# AN INVESTIGATION INTO THE SOIL NUTRIENT STATUS OF TEN PAPAYA FARMS AFFECTED BY BUNCHY TOP DISEASE IN MAYPEN AGRICULTURAL EXTENSION AREA, CLARENDON

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## Introduction

A farmer who invests a $100.00, and at the end of the crop, earns the sum of $130.00 has lost so badly that he will have to borrow if he intends to reinvest.

The most glowing thought about our farmers is that 'they are willing to work the land.' But what is the benefit of merely seeing farming as a pastime and not a business?

Farming as a business implies sustainable use of the land, efficient use of time and inputs to ensure good returns. It is a pity that crop producers have such confused thoughts on the soil that is to assist them in realizing good returns

***Photograph 1: Papaya plant (foreground) affected by Bunchy Top disease where the leaves above the fruits become very small and appear clustered forming a bunch. (Photo by B. B. Evans*****)**

## Present Condition of Papaya in the May Pen Agricultural Extension Area

On a visit to some papaya farms in the extension area observations were made of farmers and farms:

- Bunchy Top disease was observed on all farms
- Several fields of papaya plants with main stems not exceeding a diameter of 3.75 cm (1½ inch.).

- Many of the farmers blame drought for poor performance of the papaya plants.
- Of the ten farms visited, none of them had the soil tested at any time.
- Farmers justify the failure of the farm by explaining how Bunchy Top (BT) disease comes to affect their farms.
- Chopping off the apex of the affected plant (Photo. 1) or culling the plant is the common approach to managing the BT disease.
- Several farmers intercropped the papaya field with hot pepper (Photo. 2).

***Photograph 2: Hot Pepper plants (foreground) intercropped with the papaya. (Photo by B. B. Evans)***

- One farmer has been reaping fruits for the market from the same trees for over 24 months.
- The farmers use any fertilizer; sometimes mixing several blends while hoping for increased yields.
- Papaya trees with main stems >15 cm (6 inches) but very little fruits.

**Aims of the Investigation**

The aims of this investigation are:

a) To determine the nutrient status of the soil around the papaya plants.

b) To determine the soil factor/s that may be contributory to low yields and Bunchy Top disease.

c) To foster awareness of the status of soil nutrients of the farms.
d) To prepare a comprehensive report on the soil fertility status of these farms.

## Methods

Two soil samples were collected from each of ten papaya farms in the York Town, Parnasus, Gravel Hill, Spring Plain and Ebony Park, Clarendon on March 11, 2014 with the assistance of Agricultural Extension Officers from the Clarendon Rural Agricultural Development. Soil samples were taken at a depth not exceeding 30 centimeters. Several auger borings were collected to make one composite sample of 1 kg (2.2 lbs). The soil samples were delivered to the Laboratory where they were oven dried for an average of three days at $35^{oC}$ to $40^{o}C$. The dried samples were then milled and passed through a 2 mm sieve. The sieved soil samples were chemically analyzed for eleven different factors.

## Laboratory Procedures[5]

The procedures for chemical analyses are described below:

**pH ($H_2O$)**: Potentiometric determination in a 1:2.5 soil water suspension.

**Total Nitrogen**: (according to Kjeldahl) The sample was digested in sulphuric acid, potassium sulphate, copper sulphate and selenium as catalyst to convert the organic nitrogen into ammonium sulphate followed by the distillation of trapped ammonium in boric acid and subsequent titration.

**Available Phosphate**: (according to Troug) Phosphate was extracted with 0.002 M sulphuric acid, buffered at pH 3.0 with ammonium sulphate. The phosphate extract was then determined spectrophotometrically.

**Available Potassium**: Potassium was extracted with 0.5 M acetic acid. The potassium in the extract was then determined by flame photometry.

**Exchangeable Calcium and Magnesium** was determined from a leachate of ammonium acetate at pH 7.0 using an AAS.

**Trace Elements** (Cu, Fe, Zn, and Mn) were extracted from the samples using 0.1 N HCl. 50 ml of the extracting solution was concentrated to 10 ml. Element levels were then read on the AAS.

## Data Interpretation

The analytical data were compared with guideline levels developed by Mills and Jones (1996),[4] Imperial College of Tropical Agriculture[4] (ICTA) (1940) and the Soil, Plant Tissue and Water laboratory of the Ministry of Agriculture. The data for a particular nutrient or factor, obtained from the Soil Laboratory, were rated in one of three categories as low, normal or high.

## Results

The average soil nutrient data obtained from ten farms are shown in Table 1. Tables 2 – 11 give the actual data of each farm from which Table 1 was derived.

**Table 1: Showing a comparison of soil nutrients from ten Papaya farms in York Town, Parnasus, Gravel Hill, Ebony Park and Spring Plain**

| Farm | pH | (%) $N_2$ | (%) OM | PPM | | meq/100g soil | | PPM | | | | Soil Type # | ND | NE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $P_2O_5$ | $K_2O$ | Ca * | Mg + + | Cu | Fe | Mn | Zn | | | |
| 1. | 8.2 | 0.09 | 1.53 | 324 | 207 | 37.53 | 4.21 | 4.45 | 30.02 | 107.2 | 3.83 | 103 | 4 | 5 |
| 2. | 8.1 | 0.10 | 1.62 | 411 | 374 | 45.43 | 5.29 | 4.06 | 12.91 | 124.7 | 6.46 | 103 | 3 | 5 |
| 3. | 8.1 | 0.11 | 1.93 | 351 | 368 | 51.64 | 4.80 | 3.72 | 11.56 | 118.7 | 3.66 | 103 | 4 | 5 |
| 4. | 8.2 | 0.09 | 1.66 | 188 | 206 | 56.38 | 4.73 | 2.92 | 8.27 | 100.6 | 2.92 | 103 | 4 | 4 |
| 5. | 8.1 | 0.08 | 1.40 | 434 | 222 | 40.61 | 3.10 | 3.75 | 27.52 | 112.4 | 3.75 | 103 | 4 | 5 |
| 6. | 8.1 | 0.14 | 2.34 | 411 | 507 | 50.63 | 4.24 | 4.50 | 14.26 | 138.2 | 4.50 | 103 | 5 | 5 |
| 7. | 8.4 | 0.12 | 1.02 | 282 | 243 | 31.48 | 2.90 | 2.21 | 42.73 | 92.1 | 2.26 | 103/ 104 | 4 | 5 |
| 8. | 6.8 | 0.09 | 1.60 | 448 | 220 | 24.07 | 6.33 | 1.88 | 103.2 | 107.3 | 3.45 | 107 | 4 | 4 |
| 9. | 8.1 | 0.29 | 4.94 | 30 | 54 | 85.36 | 1.54 | 0.08 | 0.47 | 4.05 | 0.24 | 77/ 104 | 6 | 2 |
| 10. | 7.6 | 0.27 | 4.76 | 175 | 172 | 29.44 | 2.49 | 2.22 | 29.27 | 184.7 | 15.16 | 103/ 104 | 1 | 4 |
| **Optimum Range** | **6.0-7.0** | **0.20-0.50** | **4.0-8.0** | **60- 100** | **140- 225** | **10+** | **0.50-1.5** | **2.00- 5** | **60-120** | **50- 200** | **5.0-10** | | | |

ND–Number of deficiencies NE – Number of factors showing excess
* All samples high
+ + all samples normal to high

Table 2: Showing analytical data on Soil Nutrients for Farm 1

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep* | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 8.2 | 1.74 | 0.10 | 375 | 244 | 37.10 | 4.09 | 4.76 | 33.14 | 112.77 | 4.04 |
| 2 | 8.3 | 1.31 | 0.08 | 273 | 170 | 37.97 | 4.13 | 4.14 | 26.90 | 101.08 | 3.62 |

Table 3: Showing analytical data on Soil Nutrients for Farm 2

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep* | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 8.2 | 1.60 | 0.09 | 301 | 270 | 43.51 | 5.25 | 4.05 | 12.67 | 121.39 | 4.47 |
| 2 | 8.0 | 2.14 | 0.12 | 582 | 478 | 47.35 | 5.33 | 4.07 | 13.16 | 127.96 | 8.46 |

Table 4: Showing analytical data on Soil Nutrients for Farm 3

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 8.1 | 2.00 | 0.12 | 342 | 404 | 51.78 | 5.01 | 3.67 | 10.37 | 118.65 | 3.98 |
| 2 | 8.1 | 1.86 | 0.11 | 362 | 333 | 51.51 | 4.60 | 3.77 | 12.76 | 118.81 | 3.35 |

*Rep - Replication (Tables 2-11)

Table 5: Showing analytical data on Soil Nutrients for Farm 4

| Rep | pH | (%) OM | (%) N | ppm $P_2O_5$ | ppm $K_2O$ | meq/100g soil Ca | meq/100g soil Mg | ppm Cu | ppm Fe | ppm Mn | ppm Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.2 | 1.57 | 0.09 | 211 | 226 | 50.02 | 4.45 | 3.54 | 11.88 | 108.59 | 2.92 |
| 2 | 8.2 | 1.76 | 0.10 | 165 | 186 | 62.77 | 5.01 | 2.41 | 3.46 | 92.67 | 2.93 |

Table 6: Showing analytical data on Soil Nutrients for Farm 5

| Rep | pH | (%) OM | (%) N | ppm $P_2O_5$ | ppm $K_2O$ | meq/100g soil Ca | meq/100g soil Mg | ppm Cu | ppm Fe | ppm Mn | ppm Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.1 | 1.49 | 0.09 | 435 | 235 | 43.15 | 3.29 | 3.42 | 22.51 | 114.09 | 3.84 |
| 2 | 8.2 | 1.32 | 0.08 | 433 | 209 | 38.08 | 2.91 | 3.15 | 110.75 | 136.93 | 3.67 |

Table 7: Showing analytical data on Soil Nutrients for Farm 6

| Rep | pH | (%) OM | (%) N | ppm $P_2O_5$ | ppm $K_2O$ | meq/100g soil Ca | meq/100g soil Mg | ppm Cu | ppm Fe | ppm Mn | ppm Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.1 | 2.15 | 0.13 | 404 | 476 | 47.94 | 4.28 | 8.41 | 14.71 | 135.54 | 3.89 |
| 2 | 8.1 | 2.54 | 0.15 | 419 | 539 | 53.34 | 4.21 | 7.27 | 14.02 | 140.93 | 4.32 |

Table 8: Showing analytical data on Soil Nutrients for Farm 7

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 8.5 | 0.74 | 0.04 | 312 | 182 | 24.42 | 1.85 | 2.15 | 61.96 | 74.64 | 1.94 |
| 2 | 8.3 | 1.31 | 0.08 | 252 | 304 | 39.55 | 3.95 | 2.38 | 23.48 | 169.66 | 5.59 |

Table 9: Showing analytical data on Soil Nutrients for Farm 8

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 7.7 | 1.53 | 0.09 | 311 | 136 | 28.13 | 6.39 | 1.99 | 80.23 | 107.71 | 3.03 |
| 2 | 5.9 | 1.68 | 0.10 | 586 | 404 | 20.01 | 6.28 | 1.78 | 126.14 | 107.00 | 3.87 |

Table 10: Showing analytical data on Soil Nutrients for Farm 9

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 8.1 | 4.59 | 0.27 | 27 | 44 | 81.61 | 1.43 | 0.08 | 0.39 | 4.09 | 0.21 |
| 2 | 8.1 | 5.39 | 0.31 | 34 | 65 | 90.11 | 1.65 | 0.08 | 0.56 | 4.02 | 0.27 |

Table 11: Showing analytical data on Soil Nutrients for Farm 10

| | | (%) | (%) | ppm | | meq/100g soil | | ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep | pH | OM | N | $P_2O_5$ | $K_2O$ | Ca | Mg | Cu | Fe | Mn | Zn |
| 1 | 7.8 | 4.86 | 0.28 | 189 | 154 | 34.71 | 2.52 | 1.14 | 11.50 | 195.01 | 17.62 |
| 2 | 7.5 | 4.73 | 0.27 | 161 | 190 | 24.18 | 2.46 | 3.28 | 47.04 | 174.42 | 12.70 |

The soil reactions (pH) were mildly to moderately alkaline – pH 7.6 to 8.5. One farm (Farm 7) showed one sample to be neutral (pH 5.9). Apart from Farms 9 and 10 with organic matter 4.94% and 4.76% respectively, the farms showed very low organic matter values of 1.40% to 2.34 %. Phosphate and potash showed very high values in all but Farm 9. Calcium exceeded its acceptable value by 1 to 8 times. All farms showed high to excessive values for calcium and magnesium.

Two farms (Farms 8 & 9) showed low values for copper. Iron appeared to be of low values in all but Farm 8. Manganese was very deficient in Farm 9; and zinc was deficient in 8 of the ten farms investigated. Farm 9 (Tables 1 & 10) has shown serious deficiencies in the four micro-nutrients analyzed.

Of the eighty determinations of trace elements, only 51.25% had adequate levels of nutrients.

The number of factors deficient ranges from 1-6; while the number of excesses was 2 - 5.
The soil types[6] identified on these farms (Table 1) are Bonnygate Stony Loam # 77 (*Lithic Ustorthents/Troporthents*), Agualta Loam # 103 (*Cumulic Haplostolls*),), Agualta Clay # 104 (*Fluventicic Ustropepts*) and Morelands Gravelly Sandy Loam # 107 (*Typic Haplustalfs*). The natural fertility for all these soils is low nitrogen, medium phosphate and potash except Bonnygate Stony Loam #77, which is naturally low in potash.

***Photograph 3: A papaya farm in the May Pen Extension Area with various management problems (Photo by B. B. Evans).***

**Discussions**

Farming is concerned with the use of the land. The production of crops involves interrelations within an ecosystem - the farmer must consider what is likely to happen to other plants or to animals around the farm. He must also consider the surface and underground water while he seeks to earn a profit from his use of the land. It might be that if he fails to make a profit, several things might be out of balance.

Therefore, farming has too many implications for it to be a mere pastime. Farming may be regarded as the management of a unit with regards to land, inputs and labour. The farmer is the manager whose aim is to be a productive, profitable and sustainable user of the various resources. A study of Table 1 points to how the enthusiasm of the farmer needs good support to reduce the waste that frequently occurs.

At pH $\geq$8.0, many dysfunctions may be observed with soil nutrients. With this soil reaction of moderate alkalinity phosphate becomes insoluble, and copper, iron, zinc and manganese become deficient. The imbalances in these farms would be minimized if the organic matter (OM) content was higher. A good percentage of organic matter (4% - 8%) has the ability to create a buffer, thus preventing the pH from being extreme.

For example, Farm 7 has shown calcium(Ca) to be 31.48 mili-equivalent/100 gram of soil with its OM of 1.02 %, resulting in a pH = 8.4; but Farm 9 showed Ca of 85.36 mili-equivalent/100 gram of soil with its OM content of 4.94% showed a pH = 8.1.

The relationship between nitrogen and magnesium[4] in the tissue of a green plant should be 1:4. Table 1 shows Farms 3 and 8 with very low nitrogen. While for the same farms; magnesium is 3 to 4 times its maximum acceptable level. Here, a large number of magnesium atoms will be moving around in the plant tissue unable to link with those of nitrogen. This sets up an imbalance which is expressed in unhealthy plants and poor quality fruits.

The farmer’s reliance on fertilisers and water is not enough to get high yields and good quality fruits.

## Conclusion

The willingness of farmers to work is not encouraged by low yield and poor quality fruit. All the farms in this investigation showed signs of Bunchy Top Disease.

Photograph 1 showed what farmers[1] usually do when a papaya plant is affected with Bunchy Top Disease. The fruit from a Bunchy Top diseased plant, though appeared whole, is of poor quality in sight and taste. Chopping off the top of the papaya plant does not really solve anything.

Photograph 2 introduced the concept of mixed farming into the papaya plantation. However, this farm has suffered the stress of too high a level of calcium which affects the quality of fruits.

Photograph 3 highlighted at least three management problems: malnourished plants, weed infested field and the presence of unproductive banana plants.

The investigation shows how important it is for farmers to seek advice in site selection through soil testing with adherence to the soil test recommendation in the production of crops.

**Literature Cited**

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3) Imperial College of Tropical Agriculture (ICTA) 1940, Arbitrary Quantitative Scheme for Assessing Soil Factors.

4) Mills, H.A and J.B. Jones 1996, Plant Analyses, Handbook II pages 29, 102 & 110.

5) Soil Survey Unit. 1988. Laboratory Procedures for the Soil Survey Unit Laboratory Technical Guide No. 2. Rural Physical Planning Division, Ministry of Agriculture (For internal use only).

6) Ministry of Agriculture. 2005. Soil Technical Guide Sheets.