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PAPAYA GROWING AT THE UNIVERSITY FIELD STATION, TRINIDAD

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SUMMARY

The cultivation of papaya (Carica papaya L.), a local strain of cultivar Sunrise Solo, for fresh fruit marketing as practiced at the University Field Station is discussed. Although Bunchy Top and virus diseases constitute the major constraint to successful production, the results indicate that the crop has attractive possibilities. Analysis of cost and returns of crops grown on 0.5 ha over the period 1973 to 1982 shows a gross margin of TT$18,000 per ha at a sold marketable yield of 26,997 kg/ha for a crop duration of 16 months. Some areas requiring attention are highlighted, including the selection and rapid availability of adaptable cultivars with good yield potential associated with desirable fruit characteristics and resistance to Bunchy Top and virus diseases; the mineral nutrition of the crops, specifically the role and function of nitrogen, and calcium soil pH in mitigating the expression of the Bunchy Top disease, fruit demand analysis, and fruit market development, for the fresh trade and for processing.

INTRODUCTION

Throughout the Commonwealth Caribbean papaya (Carica papaya L.) is traditionally harvested from trees in backyards and growing wild or semi-wild on uncultivated lands. The selection of the various strains of cultivar Solo in Hawaii, the increasing emphasis being placed on fresh fruit in the diet of our people, and the development of fruit processing industries in most of the territories, probably all contributed to the increasing interest in the cultivation of papaya as an orchard crop.

Since 1972, papaya has been grown commercially at the University Field Station (U.F.S.), Valsayn, primarily for the ripe fresh fruit market[2/] with some green fruits for cottage industry and factory processing. The areas cultivated ranged from 0.23 to 0.58 ha with most plantings on 0.5 ha. Initial plantings were located at the Texaco Food Crops Farms (T.F.C.F.)[3/]

1/ The University Field Station, The University of the West Indies, St. Augustine, Trinidad. Present address: Secondary Schools Maintenance, Training and Security Company, Trincity Industrial Estate, Trincity, Trinidad.

2/ Throughout this paper fresh fruit refers to mature or ripe fruit as against green (immature) fruit.

3/ T.F.C.F. was a tri-partite project involving the Government of Trinidad and Tobago, Texaco Trinidad Inc., and the University of the West Indies located in the north-eastern section of U.F.S.

but with its closure in 1980, production is now concentrated at the main site of U.F.S. The results have been encouraging.

This paper is not an exhaustive account of our experiences with papaya at U.F.S. but a discussion of the more relevant management practices developed mainly from work in the Department of Crop Science, The University of the West Indies (U.W.I.), which are deemed important to its commercial success. Some economic aspects are also discussed in the paper.

ENVIRONMENT

The University Field Station is located about 8 km east of Port-of-Spain (10°39'N and 61°31'W) at an altitude of 16 m. The major soil types are River Estate Loam and Streatham Loam with better crops being obtained on the former which is the only Class I soil in the country. Classification and selected chemical properties of the surface 15 cm of soils at representative locations are shown in Table 1. Both soils are acidic and low to moderate in major nutrients.

The climatic conditions are characterized by the wet season from June to December with a mean monthly rainfall of 199 mm, a short dry period called "the petit careme", often occurring for one or two weeks in September or October, and the dry season which extends from January to May with mean monthly rainfall of 59 mm. Approximately 83% of the annual rainfall occurs in the wet season. The mean annual rainfall over the 59-year period, from 1923 to 1981, was 1689 mm.

The mean annual temperature is about 27°C, and the average monthly temperature varies between 26°C and 28°C. Sunshine averages 6 to 7 hours daily and very few sunless days occur throughout the year. Daylength varies from 12.75 hours in June to 11.50 hours in December (Hardy, 1974). There is 100% relative humidity at night throughout most of the year. It seldom falls below 55% during the day. Dew point temperature is around 22°C. The prevailing winds generally blow from a north-easterly direction and attain greater velocities in the dry season than in the wet. Winds are seldom strong and the velocity varies from 8.0 km/hr to 40 km/hr during the dry season to 4.0 km/hr in the wet season (Chenery, 1952).

Trinidad is unique in that it lies south of the regular hurricane path. Thus, it is less hazardous to grow tree crops than in other islands.

CULTIVAR

Research work conducted during the late 1960's in the Department of Crop Science resulted in the identification of a local strain of

Table 1.--Some characteristics of the soils (0-15 cm) at U.F.S.

Characteristics	T.F.C.F.	U.F.S. Main Site
pH	4.3	5.0
Cation exchange capacity (meq/100g)	5.8	9.0
Organic C (%)	0.5	0.78
Total N (%)	0.15	0.2
Exchangeable Ca (meq/100g)	2.8	3.8
Exchangeable Mg (meq/100g)	1.6	1.2
Exchangeable K (meq/100g)	0.38	0.05
Truog P (µg/kg)	6.3	8.5
Soil Series (Chenery, 1952)	Streatham	River Estate
Classification:USDA (Smith, 1974)	Plinthic tropudult	Fluventic eutropept

Source: Control Analytical Laboratory, U.W.I. Trinidad.

cultivar Sunrise Solo as the best performer. Initially there was some resistance to its general acceptance because of small fruit size, but this was overcome because of desirable fruit characteristics, as evidenced in its texture and flavour. Over the years this cultivar has been found to be a prolific bearer of small to medium sized fruits with an average weight of 550 g, reddish-orange flesh, smooth appearance, excellent flavour, and good consumer acceptance. Most plantings were established with seeds from open pollinated trees, but in three plantings seeds from selected selfed female and hermaphroditic trees were used.

CULTURE

Propagation

The seed rate for a hectare is 400 g. Seeds are selected from ripe fruits, dried, and the sarcotestae removed. Seeds not planted are normally stored under cool conditions until required. Experience at direct seeding in the field, even where planting hills were specially prepared and good weed control practiced, resulted in less than desirable plant stands. As such, crops are raised from seeds sown in black polythene bags filled with a soil/compost mix which was steam-sterilized or treated with Dowfume.[4/] In each bag 4 to 5 seeds are sown about 2.5 cm deep. Bags are watered at least once daily and germination is usually complete within 2 weeks. They are moved into direct sun within 2 weeks of germination. Sprayings for pest and disease control are carried out every 8 to 10 days using pesticides discussed later in this paper. Seedlings are also normally sprayed at least once with Nutrex. Transplants are ready in 4 to 6 weeks when they are 30 to 40 cm tall and only those which are free from pest damage and disease and are sturdy are selected for transplanting.

Site Selection and Land Preparation

Sites for the establishment of new plantings are chosen from areas which were not under papaya for at least 3 years, are protected from strong winds, and do not have a history of wet spots or can be efficiently drained. Staking with bamboo poles was done in some plantings because wind damage, especially during the wet season, caused toppling of trees. Generally the cambered bed system is used but where the crop was established on flat beds care was taken to ensure the establishment of surface drains. Land preparation normally consists of disc ploughing, harrowing, and rotavating. Well decomposed farm yard manure, at the rate of 200 mt/ha, is sometimes broadcasted and rotary hoed into the soil. Drainage is enhanced by the establishment of in-field surface drains.

4/Mention of a tradename in this paper is used solely to provide specific information and does not constitute an endorsement of the product by the University Field Station, The University of the West Indies, over other products not mentioned.

Planting

Close spacing has resulted in good yields but smaller fruit sizes. A distance of 1 m between plants as provided maximum yield in work by Colom-Covas (1972) has not been appropriate under the cultivation system employed, but increasing the spacing to 2 x 2 m has produced successful crops. It is the common practice now to use an intra-row spacing of 2 m and an inter-row spacing of 3 m to facilitate mechanical cultivation during the first 4 months of crop growth in the field. Such a spacing provides approximately 1991 plants/ha. In general field layout some consideration is given to the establishment of roadways to facilitate fruit collection after harvesting.

Holes, 45 cm deep by 30 cm wide, are dug, and if farm yard manure had not been rotary hoed into the soil previously at least 300 g of manure and 30 g of a complete fertilizer (13:13:21) is commonly used) are mixed and placed in each hole. During transplanting especially on soils with a history of soil pest problems, Furadan is mixed with soil from holes. Where seeds from open pollinated trees were used for seedling production 3 seedlings are planted at each hill, the distance between seedlings being about 30 cm. Care is taken to ensure that water will not accumulate at the hill after the seedlings are transplanted.

Thinning Trees

Approximately 2 months after transplanting flowering occurs and male trees are removed. The aim is to have one sturdy seedling per hill and about 95% bearing trees in the field.

Thinning Fruits

In a few plantings because of the tight packing of fruits on the stem and the general overload of developing fruits on the tree thinning out of fruits was necessary.

Irrigation

Because flowering and fruit setting are severely reduced by drought and waterlogging, at least 2.5 m of water per week is supplied by sprinkler irrigation during the dry season and in a few instances during dry spells in the wet season. Also, considerable attention is paid to the provision of adequate drainage in the wet season. Experience has shown that fruits which ripen during the dry season tend to exhibit better internal quality and are free from external blemish due to anthracnose.

Nutrition

Fertilizers are supplied regularly except during the dry season especially when irrigation is not available. Two months after the thinning of seedlings about 80 g of urea is spread around the seedling at each hill. The use of 13:13:21 fertilizer applied at the rate of 60 g per tree every 6 weeks is commonly a standard practice throughout the growth of the crop.

Preliminary observations at U.F.S. suggest that liming may improve crop growth and development (Gardner-Brown, 1971) and reduce the severity of bunchy top disease (Haque, 1973). To date it has not been possible to test these hypotheses.

Weeds

In a survey (R.A.I. Brathwaite, unpublished data) conducted in six crops, grass weed populations were consistently much greater than broad-leaved weeds and sedge weeds, and accounted for over 64% of the weed flora. Major grass weeds were Brachiaria platyphylla (Griseb.) Nash, Digitaria spp., Echinochloa colonum (L.) Link, Eleusine indica (L.) Gaertn, Paspalum fasciculatum Willd, and Rottboellia exaltata L. Predominant broad-leaved weeds were Amaranthus spp., Euphorbia spp., Parthenium hysterophorus L., and Portulaca oleracea L. with Cyperus rotundus L. and Fimbristylis millacea (L.) Vahl. the commonly occurring sedges.

Experience indicates that it is important to maintain a low infestation of weeds immediately around the seedlings, especially during the first 5 months of crop growth, in an effort to reduce the incidence of pests. During the first 5 months of crop growth, weed control is achieved by a combination of inter-row cultivation, shielded spraying with Gramoxone or Reglone, and hand weeding. Hand weeding is particularly important when controlling weeds close to the young seedlings after transplantings. Once plants attain ab4ut 1m in height a mixture of a contact herbicide and Dowpon is used.

Mulching with rice and maize straw has provided excellent weed control and proven to be advantageous in reducing loss of soil moisture during the dry season.

The use of low growing, short duration vegetables and legumes as intercrops during early field establishment has been attempted with moderate success in the case of vegetables but cowpea and mungbean generally performed miserably after succumbing to virus. Members of family Cucurbitaceae and the two legumes are deemed unsuitable as intercrops.

Pests and Diseases

Leafhoppers (Empoasca spp.), whiteflies (Bemisia spp.), aphids and grasshoppers commonly occur in crops especially when timely and satisfactory weed control is not achieved. Pest damage to fruit is never of any consequence. The presence of predators, specifically ladybird beetles, observed in many plantings, probably contribute to significant reduction of the levels of many of the common pests. The adoption of regular sprayings, at least weekly during rainy weather and once in about 10 to 14 days during dry periods, with insecticides like Malathion, Perfekthion and Sevin provide acceptable control of pests. However, it seems that the economic importance of some insect pests, especially

leafhoppers and aphids, in papaya production is more often through their virus vector potential than through their direct damage to the crop.

Diseases caused by virus and mycoplasma are major constraints to papaya production. Bunchy Top is the single most important disease and has caused the complete failure of at least one crop, under conditions of poor cultural practices. Haque and Parasram (1973) established the leafhopper (Empoasca stevensii Young) to be the vector of the disease. Table 2 gives an example of the distribution of the removal of diseased trees from a T.F.C.F. crop as reported by Cropper (1976). He reported that on 0.32 ha there were 776 trees after thinning was completed in mid-March 1974 and that at the end of January 1975 only 538 trees remained after roguing and the loss of an additional 14 trees by storm damage. It is of interest that despite the high incidence of the disease the crop was a financial successs as has been observed in more recent crops.

Papaya mosaic and papaya ring spot have occurred in some plantings at T.F.C.F. but are never as severe as bunchy top. Our experience indicates that the removal of bunchy top and virus infected trees from the cultivated area, the adoption of a regular insecticide spray programme, and the seclusion of the crop from other crops known to have virus problems do contribute to the reduction in the incidence of these virus diseases and Bunchy Top.

Fungal diseases are sometimes encountered. Anthracnose is the commonest of these; the organism (Colletotrichum gloesporioides Penz.) more frequently attacks fruits reducing their marketability but has also been found infecting petioles. A leaf spot, probably caused by Cercospora papayae, is sometimes observed. At least one crop succumbed to damping off caused by various fungi including Pythium spp. and Phytophthora spp. and necessitated replanting of the field. Dithane M-45, Benlate and Kocide have been found useful for the control of leaf spots and anthracnose. Considerable attention is paid to field sanitation and drainage as an approach to minimizing the chances of damping off.

Stem canker disease caused by a bacterium belonging to the genus Erwinia rarely occurs. The spread of the canker is favoured by wet conditions and arrested during periods of dry weather (Persad, 1978).

Many of the common weeds found in papaya fields are frequently associated with high populations of Rotylenchulus reniformis Linf. and Oliv., Meloidogyne spp., and Helicotylenchus spp. (Singh, 1975) which are considered the most serious nematodes in papaya (Singh and Farrell, 1973). Field sanitation, crop rotation and the use of Furadan are adopted as control measures.

Harvesting

The first harvest can be expected about 250 days from sowing or about 150 days after fruit set. Harvesting is a manual operation carried out 2 to 3 times a week by selected experienced pickers. In few instances a step ladder is used when pickers cannot easily and comfortably reach the fruits

Table 2.--Distribution of rogued bunchy top diseased plants from a papaya crop planted in October 1973 at T.F.C.F.[1/]

Month and Year	No. of rogued trees	Month and Year	No. of rogued trees
February 1974	9	October 1974	24
March	12	November	21
April	7	December	31
May	6	January 1975	56
June	8	February	43
July	36	March	Not available
August	0	April	79
September	25	May	136

1/ After Cropper (1976). Area cultivated was 0.32 ha.

but harvesting productivity is reduced. Fruits for the fresh market are harvested when the first yellow colour appears. They are placed in buckets or wooden crates lined with straw, newspaper, or foam and carried to a trailer, similarly insulated, located at strategic points in the field. The trailer carries the fruits from the field to the farm stores which is cool and well ventilated.

ECONOMIC ASPECTS

Yield and Quality

A crop is allowed to remain in the field for an average of 16 months, although crops of 24 months duration have been cultivated. The incidence of bunchy top and other virus diseases and labour costs are major determinants of the duration of the papaya crop. The mean marketable fresh fruit yield (sold yield) from plantings over the 9-year period of 1973 to 1982 is 26,997 kg/ha. A recently completed crop of 17 months duration gave a sold marketable fresh fruit yield of 41,793 kg/ha. Texaco Food Crops Farm records show that the highest marketable fresh fruit yield of 57,543 kg/ha was harvested from a 1975 planted crop. On the average, a 2-year crop produced marketable fruit yields of 30,000 kg/ha in the first year and 16,000 kg/ha in the second year.

In a consumer acceptance study (R.A.I. Brathwaite, unpublished data) all testers rated cultivar Sunrise Solo higher than a large type fruit (average weight 5 kg) obtained from a local grower on the basis of fruit size and shape, firmness and thickness of flesh, sweetness, and attractiveness of flesh colour. In another aspect of the study 95% of the testers found no difference in the taste or texture of the fruit from female and hermaphroditic trees. However, although green fruits from virus and bunchy top diseased plants have not been rejected by processors, fresh fruit consumers have frequently reported that mature fruits from such plants are bland and therefore unacceptable.

Marketing

Production is primarily geared for the fresh fruit market where fruits are sold by weight. As far as the authors are aware, there are no written grades for papaya in Trinidad. However, the market has some preferences. The main market for fresh fruit is private traders and consumers who travel to U.F.S. to effect their purchases as well as to institutions and supermarkets to whom deliveries are made. Wholesale and retail prices adopted are determined by those existing at the Beetham Market in Port-of-Spain. These prices fluctuate with fruit supply, decreasing as more fruits arrive on the market. The average wholesale price at U.F.S. in 1973-74 was TT$0.57/kg and is currently (1982) TT$2.21/kg.

Green fruits thinned from heavily laden trees and those removed from diseased plants are often sold to processors with an easier market

being obtained with cottage industry processors since factory processors prefer large fruit (average minimum weight of 1.2 kg). Green fruits are normally marketed at a price about 50% that of fresh fruit.

Costs and Returns

Economic data presented in Table 3 show that the mean gross margin of crops over a 9-year period was TT$18,009 per ha with a mean total variable cost of TT$14,345 per ha. The sale of green fruits to processors often contribute to the gross returns of a crop. The major contributor to the year to year variation of the data shown is bunchy top disease. Interestingly, the recently completed crop showed the best gross margin of over TT$50,000 per ha although its yield was 11,000 kg lower than a highly remunerative 1975 crop. This difference can be attributed to the high average price which existed during the 1981-82 crop.

The data clearly indicate the high variable input cost of a papaya crop. The biggest expenses in production is the cost of labour involved in carrying out crop protection practices as well as harvesting (Table 4). Furthermore, in a typical crop about one quarter of the total production cost is incurred in the purchase of agrochemicals of which the costs of herbicides, pesticides, and fertilizers represent about 54, 36, and 10% respectively.

CONCLUSION

Wilson (1980) proposed a comprehensive research and development programme for non-traditional fruit tree crops towards development of viable agro-industries based both on fresh fruit and processed product commodities. Although papaya requires a high cash outlay for its establishment and a high level of management, experience indicates that it has attractive possibilities for production for fresh fruit sale. However, there are some problems requiring resolution. Probably the single most important of these is the identification and rapid availability of adaptable high yielding cultivar, for pre-determined use, which are resistant to bunchy top and viral diseases. Cultivar Sunrise Solo is highly susceptible to bunchy top, which is widespread in Trinidad. Research on the screening of a number of exotic types known to be resistant to some viral strains is in progress in the Department of Crop Science (D. Raj Kumar, personal communication).

There is evidence (S.Q. Haque, personal communication) that drenching of seedlings with tetracycline to the extent of 500 ppm can provide protection to the plant against bunchy top up to 80 days. Research work is needed to find out whether spraying or injecting this antibiotic on young leaves or portion of young stems could provide protection against and/or be a curative treatment for late infection of mycoplasma. Preliminary work (S.Q. Haque, unpublished data) suggests that such treatments have no toxicity and that the costs are acceptable.

Table 3.--Analysis of cost and returns of papaya production[1/]

Planting Year	Gross Returns[2/]	Total Variable Cost of Production	Gross Margins
	TT$/ha	TT$/ha	TT$/ha
1973[3/]	27,117	14,260	12,857
1975[4/]	1,935	5,631	- 3,697
1975	33,029	11,168	21,861
1977	58,308	18,009	40,299
1978	8,353	7,179	1,174
1979	10,940	5,476	5,464
1979	27,025	14,005	13,019
1981	92,123	39,032	53,091
Mean	32,354	14,345	18,009

1/ Data (to the nearest dollar) for all years were derived from plantings at T.F.C.F. except the 1981 crop which were from a planting at the U.F.S. main site.

2/ Based on actual sales data which do not include the value of fruit issued gratis for research purposes or to individuals and organizations.

3/ Data derived from Cropper (1976).

4/ Data derived from Cropper and Ferguson (1977).

Table 4.--Labour requirement and cost in papaya production at T.F.C.F.[1/]

Cultural Operation	Labour	
	Requirement Mandays/ha	Cost TT$/ha
Nursery production	41	936
Land preparation	35	774
Planting	41	1,054
Irrigation	17	419
Fertilizing	24	2,351
Chemical weed control	42	2,086
Hand Weeding	95	1,975
Chemical pest and disease control	25	1,018
Roguing	86	1,789
Harvesting	147	2,924
Post-harvest handling	2	40
Total	555	15,366

1/ Data from 1977 planting in which weeds and bunchy top disease were the main problems.

More research is needed in the area of the nutrition of papaya. The work of Cooper, Haque, and Rambharose (1974) should be pursued in an attempt to clearly elucidate the role and function of various nutrients, specifically nitrogen and calcium, as well as minor elements, and in addition, soil pH factor in mitigating the expression of the bunchy top disease.

There is an appreciable domestic demand for papaya and papaya products, but the local market is not unlimited. Demand analysis and market development for fresh fruit and the potential for developing processed products like nectars, juice, and dices need to be researched. Furthermore, there is the possibility of an export market which is yet to be assessed.

In the meanwhile, at U.F.S. it is planned to commence using a production system based solely on hermaphroditic trees because of the possibilities presented by such a system for the reduction of production costs and more consistent yields of uniform fruits. With rising costs and a declining labour force, there would seem to be a good case for examining the possibility of mechanizing more operations in the production of the crop.

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