

Crop Profile for Coffee in Puerto Rico

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General Production Information

Production Facts: For 2001 the coffee production was 8,650 tons with an average farm price of \$4,041.00/ton and a total gross income value of \$34.955 million. Under normal conditions (no disasters) the production varies from 14,000 to 15,000 tons yearly.

State Rank: Coffee production occupies the second place in importance among crop commodities.

Yearly Production Numbers: Around 65,000 acres yearly. Around 95% of the total acres are harvested. The cash value at farm level is around \$4,041.00/ton. One acre can produce optimally 0.75 ton. The average production is around 0.2 ton/acre.

Imports: For 2001 a total of 5,000 tons was imported to cover the shortage of production. For 2001 local consumption was around 16,250 tons.

Production Costs: For 2001 the total gross income per acre was around \$808.20. The total production cost per acre was \$444.51 (55%) and the net income around \$363.69 (45%).

Fresh and Processing Market: All coffee production is destined for processing market (estimated at 14,000 tons per year). The local consumption is around 97.2% (13,600 tons); 2.8% (400 tons) of processed coffee is exported.

Production Areas: twenty-two municipalities compose the coffee production region, located mainly along the western central part of the island. The coffee region is hilly and humid with average rainfall of 75 inches.

Cultural Practices

Soils: Representative soils are clay and lomic.

Soil Preparation: Direct planting by hand, opening a square hole 10" x 10" x 10".

Planting Time: Done mainly in springtime during the humid period from March to June.

Types of Planting: planting to full sun and under seasonal or permanent shadow.

Pruning Practices: The pruning process first occurs when the coffee tree is 7 to 8 years old and then every 7 to 8 years.

Varieties Planted: The most common of coffee varieties planted are Caturra, Borbón, Limón being to *Coffea arabica* specie, the species that produces the bulk of the world's coffee. Other recognized, but not common species are *Coffea liberica*, *C. excelsa* and *C. canephora* or **robusta**.

Fertilization: Trees should be fertilized about one month after transplanting and every three months thereafter during the first year. About two ounces of 10-10-10 or similar fertilizer containing minor elements should be spread on the ground around each tree, starting about 4 inches from the trunk and extending as far as the tips of the lateral branches. In the second year the amount of fertilizer should be increased to 4 ounces per plant every 4 months. During subsequent years the fertilizer recommendations for mature trees should be followed.

Shade or Sunlight Planting: Well-established coffee trees can resist prolonged droughts. Coffee grows well under shade, but it is morphologically and physiologically suited to being grown in full sunlight, and is not by nature a shade loving plant.

Mulching: Mulches supply nutrients or serve as a weed control barrier. Large quantities of mulches must be applied to be effective as a fertilizer. About one ton of coffee pulp, or 2 ½ tons of green grass are required to supply the nutrients. The use of mulches is more practical with young trees, where rainfall is limited and on gentle slopes where application is easy.

Weeding: The weeds control will make together with the insect and diseases control. The weed control in the coffee plantations is summarized in two methods: mechanically (hoe, machete or machinery) and with the use of herbicides (preplant and postemergence).

Liming: Lime can be applied from March to May, two tons per acre, annually.

Hand-harvesting: The crop is carried out by hand, during the months of August to January. Three or four partial harvests are recommended.

Worker Activities

Land Preparation: All the activities are made by hand. In the preparation of the land should be avoided the use of heavy machinery due to the topography, the high risks of erosion and contamination of the water and the environment in the zone. The cleaning of the ground should be begun eliminating the weeds, then the bushes and finally the trees, according to its size. Clearing should be done partial or totally placing the material thickness and piling it in barriers against the slope of the land.

Planting Method: The transplant from seedbed nurseries occurs 6 to 8 months after seed germination.

Irrigation: No artificial irrigation. All acreage devoted to coffee depends on rainfall.

Cultivation: The representative soils thru coffee production area are clay and lomic. The pruning process first occurs when the coffee tree is 7 to 8 years old. The use of mulches is more practical with young trees, where rainfall is limited and on gentle slopes where application is easy. Mulches supply nutrients or serve as a weed control barrier. The crop is carried out by hand, during the months of August to January. Three workers harvest one acre in one day (8 hours). Three or four partial harvests are recommended. The weed control in the coffee plantations is summarized in two methods: mechanically (hoe, machete or machinery) and with the use of herbicides (preplant and postemergence). All the activities of coffee plantation are made by hand. One worker per acre (8 hours).

Scouting: Scouting is not carry out as a regular practice for monitoring of pest or diseases. **Pesticide Applications:** The pesticides applications are made by ground equipment by workers or personnel of the Department of Agriculture. By farmers request the personnel of the department of agriculture, carries out the applications. This it is a service offered by the agency.

Harvest: The crop is carried out by hand, during the months of August to January. Three or four partial harvests are recommended.

Insect Pests

Coffee Leafminer (*Leucoptera coffeella*)

Frequency: Outbreaks occur mainly during dry weather, the first in January-February and the second and most severe in June-July. Damage can be extensive; the leafminer is the most serious coffee pest. It's damage is more severe in open unshaded plantations.

Damage Caused: The leafminer causes large irregular lesions on the leaves. Affected leaves soon drop off. If not controlled it can reduce photosynthetic activity by 50% and cause marked weight loss of trunk, branches (70%) and roots (60%). The feeding of the larva on mesophyll produces brown spots that eventually affect tree yield.

Percentage Acres Affected: 100% at risk, typically up to 70% affected in a given year.

Pest Life Cycle: The adult moth deposits eggs on the underside of leaves, where eclosion occurs 5 to 7 days later. The larvae of this small silvery moth bore into the mesophyll of the leaves for about three weeks. This boring produce brown spots and causes defoliation. The pupa takes one more week to reach

adult stage. Depending on the temperature the range of life cycle varies from 30 to 40 days. During hot dry weather the life cycle is shorter, the population increase and the damage is more severe.

Timing of Cultural, Biological and Chemical Controls: Prior to dry weather. In established plantations the first control effort is February to April and the second June to July, in accordance with the seasonal activity of the coffee leafminer.

Yield Losses: Damage reduces 50% of the photosynthetic activity of the leaves, causes defoliation and reduces yields by up to 40%. It is more severe during dry hot weather in open plantations.

Cultural Control Practices: Good pruning and fertilization following the harvest. Apply adequate levels of complete fertilizers 3 to 4 times per year. Proper pruning after harvest can also decrease variation in yield by providing for the production of about the same amount of bearing wood each year. Maintain and manage the shade at around 30%. Proper weed control keeps trees healthy . These practices help minimize losses from the coffee leafminer.

Biological Control Practices: Naturally occurring predators, parasitoids and pathogens may help suppress infestations. Larvae and pupae of the coffee leafminer are attacked by several eulophids and one braconid (*Mirax insularis*). There are five species of the Eulophidae parasitoid complex and the braconid, the imported coffee leafminer parasitoid. The leafminer larvae are controlled in about 20% by the parasitoid complex, this rate is considered very low.

Post Harvest Control Practices: Good fertilization, regulation of shade and proper pruning help to reduce damage caused by coffee leafminer.

Resistant Cultivar Management: There are different degrees of susceptibility to coffee leafminer among the seven cultivars of *Coffea arabiga*. Puerto Rico 401 has the lowest percentage of damage; the dwarf cultivars like Pacas and Caturra, the highest. This susceptibility should be studied in more detail.

Chemical Control: Table 1 presents a list of approved pesticides for control of coffee insects.

Table 1: Insecticides/Nematicides for Coffee Insect and Nematode Control

Pesticide	Target Pest ¹	% Acreage	Type of Application	Typical Rates	Timing	No. of Applications
Temik 15G (Aldicarb)	CLM, N	25	Soil Systemic	13–20 gr/tree (1/2-3/4 ounce/tree)	90 days before harvest	2

Disyston 15G (disulfuton)	CLM, GS, HS, MB, A	70	Soil Systemic	½ - 1 ounce/ tree	90 days before harvest	2
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¹Key to target pests: CLM= Coffee leaf miner, N=Nematodes, GS = Green Scale, HS = Hemispherical Scale, MB = Mealybugs, A = Aphids

Scales and Mealybugs

Green Scale (*Coccus viridis*), Hemispherical scale (*Saissetia hemisphaerica*), Mealybug (*Planococcus citri*)

Frequency of Occurrence: Occurs annually throughout the island on seedlings, young and older trees, particularly during dry weather.

Damage caused: Can seriously damage young coffee trees during dry periods. The seedlings, young and mature trees become yellowish, lose many of their leaves, and may even die.

Percentage Acres Affected: up to 25%.

Pest Life Cycle: Scales and mealy bugs live in colonies on the underside of younger leaves and along young stems and branches. Large populations may result in the loss of growth vigor and smaller shoots and leaves. Their feeding reduces terminal growth and vigor interfering with photosynthesis, resulting in smaller berries and poor quality. During new terminal growth especially after rains, they grow rapidly, secreting copious amounts of honeydew. Scales suck plant juices from the inner bark by inserting their mouthparts into twigs and branches. Mealy bugs may feed also in the root zone. A small green shell and a brown shell cover green and hemispherical scales, respectively, that make control difficult. A waxy white powder covers mealy bugs. Newly hatched nymphs move from under the shell or waxy powder and settle on branches and twigs. The best time to control scales and mealy bugs is immediately after hatching. The life cycle of scales and mealy bugs takes around a month and may have more than 10 generations per year. Heavy populations may reduce production by as much as 15% if left uncontrolled.

Timing of Control: Monitoring – Look for scales or mealy bugs on twigs and branches. Best when newly hatched nymphs move from under the shell or wax. The best time to control is after hatching; before the covering is well developed.

Yield Losses: By as much as 15% if left without control.

Cultural Control Practice: Prevent ants, which protect scales and mealy bugs and interfere with parasites.

Biological Control Practices: Several natural enemies hold armored scale and mealy bug populations in check. Some predaceous beetles such as the ladybird beetle, green lacewings and minute pirate bug prey on these pests. They occur in large numbers and can keep low to moderate populations in check. Several species of parasitic wasps also help as a barrier to population increase. However, once populations are high, these natural enemies may not respond fast enough to prevent damage, and chemical control is needed. Natural fungi also control, especially when humid conditions are favorable.

Chemical Control: Because armored scales and soft scales spend most of their life protected beneath the scale covering, correct timing is important. See Table 1.

Aphids (*Toxoptera aurantii*)

Frequency of Occurrence: Occasionally attack coffee during new flush of foliage especially in seedbeds, nurseries and young trees. Appear after periods of rain.

Damage Caused: This occasional pest frequently builds up to numbers adequate to cause stress on new leaf and coffee plant growth by extracting large amounts of leaf fluids. Coffee aphid is blackish. In addition to the debilitating effect of aphid feeding, heavy infestation can cause defoliation and sooty mold growing on honeydew.

Percentage Acres Affected: Varies from 5 to 10%

Pest Life Cycle: Coffee aphid is black and typically found scattered on the lower side of the leaf, whereas other aphids feed in rows along the midvein. Aphids live in colonies, reproduce year round, begin feeding on the leaves and reproduce without mating, giving birth to living young. The aphids have many generations in a year and can build up to several hundred per leaf.

Timing of Control: At the beginning of foliage flushing when runners are present.

Yield Losses: Up to 2 to 3% in severely affected plantations.

Cultural Control Practices: None during rainy periods when populations are affected.

Biological Control Practices: Naturally occurring predators, parasitoids and pathogens help suppress infestations. Predators beetles like the ladybird beetle and the green lacewing are common.

Diseases

Coffee Rust (*Hemileia vastatrix*)

Frequency of Occurrence: Can be found in most coffee growing areas in most years, especially during wet periods.

Damage Caused: The disease is caused by the fungus *H. vastatrix* that produces yellow spots on underside of the leaves. Eventually the spot grows, produces drying and leaves drops suddenly. The spots appear in young and older leaves. In mature stages of the disease coffee trees are defoliated. The disease reduces the vitality of the tree and the life span of the plantation. *H. vastatrix* attacks all coffees of the Arabica species.

Percentage Acres Affected: up to 35%

Pest Life Cycle: The disease is stronger and more harmful during rainy periods. The development is favored by high humidity, poor light and cool temperature. Also poor aeration inside plantations increases the damage. The spores of the fungus can remain viable for several months under unfavorable conditions. Typically the symptoms appear from three to five weeks after the germination of the spore over the leaf, depending on climatic conditions.

Timing of Control: Inspect plantation periodically between August and March to determine presence of the disease. If systemic fungicides are available they are recommended for applying during June and July or May to June. Contact fungicides are recommended during November and January or during August and November after the harvest.

Yield Losses: 15 to 20%

Cultural Control Practices: Follow appropriate planting distance, prune to reduce shade and improve air circulation, manage and excessive shade, maintain adequate nutritional balance for the vigor of the trees, and maintain good control of other insects and weeds.

Biological Control Practices: None

Cultural Control Practices: Refer to Table 2 for coffee disease control. There are only a few fungicides registered for disease control in coffee. No systemic fungicides are registered.

Cercospora Spot or "Ojo de Gallo" (*Cercospora coffeicola*)

Frequency of Occurrence: more common and more harmful in strong sunlight.

Damage Caused: Causes small, round leaf spots with concentric rings, spotting and mummification of the berries. These fungi cause severe defoliation of young coffee trees.

Percentage Acres Affected: up to 50%

Pest Life Cycle: This fungus is stronger and more harmful in strong sunlight than under shade, probably because of greater dew formation.

Timing of Control: Take preventive measures during hot sunny days with high percentage of humidity.

Yield Losses: Around 15%

Cultural Control Practices: Establish plantation under shade. Providing light shade to young coffee trees which do not shade themselves to any extent, helps reduce the damage caused by this fungus, which can also be partly controlled by spraying with a copper solution.

Biological Control Practices: None

Chemical Control Practices: Can be controlled with a solution of copper compounds. See Table 2 for chemical control of coffee diseases.

Damping off (*Rhizoctonia solani*, *Fusarium spp.*, *Myrothecium roridum*)

Frequency of Occurrence: Common in the seedbeds, more prevalent during moderate temperatures periods, humid culture media and unfavorable conditions to the plant.

Damage Caused: The characteristic symptoms are dark spots in the roots and cankers in the base of the stems.

Percentage Acres Affected: 5% in the seedbeds.

Pest Life Cycle: The disease is more prevalent during moderate temperatures periods. The development of the disease is favored by excess of humidity.

Timing of Control: Before planting.

Yield Losses: 5%

Cultural Control Practices: Change the sand of the seedbed periodically. Select good quality seed, free of diseases. Use the proper recommended planting density.

Biological Control Practices: None

Chemical Control Practices: None

Cancers (*Myrothecium roridum*)

Frequency of Occurance: Common in the nurseries and seedbeds.

Damage Caused: Cancers are observed in the low part of the stems of the infected plants and/or in the main root. In both cases the development of adventitious roots is observed.

Percentage Acres Affected: In nurseries up to 25%.

Pest Life Cycle: The infection is favored by conditions of high humidity and moderate temperatures.

Timing of Control: Treat the soil mixture with a registered fungicide.

Yield Losses: 10 - 15%

Cultural Control Practices: Select the seedling rigorously for transplant. Don't use the seedlings located to 10 inches of the border of the focus of the infection.

Biological Control Practices: None

Chemical Control Practices: See table 2.

"Mal Rosado" (*Corticium salmonicolor*)

Frequency of Occurance: The infection is favored by conditions of high humidity and moderate temperatures.

Damage Caused: It is characterized by the presence of a scab in the stems and the branches. The fungi penetrate the tissues of the stems causing the internal strangulation of them. In some cases it causes fissures in the stems. When the infection occurs in the branches it causes a die back of the branch. In the fruits this disease causes circular spots of clear color.

Percentage Acres Affected: 10%

Pest Life Cycle: The disease is more prevalent during high humidity and moderate temperatures periods, more common during the rainy season.

Timing of Control: Provide good ventilation in the plantation and avoid the excessive of shade and humidity.

Yield Losses: 10%

Cultural Control Practices: Avoid the excessive of shade and humidity. Identify the areas in the coffee plantation more for the development of the infection

Biological Control Practices: None

Chemical Control Practices: Refer to Table 2 for coffee disease control. There are only a few fungicides registered for disease control in coffee. No systemic fungicides are registered.

Bacterial Spot (*Pseudomonas sp*)

Frequency of Occurance: Most frequent during high humidity and low temperatures periods.

Damage Caused: The bacterial spot are observed in the leaves of coffee plants in the nursery and in coffee plantations where the humidity is excessive. The lesions are irregular of dark color and of oily appearance.

Percentage Acres Affected: Nurseries (25%), new plantations (15%)

Pest Life Cycle: The bacteria are disseminated by the rain and wind, and penetrate through the stomas and wounds.

Timing of Control: At the nurseries, before planting.

Yield Losses: 10 – 15%

Cultural Control Practices: Propitiate good ventilation and avoid the excessive humidity in the foliage.

Biological Control Practices: None

Chemical Control Practices: Can be preventing at the nursery by the use of copper fungicide.

Gotera (*Mycena citricolor*)

Frequency of Occurance: Common, more prevalent during cold wet periods at high elevations.

Damage Caused: Gray leaf lesions, which soon drop out leaving, round holes in the leaves. Causes leaf and fruit drops and discoloration of the coffee beans.

Percentage Acres Affected: Around 5%

Pest Life Cycle: The disease is more prevalent during cold wet periods at high elevations. The development of the fungus is favored by excess of shade, high humidity in the soil and air.

Timing of Control: Take preventive measures during cold rainy periods.

Yield Losses: Up to 15% in severely affected fields.

Cultural Control Practices: Controlled by thinning the shade trees and pruning the coffee trees.

Biological Control Practices: None

Chemical Control Practices: Can be controlled by spraying with a 2% aqueous solution of copper chloride or copper oxide, with sticker. Table 2 summarizes fungicide use for managing diseases.

Table 2. Fungicides for Coffee Disease Control

Pesticide	Target Pest ¹	Percentage Acreage Treated	Type of Application	Typical Rates lbs/acre	Timing	No. of Application
Copper Compounds (Copper hydroxide, chloride, oxide)	CC, R, MR, DO, Bac	10	Foliar	1.0	Fruit set	2
Vapam (sodium methyldithio-carbamate)	DO, CA, N	21	Seedbeds and nurseries	3.10 lbs/ yd ²	Before planting	1

¹Key to target pests: R= Rust (*Hemileia vastratix*), CC= Ojo de Gallo (*Cercospora coffeicola*), DO = Damping Off (*Rhizoctonia solani*, *Fusarium* spp., *Myrothecium roridum*), CA = Cancer (*Myrothecium roridum*), MR = Mal Rosado (*Corticium salmonicolor*), Bac = Bacterial spot (*Pseudomonas syringae*), Gotera (*Mycena citricolor*), N = Nematodes (*Pratylenchus* sp., *Meloidogyne*)

sp.).

Weeds

Frequency of Occurrence: year round

Damage Caused: Reduced yields from weed competition, and loss of efficiency in nursery operations. Weeds can interfere with pesticide applications. Damage occurs primarily in nurseries and young plantations during the first two to three years. Weeds reduce the growth of young trees because they compete for water, nutrients and space. Weeds also increase the need for water use, cause vertebrate, invertebrate and other pest problems and may enhance the potential for disease.

Percentage Acres Affected: 75% new plantings (1-3 years), 50% old plantations (>3 years)

Pest Life Cycle: annual and perennial weeds, such as vines, yellow and purple nutsedge, nightshade species, comelina, annual and perennial grasses, are a problem throughout the growing season.

Timing of Control: Preplant and postemergence

Yield Losses: As high as 80% in severely infested fields.

Cultural Control Practices: since few herbicides are registered for coffee, cultivation is necessary. Fields are planted with a minimum of soil disturbance and in addition, growers frequently rely on mechanical and expensive hand weeding to clean up weeds. Early shading of grove floor surface by tree canopy and leguminous cover crops that can supply nitrogen and require less annual maintenance.

Biological Control Practices: None

Chemical Control Practices: Preplant, preemergence and postemergence herbicides are used to control perennial and annual weeds. The following table summarizes herbicide use for managing weeds.

Table 3. Herbicides

Pesticide	Percentage Acreage Treated	Type of application	Typical rate lbs a.i./acre	Timing	No. of applications
Paraquat (Gramoxone)	70	Soil surface, foliage	1.0	Preplant, Postemergence	2

Goal 2XL (Oxyfluorfen)	10	Soil surface, foliage	0.5 – 2	Preemergence	3
Glyphosate (Roundup)	80	Soil surface, foliage	2.0	Preplant, postemerge	3

Nematodes

Root-knot Nematodes (*Meloidogyne incognita*), Lesion Nematode (*Pratylenchus coffeae*)

Frequency of Occurrence: sporadic in established plantations. Is more common in seedbeds and nurseries.

Damage Caused: nematodes attack coffee roots. These two endoparasitic nematodes are the most serious pests to coffee. *Meloidogyne* produces small-elongated galls located primarily at roots tips; roots may show cracks, necrosis and sloughing of cortical tissue. *Pratylenchus* frequently cause wounds in roots through which other pathogenic organisms, such as fungi and bacteria, enter the root tissues. With the presence of both nematodes the root system effectiveness is greatly diminished, with rootlets and root hairs practically eliminated.

Percentage Acreage Affected: Less than 1%. Is more common in seedbeds and nurseries where around 500 acres are affected and treated every year.

Pest Life Cycle: the eggs of rootknot nematodes are the most resistant stage to adverse environmental conditions. Second stage juveniles of *Meloidogyne* hatch from eggs and move freely in the soil. Seasonal variation may cause fluctuations in populations of eggs and females from month to month, but the number of second stage juveniles in the soil is high and remains stable. Second stage juveniles and eggs of *Meloidogyne* may remain alive in soil for approximately six months following the removed of coffee trees. Populations of *M. incognita* are reduced by only 27% after the host plant is absent for six months. *P. coffeae* or lesion nematodes are typically migrant parasites of plant roots. Adults and juveniles of various ages constantly migrate into and out of the roots. Both young and adult nematodes enter roots by penetrating through or between the cells of the cortex, feeding on the cell contents as they migrate through tissues. Eggs hatch in 6 to 8 days. The first stage juvenile is seen on the 8th day. Within six more days, the second stage juvenile forms. Adults emerge at 29 to 32 days. In the absence of host plants, *P. coffeae* survives in moist soil up to eight months.

Timing of Control: Take prevention measures prior the establishment of seedbeds and nurseries and before planting.

Yield Losses: Less than 1%

Cultural Control Practices: Sanitation of nursery rootstock by coffee growers to avoid introducing nematodes from infested nurseries. Use properly soil treated. Infected seedlings should be destroyed. Nurseries should be located far away from infested plantations. Use good water for irrigation to avoid transport, disinfest equipment and sterilize all implements employed in seedbeds and nurseries. Replanting of old, infested plantations should be preceded by a fallow period of one year more or less.

Biological Control Practices: None

Chemical Control Practices: Chemical treatment of infected trees with systemic pesticides. Soil fumigation in seedbeds and nurseries has been used effectively. Refer to Tables 1 and 2.

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