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Quantitative Analysis of Soil, Nitrogen, Phosphorus, and Potassium in the Mango Farm of MEFCO, Mati City, Davao Oriental

Tediolin C. Ato
Bachelor of Science in Environmental Science, Davao Oriental State College of Science and Technology, Mati City, Davao Oriental, Philippines

Abstract

The study was conducted at the Mango Farm of MEFCO to determine the concentrations of soil nitrogen (N), phosphorus (P), and potassium (K), and the two specific environmental parameters, soil temperature and soil moisture. This was conducted from December 2002 to January 2003. Quantitative analysis of soil nitrogen was determined using Wilde's Colorimetric Method, soil phosphorus using Modified Olsen Method, and soil potassium using Warm H_2SO_4 Extraction. Moisture content was determined using the percent moisture calculation, and soil temperature was measured with a thermometer. Results showed that the mean available soil nitrogen concentration in the mango farm was 300 ppm. Soil phosphorus concentration ranged from as low as 1 ppm (Stations 1,2 and 3) to as high as 20 ppm (Station 5). The average available phosphorus concentration in the mango farm was 5.6 ppm. Soil potassium concentration in the mango farm was 444 ppm. Soil temperature in the mango farm of MEFCO ranges from 25.4 °C (Station 1) to 26.6°C (Station 2). Average soil temperature was found to be 26.08 °C. Soil moisture content ranges from 1.02 % to 1.04 %, with a mean of 1.03 % Result of the 1-Test for physicochemical parameters, as compared with desirable values and soil sufficiency level, was highly significant. This means that the parameters were found to be lower than the desirable and sufficient value. Environmental parameters, as compared to soil sufficiency and desirable levels, were also highly significant.

Keywords: Analysis, Nitrogen, Phosphorus, Potassium, Quantitative

Introduction

Soil is generally regarded by man as a valuable resource. It is considered by humans as a primary asset that plays a vital role in their daily lives (Brady & Weil, 2002). The food he eats, for instance, comes from the plant that is being supported and nurtured by soil. Almost all of the things that are needed by man come from the soil. Soil provides nitrogen (N), phosphorus (P), and potassium (K), and other nutrients (PDAP/USAID, 1976) needed by plants in order to grow and bear fruit. Those nutrients found in the soil are so important for crop productivity that they are commonly added to the soil as fertilizers. In most soils, over 90% of nitrogen that is in the form of water-soluble nitrate ion (NO) and ammonium cation (NH4), and phosphorus that is in the form of phosphate ion (PO) are essential for plant growth. Potassium, on the other hand, activates some enzymes and plays a vital role in water balance and carbohydrate transformations (Manahan, 1994).

Most of the farmers today have difficulty maximizing their profit, and they even suffer a deficit during farm operation, due to a lack of knowledge in baseline data on the status of the soil in their farmland (Barrios & Trejo, 2003). Many farmers struggle to maximize profit and may incur losses due to limited knowledge of soil conditions, including soil fertility, chemical properties, and appropriate management practices (Ali, 2003). It is important to study the soil nutrients, specifically nitrogen, phosphorus, and potassium, in a certain locality in order to come up with sound management and agricultural practices suited for the area.

Methodology

The study was conducted in the mango farm of Menzi Farmers' Cooperative (MEFCO). It is situated in the eastern part of Mati, about 5 kilometers from the Poblacion. Under the eco-political boundary, almost all of its total land area belongs to Barangay Don Martin Marundan, Municipality of Mati, Province of Davao Oriental. It has a land area of 413.86 ha. The 379.29 ha are planted with different crops, of which 60 ha are planted with mango, 4.26 ha are allocated for housing area, and the remaining 34.31 ha are allocated for perimeter road. The Mango farm of MEFCO is divided into five (5) blocks. These are blocks 4, 6, 6A, 6B, and X. In establishing sampling stations, block 4 was designated as Station 1 (S1), block 6 as Station 2 (S2), block 6A as Station 3 (S3), block 6B as Station 4 (S4), and block X as Station 5 (S5).

Field Data collection

Five (5) sampling stations were established in the site. Each sampling station was divided into substations. At each substation, a homogeneous area of 100m x 100m was Five (5) established. Modified "Z" line transect was laid in a 100m x 100m area. Replicate cores were taken at 15m intervals per core in the catch substation. A 10 cm area with a depth of 20cm was excavated for the collection of samples. About 0.2 kg of soil sample was taken in each substation. This means that for every sampling station, about 1.0 kg of soil sample was taken. A total of 5.0 kg of soil samples were taken for laboratory analysis.

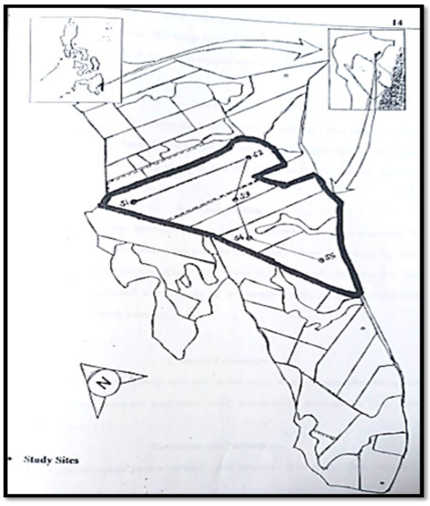

Figure 1. Map of Menzi Farm

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Soil analysis

In the soil analysis, samples were air-dried for several days. They were pulverized, placed in sterile plastic bags, labeled, and then sealed. The soil samples were brought to the Department of Agriculture-Regional Soil Analysis Center in Davao City for laboratory analysis.

Analytical method

Soil nitrogen was determined using Wilde's Colorimetric Method. Total soil phosphorus was determined using the modified Olsen method, while extractable potassium was determined using the Warm H_2SO_4 Method. Soil temperature was obtained with the use of a thermometer, while moisture content was determined using the oven-dry method.

Chemical parameters

The chemical parameters analyzed in the study were nitrogen, phosphorus, and potassium. These important parameters were quantitatively analyzed in the Department of Agriculture. Soils Laboratory, Davao City.

Environmental parameters

Two environmental parameters were emphasized in the study: soil temperature and soil moisture. The determination of soil temperature was done during the sampling period, with the use of a thermometer. Moisture determination was included in the analysis of chemical parameters, using the oven-dry method.

Sampling duration

Since the study focused only on the quantitative analysis of nitrogen, phosphorus, and potassium, sampling was done only once.

Data analysis

Data were analyzed using descriptive statistics, mean, median, and standard deviation. 1-Test was used for the comparison of results with the desirable level for the mango orchard and the soil sufficiency level.

Statistical design

A statistical data matrix was used to summarize the data obtained from sampling. The following were computed.

Descriptive statistics

Descriptive statistics measures were derived from sample data taken from the population (eg, mean and median) (Downie, 1983).

a. Mean- this is a measure of the central tendency of a population and is computed as:

$$\overline{x} = \sum x/n$$

Where x = sample mean
$\sum x$ = sum of all values of x in the sample, and
n = amount of data in a sample

The sample mean is a reasonable estimate of the population when the former is obtained at random from the entire population.

b. Median- this is the middle measurement in a ranked data. If there is an error in the number of data, the median is the mean of the two middle measurements.

c. Range: a measure of how variable the gathered data is. The range is simply the difference between the largest and smallest measurements. The big disadvantage of using the range to describe the dispersion of sample data is that it tends to underestimate the population range.

d. Standard Deviation (SD)- this is a measure of how the data are dispersed relative to the mean. For this reason, it becomes very useful in statistics.

$$s = \sqrt{s^2}$$

Where s = sample standard deviation, and
s^2 = sample variance

e. Variance: This variance is:

$$s^2 = ss/df$$

Where ss (sum of squares) = $(x-x)^2$; and

df (degree of freedom) = n-1

f. Standard Deviation Error- each sample has a different mean, and how the sample means vary from each other can be measured by the standard deviation of the mean or standard error

$$SE = s\sqrt{n}$$

Where s = standard deviation and
n = amount of data in the sample.

RESULT AND DISCUSSION

Chemical parameters

Soil nitrogen

Figure 2 shows the uniform amount of available soil nitrogen in the five (5) sampling stations. The amount of available soil nitrogen was 300ppm. Results of analysis showed that the available soil nitrogen in the mango farm of MEFCO was found at 1% OM, which is equivalent to 1000 kg. nitrogen per hectare of land. This amount coincided with the normal Philippine soil (Brady & Weil, 2002).

The uniform amount of available soil nitrogen in the five sampling stations could be attributed to the fertilizer management in the mango farm, since farmers applied an equal amount of fertilizer containing nitrate compounds. Aside from that, soils in the five sampling stations had the same percent organic matter (%OM) level (Tisdale et al., 1993).

Before the sampling period, it rained for three (3) consecutive days. Lightning was also observed. Basically, little nitrogen was supplied into the soil by lightning discharges (PDAP, 1976). This environmental condition influenced the presence of nitrogen in the soil in the form of nitrates (Heimer, 1989).

The slope of the terrain of the five sampling stations is relatively flat, such that during rainy seasons, rainwater usually percolates directly to the ground, and this is another reason why soil nitrogen remains in place.

Another reason for the uniform soil nitrogen in the five sampling stations is the soil type. The mango farm of MEFCO has a clay loam type of soil. Clay loam soil usually exhibits a heavy texture with 1% OM level.

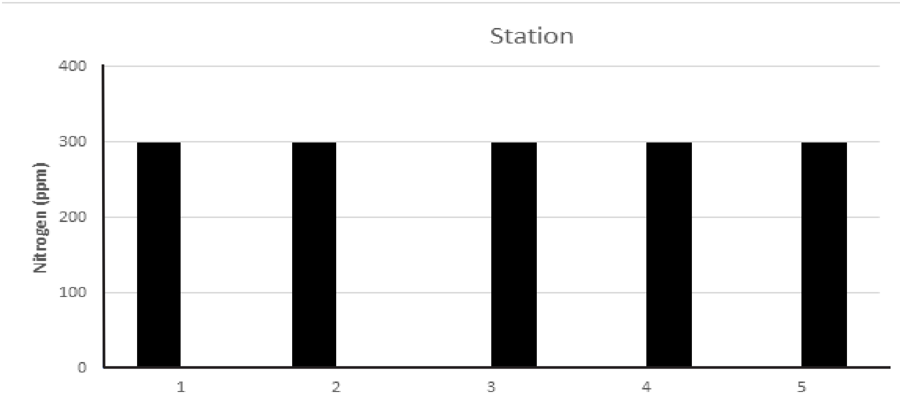

Figure 2. Graph of Nitrogen (ppm) from Station 1 to Station 5.

Soil phosphorus

Figure 3 shows the uniform amount of available soil phosphorus in Stations 1, 2, and 3, which is 1ppm. Station 4 was found to have 5ppm, while Station 5 had the highest value noted at 20ppm Analysis showed that Stations 1, 2 and 3 had deficient available soil phosphorus while Station 4 and 5 had sufficient available soil phosphorus The mean value of available soil phosphorus was 5.6ppm The higher concentration of available phosphorus in Stations 4 and 5 was attributed to the application of inorganic fertilizer (urea and phosphate), Human induced a ctivity such as applications of inorganic fertilizers had greatly affected the higher concentration of available phosphorus in these stations. Consistently, Stations 4 and 5 are said to have poorly drained soil.

This coincided with the statement of Tisdale et al. (1993) that the phosphorus concentration is greater in poorly drained soil. With the absence of fertilizer application and characterized as well-drained soil, the available phosphorus concentration of 1ppm in Stations 1, 2, and 3 is said to be natural and deficient in concentration.

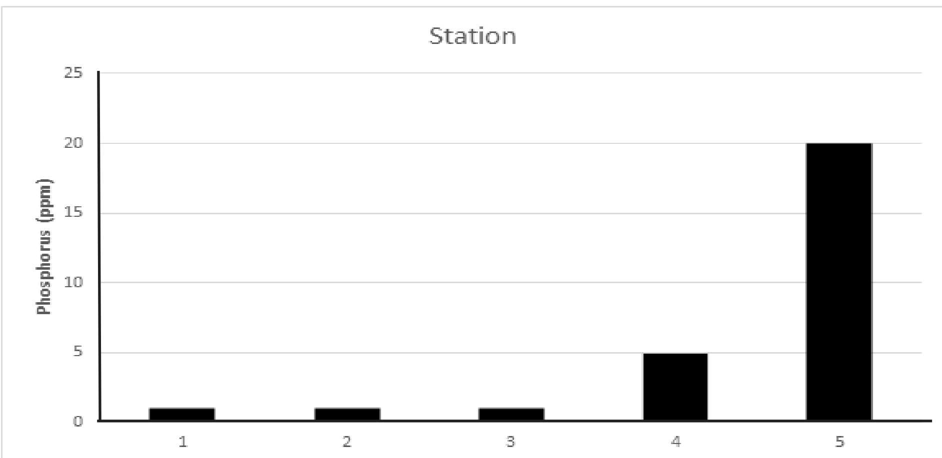

Figure 3. Graph of Phosphorus (ppm) from Station 1 to Station 5.

Soil potassium

Figure 4 shows the variation in the amount of available potassium concentration in the five sampling stations. The potassium concentration ranged from 235ppm to 725ppm. The mean available potassium concentration in the Mango farm was 444ppm.

The available potassium concentration in the mango farm of MEFCO is said to be sufficient. Based on the nutrient requirement, potassium concentration in the mango farm ranged from 0.1 to 3.3% K_2O as total soil potassium. This means that about 2,000 to 60,000 kg of K_2O was found per hectare. As shown in Figure 5, Station 5 had the highest available potassium concentration, which was 725ppm. On the other hand, Station 3 had the lowest potassium concentration, which was 235ppm. Stations 2 and 4 had nearly the same available potassium concentration, which was 470ppm and 240ppm, respectively. Before the sampling activity, environmental factors such as rainfall affected the presence of potassium concentrations in the soil. As noted by Brady & Weil (2002) on soil fertility and Mengel & Kirkby (2001) on plant nutrition and potassium dynamics, potassium is more available during the wet season than during the dry season. The sufficient amount of the said plant nutrient can be attributed to such environment factor. Another factor that affected the availability of potassium with regard to plant uptake is soil temperature. When the soil temperature is lower than 15°C, plant potassium uptake decreases. In Station 1, the average soil temperature was 25.4°C. This means that potassium uptake by the plant is maximized at this temperature level. This is also true for Stations 2, 3, 4, and 5, which had nearly the same temperature readings.

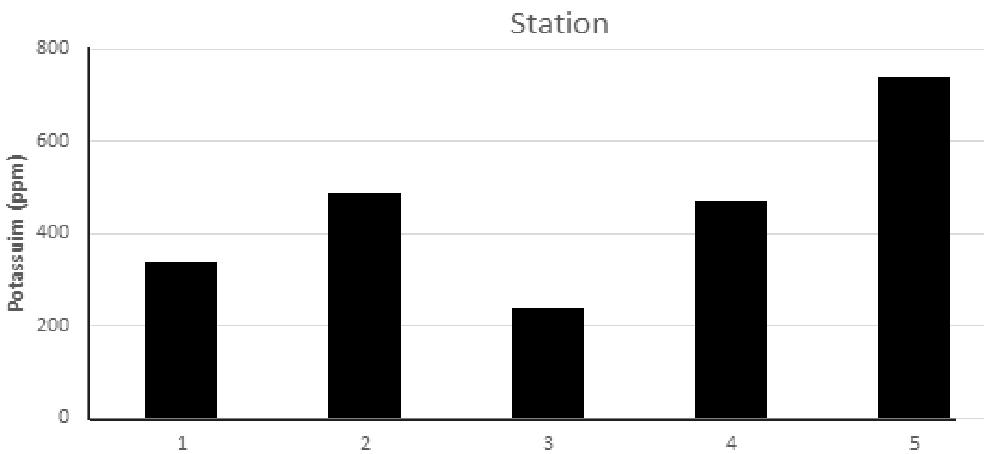

Figure 4. Graph of Potassium (ppm) from station 1 to station 5.

Environment parameters

Moisture

Moisture content of the mango farm soil ranged from 1.02% to 1.04%. The highest moisture content was noted in Stations 1 and 2, and the lowest moisture content was observed in Station 3. The average soil moisture content of the mango farm was 1.032%. Soil moisture had significant effects on plants with regard to nutrient availability in the soil. According to Mengel & Kirkby (2001), it is observed that potassium is more available during the wet season. As observed, the wet season is characterized by heavy rainfall. This environmental condition directly links to higher moisture content of the soil, such that the higher the soil moisture, the higher the uptake of nutrients by plant roots.

Lower soil moisture content was observed in Station 3. This is because the soil type in this station is sandy loam. This soil readily loses water or moisture, especially during the dry season.

Sandy loam soil has low water-holding capacity. On the other hand, Stations 1,2,4 and 5 had higher water holding capacities because the soil type in these stations is clay loam. Clay soil is noted for its higher water-holding capacity because of its voids, pores, and spaces that store water.

Soil moisture content is important because it dictates the availability of needed nutrients by plants, and it is the basic parameter of water requirement by soil.

Temperature

The variation of soil temperature in the five (5) sampling stations is shown in Figure 6. The temperature reading observed in the mango farm of MEFCO ranged from 25.4°C to 266 °C. The lowest value was observed in Station 1, and the highest value was noted in Station 2. The total average temperature of the mango farm was 26.08°C. The time of sampling had affected the variations of the temperature as collection started at 9:45 in the morning in Station I and ended at around 2:45 in the afternoon in Station 5. Sample collection in Stations 2,3 and 4 happened during noon time when the surrounding air temperature reached as high as 30°C. During this time, surface soil temperature became warmer because of direct sunlight or solar radiation.

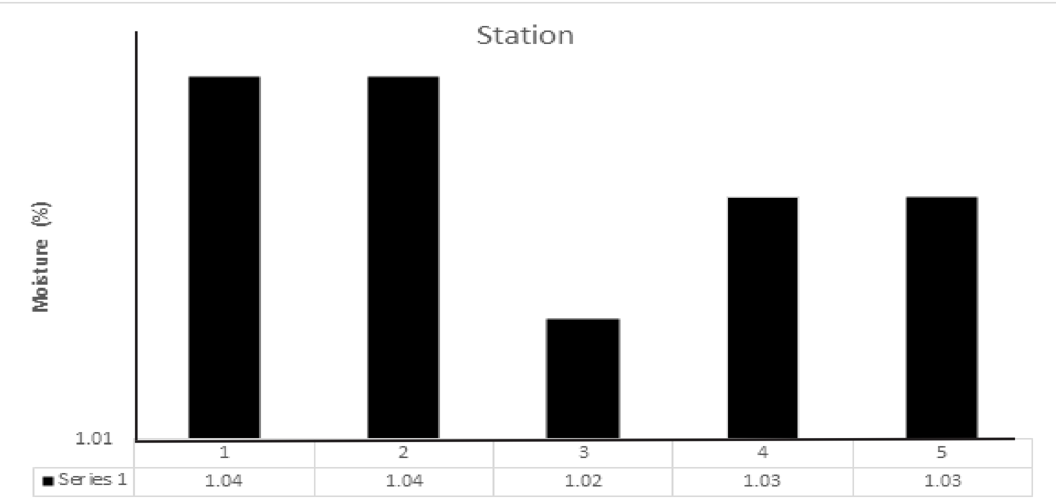

Figure 5. Graph of Moisture (%) from Station 1 to Station 5.

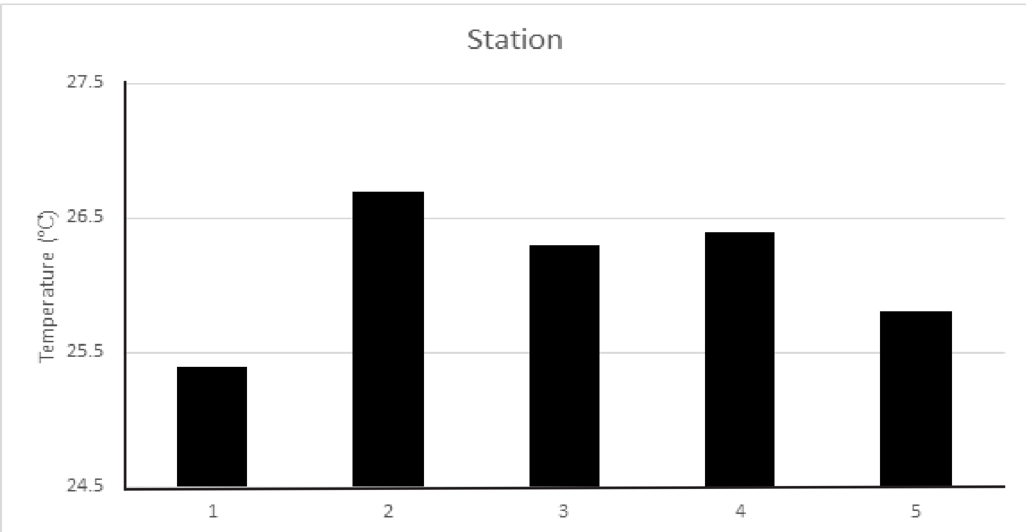

Figure 6. Graph of Temperature (°C) from station 1 to station 5.

During noon time, while collecting the samples is Stations 2, 3, and 4, a higher temperature was noted, and there was a relative absence of wind movement. This coincided with the statement of Kinne (1970), that through the direct capture of light, a heat change or specific reactions such as photosynthesis may result. The presence of mango trees as vegetative cover and soil grasses results in lower temperatures in the mango farm. The presence of mango trees as a canopy helps prevent the direct exposure of the soil to sunlight, maintaining its natural moisture. This is the basic factor of the lower thermal reading in the area. Soil temperature is essential to plants because it influences the rate of chemical reactions. This coincides with the statement of Brady (1979) that plant growth is affected or influenced by the nutrients, moisture, and temperature. That is, plants grow abundantly if soil nutrients (such as nitrogen, phosphorus, and potassium) and climatic conditions (such as temperature and moisture) are at optimal levels. The optimum soil temperature for plants to maximize their nutrient uptake ranged from 25°C to 35°C. The MEFCO mango farm soil temperature was within this range.

Conclusion

The results revealed that the soil in the MEFCO mango farm contained 300 ppm of available nitrogen, as determined by Wilde's Colorimetric Method of percent organic matter. Available phosphorus averaged 5.60 ppm using the Modified Olsen method, while potassium reached 444 ppm through the Hot H_2SO_4 extraction method. Based on the availability index for NPK from the Regional Soils Laboratory Center, the soil was deficient in nitrogen and phosphorus but sufficient in potassium. The average soil temperature was 26.08°C, which falls within the optimum range for maximizing plant nutrient uptake. However, soil moisture content was measured at only 1.032%, indicating a deficiency according to the same index.

When compared with standard values for mango orchards, the nutrient levels showed significant differences. The nitrogen level of 300 ppm was far below the desirable 600 ppm, while phosphorus at 5.60 ppm was also below the recommended 15 ppm. In contrast, potassium at 444 ppm exceeded the required 100 ppm. Similarly, when compared to soil standard sufficiency levels, nitrogen (1350 ppm) and phosphorus (300 ppm) were notably deficient, while potassium (250 ppm standard) was more than adequate.

These variations were influenced by soil temperature and moisture, which directly affect nutrient availability. As a result, the imbalance in soil nutrients and low moisture content negatively impacted plant growth and productivity. This condition is evident in the MEFCO mango farm, where trees produce limited fruit and leaves are more vulnerable to diseases.

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