11. Soursop

(*Annona muricata* L.)

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11.1. Introduction

Soursop (*Annona muricata* L.) is grown in many tropical countries, for example Angola, Brazil, Columbia, Costa Rica, Cuba, Jamaica, India, Mexico, Panama, Peru, Porto Rico and Venezuela (Pinto and Silva, 1994). The generic name *Annona* means "annual harvest" in Latin (Lizana and Reginato, 1990). *Annona* species have many characteristics in common with many other tropical fruit species, especially the height of the plant, root system, flower biology, and type of fruit type (Ochse *et al.,* 1974).

Soursop is considered a bush plant, the height varying from 4 to 8 m, depending on factors like climate, soil and crop management. It tends to have an extended growth. The flowers are hermaphrodite and emerge from the branches and trunk in groups of two to four flowers with three green sepals and six petals arranged in two whorls. The fruit is a spiny berry with many carpels commonly called "spines" or "barbs" with a weight varying from 0.9 to 10 kg (León, 1987).

The root system consists of a main (or tap) root, 1.5 to 1.8 m long, and abundant lateral roots (Pinto and Silva, 1994). The tap root is not as vigorous and does not grow as deep as that in other tropical fruit trees, like the mango (*Mangifera indica* L.). These characteristics are very important when planning fertilization and making decisions about managing this crop.

11.2. World production and trends

There is very little literature about this crop with the exception of information from Mexico, Brazil and Venezuela. In the Americas, Mexico is the most important producer of soursop and in 1997 it was grown on approximately 5,900 ha and produced about 35,000 mt of fruit. In 1987, in Venezuela, there were about 3,500 ha and total production was about 10,000 mt (Hernández and Nieto Angel, 1997).

Brazil grows approximately 2,000 ha with an estimated production of about 8,000 mt, almost completely for sale in the internal market. Owing to the

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favorable climate, about 90% of the total Brazilian production comes from the north-eastern region of Brazil. In the state of Ceará, located in the Brazilian north-east, there is an estimated 500 ha of soursop, and the fruit goes mainly to produce juice (Bandeira and Braga Sobrinho, 1997).

Soursop is rich in mineral salts, principally calcium (Ca) and potassium (K), and its flavor is enjoyed as juice and jam. It is considered to be a commercial fruit mainly grown for the internal market and selling in the local in Brazilian currency for about R$ 2.50 kg/fruit. Very little of the fruit is exported and there is little growth in exports which rely on the actions of a few pulp and juice manufacturers in the north-east of Brazil.

11.3. Climate and soil

11.3.1. Climate

The genus *Annona* includes, for the most part, tropical and subtropical plants, although a few species develop in temperate climates. Many species grow at low altitudes and those with a wide adaptation to altitude are also the species most adapted to variations in latitude. The optimal range of latitude is between 27ºN and 22.5ºS (Nakasone and Paull, 1998).

Soursop is the most tropical of the *Annona* species and is considered a plant of low altitudes and a hot and humid climate. It is grown primarily at altitudes lower than 900 m above sea level (Zayas, 1966). However, good productive orchards are found at altitudes of up to 1100 m (Pinto and Silva, 1994). Soursop adapts well to Savanas and tropical humid regions, *i.e.* A and Aw type climates, where the annual precipitation generally exceeds evapo-transpiration (Ayoade, 1991).

Two important climatic factors are rain, principally when out of season, and strong winds. Both, when they occur in great intensity and during flowering, greatly reduce pollination (Nakasone and Paull, 1998).

Although the photoperiod is not an important physiological factor for the annonas, excessive shading induces poor setting of the fruit. Therefore, pruning, plant spacing and fertilization are some of the very important practices in orchard management. Soursop is very demanding of light and shading the plants greatly reduces the production of fruit (Villachica *et al.,* 1996). Soursop grows and produces well at 21 to 30ºC, being very sensitive to severe changes in temperature, especially if the limit of 12ºC is reached (Pinto and Silva, 1994). Nakasone and Paull (1998) considered that the best temperature range was between 15 and 25ºC.

11.3.2. Soil

Soursop will grow in a wide variety of soils, from sandy to clay loams, but it prefers deep soils with good aeration (Melo *et al.,* 1993; Ledo, 1992). Good drainage is necessary for good root development, and, especially, to avoid problems of root diseases. Soil pH should be between 6.0 and 6.5 (Pinto and Silva, 1994).

11.4. Soil and crop management

Soil preparation for a soursop orchard includes land clearing, aeration, ploughing, application of lime, if necessary, and appropriate fertilization.

Soil sampling and analysis are precede aeration and ploughing. The amounts of lime and fertilizer to apply are decided on the basis of the analytical data. Where the soil is acidic, which is very common in Brazil, liming is extremely important not only to adjust the pH to 6.0 to 6.5, the best range for soursop, but also to achieve a base saturation of between 60 and 70% (Pinto *et al.,* 2001). Liming is also recommended when the subsoil to a depth of 60 cm is acidic, *i.e.* Al saturation >20% and/or Ca <0.5 $cmol_c/dm^3$ (Andrade, 2002).

Fertilization is generally recommended for soils deficient in phosphorus (P) and potassium (K), and the fertilizers are broadcast onto the soil around the plant, followed by incorporation into the soil (Andrade, 2004). The recommendation for P fertilizer is based on the amount of clay and the quantity of plant-available P determined by soil analysis (Table 11.1).

Table 11.1. Phosphorus fertilizer application according to percent clay in the soil and level of plant-available phosphorus in the soil.

Clay concentration	Phosphorus availability in the soil (mg/kg)		
	0-10	10-20	>20
g/kg	---------- P application, P_2O_5 (kg/ha) ----------		
≤150	60	30	0
160-350	100	50	0
300-600	200	100	0
>600	280	140	0

Source: Sousa and Lobato, 2004.

Correcting soil fertility where an orchard is to be planted has a cost, which must be considered. If fertilizer is broadcast over the whole area of the orchard annual plants should be grown between the rows of soursop to provide some economic return to the grower before the soursop starts to produce harvestable fruits three years after planting the trees.

Soursop can be propagated from seed ("loam tree") and by budding. The height of the plant is not greatly affected by budding and the majority of producers prefer using grafted seedlings rather than seeded seedlings. Propagation by seed or graft is done in plastic bags in a growth medium that varies from region to region. The constituents in the growth medium in the nursery phase are very important. Depending on the material and quantity used, there is the possibility of interfering with seed germination and of phytotoxicity burning the young leaves and causing the death of the seedlings (Pinto and Silva, 1994).

Although there is variation in the recommended use of nutrients in different regions, Pinto (1996) recommends the following constituents for each m^3 of growth medium (about 700 kg): 300-350 kg of local soil, 300-350 kg cured bovine manure, 300-500 g lime and 400-600 g of single superphosphate. After preparing the mixture it should be exposed to sunlight to eliminate diseases. Rego (1992) studied the effect of cured bovine manure applied at 0, 5, 10, 15, and 20% of the growth medium on the growth of seedlings over a period of four months. The author concluded that 15% manure was the most effective.

After germination and during seedling growth, nitrogen (N) should be applied every 21 days as a solution of ammonium sulphate at 5 g/L water. After the fourth month the seedlings should receive micro-nutrients as a foliar spray bimonthly using a commercial product in a 1-2% solution (Pinto and Silva, 1994).

11.5. Mineral nutrition

11.5.1. Uptake and export of nutrients

When the plants are producing fruit, the amount of fertilizers required should be based not only on soil and leaf analysis, but also the nutrients removed in the harvested fruits. In fact the nutrients removed in the fruit are an excellent guide to establish a fertilization programme for any fruit tree in is production phase (Mengel and Kirkby, 1987; Torres and Sánchez López, 1992; Hermoso and Farré, 1997). The quantity of each nutrient removed in the fruit varies between varities but, on average 10 mt fruits remove 27 kg N (Table 11.2).

The amount of nutrients in soursop fruits produced in Venezuela and in Brazil differs greatly in K and Ca but is similar for the other macro-nutrients (Table 11.3). In Paraiba state, Brazil, the quantity of micro-nutrients per tonne of soursop fruit is: Fe, 8.03 g; Cu, 1.65 g; Mn, 2.71 g; Zn, 3.71 g; and B, 2.75 g (Silva *et al.,* 1984), with Fe being the largest amount.

Table 11.2. Amount of macro-nutrients in some tropical and subtropical fruits (kg/mt fruit).

Nutrient	Avocado(1)	Pineapple(1)	Orange(1)	Banana(1)	Soursop(2)
Macro-nutrient			kg/mt		
N	2.80	0.90	1.20	1.70	2.70
P	0.35	0.12	0.27	0.22	0.54
K	4.53	2.00	2.60	5.50	3.60
Ca	0.13	0.10	1.05	0.21	0.26
Mg	0.20	0.16	0.20	0.27	0.24

Source: (1)Marchal and Bertin, 1980; (2)Silva *et al*., 1984.

Table 11.3. Amount of macro-nutrients in harvested soursop (kg/mt fruit) grown in Venezuela and in Brazil.

Nutrient	Venezuela(1)	Brazil(2)
Macro-nutrient	kg/mt	
N	2.97	2.70
P	0.53	0.54
K	2.53	3.60
Ca	0.99	0.26
Mg	0.15	0.24

Source: (1)Avilan *et al*., 1980 ; (2)Silva *et al*., 1984.

11.5.2. Functions and importance of macro-nutrients

Nitrogen (N): Deficiency of N causes an intense yellowing in the oldest leaves because if the supply of N is limited it is mobilised and transported to the youngest tissues, principally for growth. Symptoms of deficiency in young plants (seedlings) appear in the first 30-40 days after germination. Generally, plants of the genus *Annona* when N is deficient show a visual progression in the symptoms to intense yellowing and loss of leaves. Other than yellowing of the leaves, young plants are markedly smaller in height and have a very premature loss of leaves.

Phosphorus (P): Deficiency of P is seen by an irregular chlorosis of the basal leaves with many showing a dark green coloring. With increasing deficiency, the leaves become small and take on irregular shapes. Deficient plants grow very slowly and have brown spots on the leaves with necrosis on the lamina margins, followed by the leaves falling off the plant.

Potassium (K): In general, K deficient plants do not have the ability to transport sugars produced by photosynthesis in the leaves to the other organs, principally the fruit. Potassium can move from the oldest organs, primarily the leaves, to the youngest or to growth. Brownish spots start at the apex and the basal portion of the leaf lamina and gradually merge. In seedlings these symptoms first appear eight months after sowing the seed when the size of the leaves is reduced and they become yellow and fall off. Deficient plants produce fewer flowers but there is no loss of yield.

Calcium (Ca): Symptoms of Ca deficiency are manifest 30 days after sowing and appear first at the points of growth, like buds and the young leaves because Ca is not mobile within the plant. About 70 days after sowing, the leaves show interveinal chlorosis, stop growing and become curled.

Magnesium (Mg): Unlike Ca, Mg is mobile in plants so that initially deficiency symptoms occur in the oldest leaves. In nursery conditions, an interveinal chlorosis starts in the leaves about 50 days after sowing and progressively the leaves become totally necrotic. The adequate ratio of Ca: Mg is 3: 1 because a greater proportion than this of Ca induces Mg deficiency. In the same way, elevated ratios of K induce deficiencies of Mg and Zn.

Sulphur (S): Like calcium, the first symptoms of S deficiency occur in the youngest leaves because S is largely immobile in the plant. In nursery conditions, young S deficient plants are intensely yellow and atrophied after about 75 days.

11.5.3. Functions and importance of micro-nutrients

Boron (B): Like Ca, B is immobile in phloem and for this reason the first symptoms of its deficiency occur in the young leaves. In seedlings still in the nursery, deficiency symptoms appear around 70 days after sowing, when the seedling leaves have an intense green color with chlorosis of the lamina. By 140 days after sowing the plants have atrophied. Maintaining adequate amounts of plant-available B and Ca during flowering and the first stages of fruit production reduces the possibility of internal darkening of the pulp, which is common in annonas.

Iron (Fe): Like Ca and B, the redistribution of Fe in the plant is practically zero. Thus the initial symptoms of Fe deficiency occur in the young leaves and are characterized by partial chlorosis with yellowish-green coloration of the lamina, which with time becomes totally yellow except in the region around the veins.

Zinc (Zn): Plants with Zn deficiency frequently show interveinal chlorosis in the leaf lamina area and appear pale-green in color. Deficient plants have irregularly distributed, small, branched and hardened leaves at the apex of new branches, and this is known as leaf rosette.

The observation and identification of the nutrient deficiency symptoms in the field can be done quickly but it requires very experienced people. Therefore, not only field observation, but also soil, fruit and leaf analysis are very important to determine the nutritional state of the plant. To aid the determination of macro- and micro-nutrient deficiencies in plants, including the annonas, the symptoms have been described by many authors (Avilan, 1975; Navia and Valenzuela, 1978; Mengel and Kirkby, 1987; Torres and Sánchez, 1992; Silva and Silva, 1997). Finally, there is evidence that well nourished plants are more resistant to pests and diseases, producing a larger yield of good quality fruits.

11.6. Fertilization

At planting: Adequate fertilization of the planting pit is a basic condition for excellent seedling growth that will result in a productive adult plant producing good quality fruit. The amount of fertilizer to apply is based on soil analysis and on the volume of pit, which is usually 60 x 60 x 60 cm.

In Venezuela it is recommended to mix 250 g of a 10-10-15 or 10-15-15 fertilizer with 5 kg of corral manure (Araque, 1971). For the acidic soils of the Cerrados, Andrade (2004) suggests the following quantities of manure, lime and fertilizer per pit: 21.6 L of cured bovine manure or 5.4 L poultry manure; 216 g lime (PRNT 100%); 151 g P_2O_5 (367 g of triple superphosphate); 1.0 g B; 0.5 g Cu; 1.0 g Mn; 0.05 g Mo and 5.0 g Zn. Nitrogen and K, at 20 g/plant, should be applied around the plant in three portions at intervals of 30 days between each application (Andrade, 2004). In pit fertilization with micro-nutrients it has been quite common to use 100 g/pit of F.T.E. formula BR-12. For virgin soil, when soil analysis results are not available, the following quantities (kg/ha) of micro-nutrients should be applied broadcast: B, 2 kg; Cu, 2 kg; 6 kg Mn; 6 kg Zn (Galrão, 2004).

During growth: After planting the seedlings, the amounts of fertilizer applied during the next three years should be based on chemical analysis of the soil (Table 11.4) as recommended by Silva and Silva (1997).

Table 11.4. Nitrogen, phosphorus and potassium for soursop according to the age of the plant and the availability of soil phosphorus and potassium.

Age	N	P-resin (g/dm^3)			K-exchangeable (g/dm^3)		
		0-10	11-20	>20	0-45	46-90	>90
Yr	g/plant	P_2O_5 (g/plant)			K_2O (g/plant)		
0-1	40	0	0	0	60	40	30
1-2	80	80	60	40	80	60	40
3-4	120	120	80	60	120	80	60
>4	180	120	80	40	180	120	60

Source: Silva and Silva, 1997.

Fertilizer should be applied around the plant but only lightly incorporated into the soil to avoid damaging the developing root system whilst putting the fertilizer near them. In a dryland plantation, the annual fertilization with P should be done in a single application at the beginning of the rainy season. The required quantity of N and K fertilizer should be divided into three and one third applied at the beginning, in the middle and at the end of the rainy season. The amount of fertilizer applied can be changed from one year to another. At the end of the first year after planting, the fertilizer given in the second year should be based on soil analysis and for the third year on the basis of leaf analysis.

During production: Torres and Sánchez López (1992) recommend different quantities of nutrients depending on the region, *i.e.* the InterAndean Valley, the Atlantic Coast and Eastern Plains of Columbia. These authors suggest that the amount of N fertilizer for plants between three and six years old should be based on the amount of soil organic matter, whilst for P and K they should be based on the level of plant available P and K in the soil. Because N and K are the nutrients in greatest demand by soursop, the amounts should increase proportionally with the age of the plant and its level of production. However, care should be taken to give excess N because this causes the plants to grow too quickly and produce less fruit. Soursop's large demand for K means that the concentration of K in the leaf should not be less than 10 g/kg to ensure that K is not limiting growth. On sandy soils and others where there is a risk of N and K being lost by leaching, N and K fertilizers should be applied six times during the growing season. For adult plants fertilizers should be applied beneath the crown in an area including two thirds of the radius beneath the crown and extending one more quarter from the edge of the crown's projection (Fig. 11.1).

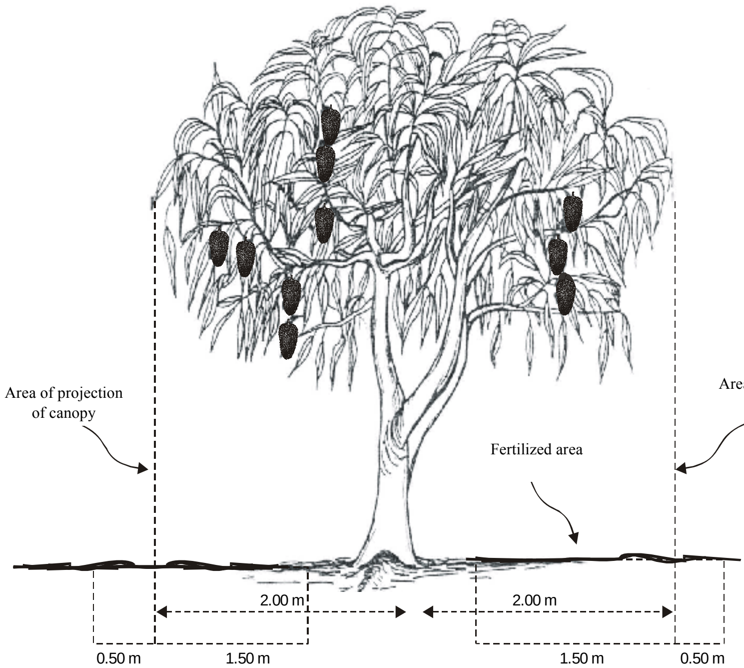

Fig. 11.1. Fertilizer should be applied on both sides of adult plants and cover two thirds of the radius of the crown and one more quarter beyond the edge of the crown (Pinto, A.C. de Q., 2001).

In general, soursop is sensitive to Zn and B deficiency. To prevent deficiency, 2 g m^{-2} B can be incorporated monthly into the 10 cm of soil beneath the plant's crown before irrigation and a 0.1% solution of zinc sulphate applied as a foliar spray. Galrão (2004) recommends the following quantities of micro-nutrients during the production phase of the adult plant: 2.0 g B, 3.0 g Cu, 4.0 g Mn and 5.0 g Zn, all incorporated into the soil below the crown projection together with other fertilizers, at the start of fruit production.

There has been little research on foliar applications of both macro- and micro-nutrients for soursop. When the fruit is mature the absorption of nutrients diminishes and foliar applications of nutrients are more effective at this time.

Today producing fruit by organic systems of production is an excellent method for increasing the value of the fruit. However, there is serious lack of information regarding appropriate methods of growing annonas, especially soursop, by organic methods. One of the few exceptions is that of Bonaventure

(1999) for cherimoya (*Annona cherimola Mill.*). He recommends using microorganisms and algae, as well as a bio-activator, which accelerates the metabolism and increases the production of this important annona.

Currently, the use of organic compost and mulching with organic material in soursop plantations has been recommended because the plants respond both in growth and yield. Organic compost and mulching facilitates not only the development of vigorous and abundant roots, but also improves moisture retention in the soil and minimises the risk of soil erosion.

As with other perennial fruit trees, chemical soil and plant tissue analysis are the techniques most used to evaluate the nutritional state of the plants. In some cases, for example, leaf analysis may indicate deficiency of Mg but the cause may be in the soil where there may be too little Mg or an excess of Ca. Currently, some researchers have also tested the analysis of fruit tissue (Stassen 1997) to complement soil and leaf analysis.

Soil sample collection in soursop orchards in the production phase is the same as that recommended for other crops, but the soil should come from within the crown projection.

The recommended method for leaf sampling for nutrient content depends on the age of the plant, the position of the leaf within the crown, the variety and whether the branches are with or without fruit and the period of sampling. Laprode (1991) suggests that the leaves should be taken from the third and fourth pairs of intermediate branches in the crown and of the four cardinal points. Pinto and Silva (1994) recommend that the leaves should be 8 to 9 months old, taken from healthy plants free from residues from any foliar sprays.

In general, the sample should consist of 100 leaves for every five hectares by taking four leaves per plant from a group of 25 plants randomly selected in the orchard. For a more uniform sample it is recommended to divide the orchard into sections of similar soil characteristics, and in each section separate the plants by chronological age. Collect only healthy leaves from plants that have not been recently fertilized, avoiding the period of flowering and periods of intense rain.

Soil and leaf analysis data are interpreted using calibration curves for each nutrient, based on the correlation between the composition of each nutrient and the productivity of the fruit tree (Silva *et al.,* 2002).

Isolated leaf analysis is not sufficient for precise interpretation and diagnosis of the nutrient status of the plant because of the many factors that cause variation in leaf nutrient status. In general, the composition of N is about ten times that of P and twice that of K. Gazel Filho *et al.* (1994), analysed leaves from a range of one-year-old soursop varieties growing in Cerrado do Amapá, Brazil. The varieties were: Blanca, Lisa, Morada, Soursop A, Soursop B, FAO II and Matriz

CPATU 415. The content of macro-nutrients in g/kg ranged from: 19.6 to 20.4 for N; 1.2 to 1.4 for P; 14.9 to 17.2 for K; 12.0 to 15.2 for Ca and 1.9 to 2.2 for Mg. The authors only found significant differences for Ca and Fe and the largest concentrations were in cv. Morada with 15.2 g/kg Ca and 215.8 mg/kg Fe.

This result seems to contradict the belief that the nutrient composition of the leaves is genetically controlled and this may vary with variety. However, in this case many of these analyses were made on different leaves, whether they showed deficiency or not and came from branches with or without fruit. Some authors point out that the comparison of leaf composition between macro- and micro-nutrients is important in leaves with and without visible deficiency. Avilan (1975) in Venezuela and Silva *et al.* (1984) in Brazil (Table 11.5) made these comparisons.

Table 11.5. Normal concentrations of macro-nutrients and some micro-nutrients in soursop leaves in Venezuela and Brazil.

Plant part	N	P	K	Ca	Mg	S	B
	------------------------------------ g/kg					------------------------------------	mg/kg
Normal leaves[1]	17.6	2.9	26.0	17.6	0.20	-	-
Deficient leaves[1]	11.0	1.1	12.6	10.8	0.08	-	-
Normal leaves[2]	25.0-28.0	1.4-1.5	26.1	8.2-16.8	3.6-3.8	1.5-1.7	35-47
Deficient leaves[2]	13.0-16.0	0.6-0.7	26.4	4.5-8.1	0.7-0.8	1.1-1.3	6-14

Source: [1]Avilan, 1975 in Venezuela; [2]Silva *et al.*, 1984 in Brazil.

Normal leaf concentrations for N and K in soursop grown in Brazil are 1.6 to 2.0 times greater than those in deficient leaves. The difference in N composition between normal and deficient leaves in Venezuela was much greater than that in Brazil but the difference in K was small.

11.7. Irrigation

In general, because soursop grows in the humid tropics it needs extra water by irrigation to guarantee adequate growth and fruit yield especially during periods of drought. George *et al.* (1987) described a common disorder in annonas, especially in soursop and sweetsop, which is a hardening of the pulp with brownish lumps. It is suspected that this symptom is caused by sudden movements of water within the pulp that, together with the deficiency of B, produces a more serious manifestation of the symptom. This disorder is very common in north-eastern Brazil, especially in dryland orchards or irrigated orchards with limited water supplies. The occurrence of any water stress generally slows the growth of young plants, preventing vegetative growth and decreasing the size of the fruit, highlighting the importance of irrigation for soursop.

11.7.1. Irrigation methods

The selection of the most appropriate irrigation method is directly associated with three factors: technical, economical and human (Silva *et al.,* 1996). Soil factors related to water infiltration, water management, with respect to its quality, quantity and availability, climatic factors and plant features are important technical factors. For example, the spray method is recommended only in areas where water is not limiting and the gradient of the surface is not greater than 16% (Nunes, 1997). The price of the system and its installation and maintenance costs are very important economic factors. Finally, for success in the installation and operation of the system, the quality of the available labour should not be disregarded.

Simple irrigation methods are used in many regions in north-east Brazil, depending on economic conditions, quantity of water available and the type of soil. At Fazenda Bom in the municipality of Trairi, in Ceará state, the soil is a Quartz Neosol (Sandy Quartz). There they use a simple yet effective installation comprised of a flexible hose at the end of which is a hard PVC ring with 0.5 cm diameter holes giving a flow of water of about 20 to 30 L/h. Each plant is watered for 1-2 hours at 7 to 14 day intervals.

Currently, localized drip and jet irrigation are recommended especially where there is a shortage of water. In these systems, water is applied only to the soil in the region of the root system, thus reducing water loss by evaporation and limiting the area infested by weeds. Overall, the great disadvantage of drip irrigation is the need to use filters to avoid blockages in the system where water quality is poor and insoluble fertilizers are used. Therefore, for success with drip irrigation, the system should be installed adequately following the method proposed by Bucks and Davis (1986).

11.7.2. Water requirements

The amount of water required varies from one area to the next and depends on climatic conditions, soil type and growth stage of the plant. For example, the dry period in the Cerrados of Brasilia coincides with lower solar radiation and low temperature that create a comparatively smaller evapo-transpiration demand than in the north-east of Brazil. Consequently, water deficiency in the Cerrados is less serious than that in the north-east. An adult plant requires much more water than a young plant and Latosol soils retain much more water than Quartz Neosols. Soursop orchard of adult plants with a 3 m radius crown and a density of 204 plants/ha (spacing 7 x 7 m), using jet irrigation to cover 60% of the crown area with water, requires a daily input of approximately 63 L/plant, or 3.72 mm/plant, which is equivalent to 1,000-1,200 mm of yearly rainfall (Pinto *et al.,* 2001).

It is estimated that the annual water needs of soursop for growth and production are about 1,000 to 1,200 mm/plant. In regions where the annual precipitation is equal to or greater that 1,600 mm, the cv 'Morada' produces up to 10 kg fruit/plant. In the Brazilian semi-arid regions, where annual precipitation is about 500 mm, this same variety only produces more than 3 kg fruit/plant if it is adequately irrigated.

11.7.3. Fertigation

Compared to applying fertilizers to the soil, the application of nutrients in the irrigation water allows a faster response by the crop, better control of the quantity of nutrients used and larger yields of better quality fruits.

Water quality is just as important as the quantity to be applied and the period of application, because elements like calcium could precipitate with phosphates and cause blockage of the emitters (Pinto and Silva, 1994). Equally, producers of soursop should be concerned about the presence of sodium in the water, because it accumulates in the soil, especially in shallow and poorly drained soils. It goes without saying that salting severely damages growth and production of soursop. Mansour (1997) commented that sodium chloride, calcium chloride and calcium carbonate all adversely affect the growth of annonas and drastically reduce the total dry weight of the plants, especially at a leaf concentration of 0.3% Na. Elevated levels of any of these salts causes leaves to burn and fall. Also, elevated levels of B and Cl in irrigation water induce phytotoxicity and injuries to the leaves and fruit that are difficult to control (Pinto and Silva, 1994).

11.8. References

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