pollen from stamens to stigma.
- Fruit Set: Successful pollination results in fruit development; otherwise, the flower will wither and fall off.

Cross-Pollination vs. Self-Pollination:

- Cross-Pollination: This method is preferred for soursop trees. Pollen from another soursop tree (of the same variety) is transferred to the stigma of another flower, promoting larger and more vigorous fruits.
- Self-Pollination: Although possible, self-pollination is rare and typically yields smaller fruits with fewer seeds.

Improving Pollination:

- Hand-Pollination: Given the challenges with natural pollination, hand-pollination is frequently employed in soursop orchards to ensure fruit set. This involves collecting pollen from flowers in the morning and manually transferring it to receptive stigmas later in the day.

- Attracting Pollinators: Enhancing the presence of Nitidulidae beetles can be beneficial. This may include avoiding pesticide use and providing suitable habitats for these beetles.

**Hand Pollination Procedure**

Timing

- Pollen Collection: Early morning, as soon as flowers start to open.
- Stigma Receptivity: A day or two after the flower opens, when the stigma lobes are slightly open and glossy.

Equipment (Tools)

- Pollen Collection:
- Soft-bristled brush: A small paintbrush (like those used for art) is ideal. Choose one with soft, natural bristles to avoid damaging pollen.
- Cotton swabs: A good alternative to brushes, especially for collecting small amounts of pollen.
- Small container: A clean, dry container (like a small plastic vial or a clean jar lid) to collect pollen if you're not applying it immediately.

Pollen Application:

- Same brush or cotton swab: You can use the same tool for collecting and applying pollen.
- Flower Protection (Optional):
- Small paper bags: These can be slipped over pollinated flowers to prevent interference.
- Cheesecloth: A breathable alternative to paper bags.
- Twist ties or string: To secure bags or cheesecloth.
- Record Keeping:
- Tags: Small tags (like those used for gardening) to mark pollinated flowers.
- Pen or marker: To write dates on tags.

Materials and Supplies

- Water: To keep your brush or cotton swab slightly moist (not wet) to help pollen adhere.
- Optional:
- Magnifying glass: To get a closer look at the stigma and pollen.

Other Important Considerations

- Cleanliness: Make sure all your tools and containers are clean and dry to avoid contaminating the pollen.
- Gentle Handling: Soursop flowers are delicate. Handle them with care to avoid damaging the reproductive parts.
- Pollen Storage (If Needed): If you can't pollinate immediately, store collected pollen in a cool, dry place (like the refrigerator) for no more than a day or two.

Step-by-Step Methodology

- Gather your supplies: Have everything you need within easy reach.
- Identify pollen source: Choose flowers that have just opened in the early morning.
- Collect pollen: Gently use your brush or swab to collect pollen from the anthers.
- Identify receptive stigmas: Look for flowers that opened a day or two earlier, with slightly open and glossy stigma lobes.
- Apply pollen: Gently dab or brush the pollen onto the receptive stigma, ensuring complete coverage.
- Protect (optional): Cover pollinated flowers with a paper bag or cheesecloth.
- Tag and record: Mark the pollinated flowers with a tag and record the date.

***BAGGING***

Soursop is a fruit susceptible to various pests and diseases, which can significantly impact fruit quality and yield. One effective method to protect soursop fruit is bagging, a practice that involves covering the fruits with protective materials.

**Importance of Bagging**

Bagging serves multiple purposes in fruit cultivation:

1. Pest Control: It protects fruits from insects, birds, and other pests that may damage the fruit or introduce diseases.
2. Disease Prevention: By creating a barrier, bagging reduces the risk of fungal infections and other pathogens that thrive on exposed fruit.
3. Quality Enhancement: Bagging can promote higher quality fruits by minimizing blemishes and sunburn, leading to better marketability.
4. Harvest Timing: It can also help in managing the ripening process by protecting fruits during their sensitive stages.

**Best Time for Bagging**

The timing of bagging is crucial for maximizing the benefits. The ideal time to bag soursop fruits is during the early stages of fruit development, generally when the fruits are about 2-4 inches in diameter. This timing allows for effective protection against pests and diseases while still enabling the fruit to grow and mature properly.

Specifically, bagging should occur:

- Before Fruit Maturation: This protects the young fruits from pest infestation and environmental stress.
- When Fruits Begin to Set: Observing the formation of fruits is important; bagging should happen soon after fruit set, before any significant damage can occur.

**Best Bags to Use**

Selecting the appropriate bag is essential for successful fruit bagging. The following types of bags are commonly recommended for soursop fruit:

1. Paper Bags:
    a. Pros: Breathable, lightweight, and biodegradable. They allow for air circulation while protecting against pests and UV rays.
    b. Cons: Less durable against rain and may need to be replaced if wet.

2. Plastic Bags:
    a. Pros: Water-resistant and durable, offering excellent protection against environmental conditions.
    b. Cons: Can create a humid environment inside the bag, potentially encouraging fungal growth if not monitored.

3. Mesh Bags:
    a. Pros: Provide ventilation, allowing for airflow while keeping pests out. They are reusable and often made from biodegradable materials.
    b. Cons: May not offer as much protection against heavy rain or strong winds.

4. Non-Woven Fabric Bags:
    a. Pros: Lightweight, breathable, and offer good protection while allowing moisture and air exchange. They are also reusable.
    b. Cons: Can be more expensive than traditional paper bags.

**Coloured Bagging**

One of the most important quality problems with Soursop is the variation of internal maturity at harvest time. This problem causes Soursops to have different taste when harvested, a problem for processors and consumers in general. They also ripen to the ready to eat stage at different times. These critical defects can be eliminated by harvesting the Soursop by the age of the fruit which is defined as the number of weeks from bagging. The bag determines the age of the Soursop at harvest time, but it is necessary to use coloured bags.

Every week, a different colour bag is used for tagging the age of the fruit based on an annual colour chart (Coloured Bag Calendar) prepared by management. It is important to use the same calendar for all farms (areas) harvesting fruit together.

The Fruit Desk of the PUC keeps the count of the number of coloured bags placed in a week. These counts create a true inventory (fruit inventory) of Soursop hanging by colour (age). This inventory is kept until all the fruit for the colour is harvested. Losses and sales to the local market of tagged fruit are also part of the fruit inventory. The Fruit Desk Officer keeps and manages the fruit inventory. Counts making up the inventory enable the PUC to know, with a high level of confidence, how much fruit is available 18 to 20 weeks in advance of the harvest. This knowledge is crucial for planning the the marketing and sales strategy for the fruit. The fruit inventory is also used to procure packing materials and supplies.

***HARVESTING***

Harvesting soursop fruit at the right time is crucial for obtaining the best flavor and texture. The following are the signs to look for:

**Harvesting Criteria**

External Signs of Optimum Maturity:

1. Color Change: The skin of the soursop fruit changes from a dark green to a lighter green or yellowish-green as it ripens. Look for a uniform color without any dark spots.
2. Size: Mature soursop fruits typically reach a size of about 5 to 12 inches long and should feel heavy for their size.
3. Thorns Softening: The thorns on the skin will begin to soften as the fruit ripens. If they feel less sharp and more pliable, the fruit is likely ready for harvest.
4. Slight Yield: Gently press the skin with your fingers. If it yields slightly to pressure, it indicates that the fruit is ripe.

Internal Signs of Optimum Maturity:

1. Fruit Texture: Once opened, the flesh should be creamy and custard-like, without any hard or fibrous sections. The pulp should be soft but not mushy.
2. Flavor: Ripe soursop has a sweet, tangy flavor. If you taste a sample and it’s still sour or overly firm, it may not be fully mature.
3. Seeds: The seeds inside a mature soursop fruit should be dark brown and shiny. Immature seeds are often lighter in color and less developed.

Timing for Harvest:

1. Season: Soursop typically ripens in warmer months, but the exact timing can vary based on local climate conditions.
2. Days Post-Pollination: Generally, the fruit takes about 5 to 6 months to mature after pollination.

**Harvesting by Age (Coloured Bags)**

In harvesting by age, the fruit will be picked by the colour of the bag using 3 colours. The farmers will check for the colour bags with fruit at ages 16- and 17 weeks-from bagging and harvest those that are ready according to the buyer's specifications for maturity index and appearance. However, all the fruit with the coloured bag for 18-week-old fruit must be harvested without checking. This age is called the "Sweep" age like in bananas.

This harvesting procedure needs to be adjusted according to the fruit's growth and development. If the fruit is developing fast, we can reduce the harvesting ages by one week and if the fruit is growing slowly, we can increase the age by one week.

***POST-HARVEST HANDLING***

Soursop is a tropical fruit known for its unique flavor and numerous health benefits. To maintain its quality and extend shelf life postharvest, effective handling practices are crucial.

**Postharvest Handling Procedures**

1. Sorting and Grading:
   a. After harvesting, sort the fruits to remove any damaged or diseased ones. Grade the fruits based on size, weight, and appearance to ensure uniformity in quality.

2. Cleaning:
   a. Gently wash the fruits to remove dirt and residues. Use clean, potable water and avoid harsh chemicals that could affect quality.

3. Packaging:
   a. Use ventilated boxes or crates to prevent moisture accumulation. The packaging material should be lightweight yet sturdy to protect the fruit during transport.

4. Temperature Management:
   a. Soursops are sensitive to temperature. Ideally, it should be stored at 10-13°C (50-55°F) to slow down ripening and decay.

b. Avoid exposure to temperatures below 10°C, as this can lead to chilling injury.

5. Humidity Control:
   a. Maintain relative humidity levels between 85-90% to prevent dehydration and maintain fruit firmness.
   b. Use humidifiers or place damp cloths in storage areas to achieve the desired humidity.

6. Ethylene Management:
   a. Soursop is an ethylene-sensitive fruit. Store it away from ethylene-producing fruits (like bananas and apples) to mitigate premature ripening.
   b. Consider using ethylene absorbers or controlled atmosphere storage to regulate ethylene levels.

**Quality Protection Strategies**

Transportation:

- Use refrigerated transport, when possible, to maintain optimal temperature. Minimize transport time to reduce stress on the fruit.

Storage Conditions:

- Implement temperature and humidity monitoring systems in storage facilities to ensure conditions remain ideal.
- Regularly inspect stored fruits for signs of spoilage or disease.

Market Timing:

- Aim to distribute fruits as soon as possible after harvest. Implement a just-in-time delivery system to ensure freshness.

Consumer Education:

- Provide information to consumers on the best practices for storing soursop at home to extend its shelf life. Recommendations include keeping it in a cool, dry place and consuming it within a few days of purchase.

## *ANNEX 1: SOIL TEST RESULTS AND FERTILIZER RECOMMENDATIONS*

**Soursop Ampara**

| Sample Code | pH | OM | EC | Ca | Mg | K | NH4- N | P | S | B | Cu | Fe | Mn | Zn | CEC | Ca/Mg | Mg/K | Ca/K | Ca+Mg/K | Ca sat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | µS/cm | Exchangeable (meq/100g) | | | Available(ppm) | | | | | | | | cmol/kg | Cation Ratios | | | | |
| Sample–1 | 5.84 | 2.82 | 48.2 | 1.18 | 0.82 | 0.55 | 26.2 | 14 | 25 | 0.5 | 1.8 | 74.8 | 8.9 | 1.3 | 2.95 | 1.44 | 1.49 | 2.15 | 3.64 | 46.27 |
| Sample–2 | 5.81 | 0.94 | 67.3 | 2.07 | 1.2 | 0.62 | 47.7 | 35 | 29 | 1.25 | 3.7 | 698 | 130 | 1.7 | 4.29 | 1.73 | 1.94 | 3.34 | 5.27 | 53.21 |
| Sample–3 | 5.98 | 1.21 | 42.2 | 1.62 | 0.77 | 0.52 | 34.8 | 19 | 17 | 0.75 | 2.5 | 314 | 104 | 3.7 | 3.31 | 2.10 | 1.48 | 3.12 | 4.60 | 55.67 |
| Sample–4 | 5.91 | 1.61 | 48.4 | 1.65 | 0.81 | 0.66 | 21 | 17 | 14 | <0.10 | 1.3 | 149.9 | 33 | 2 | 3.52 | 2.04 | 1.23 | 2.50 | 3.73 | 52.88 |

**Interpretation:**
Low Organic matter in 3 samples
Low Magnesium in 3 samples
Low Potassium
Low liquid Nitrogen
Low Phosphorous
Low micronutrients except Boron, Iron in 3 samples and Manganese in 2 samples
Cation Ratios not balanced
Low Ca Saturation

**Fertilizer Recommendations:**
Urea as required by the crop
TSP
MOP
MgSO4
CaCO3 Lime
Foliar micronutrients

### Recommendations for Year 1

| Plot/Application | Unit | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|---|
| Urea | Kg | 1.11 | 1.48 | 1.97 |
| TSP | Kg | 0.35 | 0.47 | 0.62 |
| MOP | Kg | 0.38 | 0.50 | 0.67 |
| MgSO4 | Kg | 1.04 | 1.38 | 1.84 |
| Applications per Week | | 2 | | |
| Phosphoric Acid (ml) | ml | 300.0 | 300.0 | 300.0 |
| Application every two weeks | | | | |

Apply Calcium in the form of CaCO3 at a rate of 200 Kg/Half Acre or 40 gm/Tree per month all around the plant
Foliar Applications of Micro Nutrients (T-Flush 100 ml/16 L) or Similar Are also Recommended weekly. Very important

### Recommendations for Year 2

| Plot/Application | Unit | Veg. Growth | Flowering | Fruiting |
|---|---|---|---|---|
| Urea | Kg | 3.54 | 1.93 | 5.91 |
| TSP | Kg | 1.87 | 1.02 | 3.11 |
| MOP | Kg | 1.51 | 0.82 | 2.51 |
| MgSO4 | Kg | 4.14 | 2.26 | 6.91 |
| Applications per Week | | 2 | | |
| Phosphoric Acid (ml) | ml | 300.0 | 300.0 | 300.0 |
| Application every two weeks | | | | |

Apply Calcium in the form of CaCO3 at a rate of 200 Kg/Half Acre or 40 gm/Tree per month all around the plant
Foliar Applications of Micro Nutrients (T-Flush 100 ml/16 L) or Similar Are also Recommended weekly. Very important

***ANNEX 2: FERTIGATION PROTOCOL***

Management of the Irrigation System

1. Turn irrigation pump on and allow the operating pressure of the system to become stable at the correct operating pressure (1 Bar to 2 Bar).
2. When pressure is stable, make sure venturi system is working correctly using only water in the fertigation tank or container.
3. Once venturi system is checked, proceed to fertigate with the fertilizer solution.
4. After fertigation, allow the system to continue to apply irrigation water to the plot for at least 10 minutes in order to flush out any fertilizer solution residue remaining in the system.
5. Make sure to apply Phosphoric acid every two weeks as recommended to make sure system remains unclogged by deposits of calcium salts.



Using Fertigation Solutions

1. Carefully follow "*Irrigation and Fertigation Recommendations"* issued by the ISP to make sure the right amounts and types of fertilizer materials are used for fertigation.
2. To prepare the fertigation solution, accurately weigh the correct amounts of fertilizer materials using a portable weighing scale.
3. Mix the weighed fertilizer material with water in an appropriate container such as a 20-litre plastic bucket using a clean wooden stick to stir the fertilizer material into the water to make sure all the fertilizer material is dissolved.
4. In case there is a fertilizer material that is not 100% soluble in water such as TSP, mix for at least 5 minutes to dissolve as much material as possible.
5. Filter the fertigation solution into the fertigation container to be used with the venturi system (fertigation tank or container) using a cloth filter such as an old t-shirt or similar.
6. After filtering, the fertilizer material left on the cloth filter when using a partially soluble fertilizer material such as TSP must be saved into a container to be used in the next fertigation with the same material.

7. Close the main valve of the irrigation system and open the valves of the venturi system to force the irrigation water to flow through the venturi system. This will create the necessary vacuum to suck the fertigation solution into the irrigation system to be distributed throughout the plot and applied to the crop.
8. After the fertigation solution is applied, add clean water to the fertigation container and allow this water to flow though the venturi system to clean it.
9. Open the main valve and close the venturi system valves to allow for normal irrigation to resume.