Soil Nutrient Analysis and Management of Soil Nutrients in Guava Orchard

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Abstract:
Management of nutrients in guava refers to the maintenance of soil fertility and plant nutrient supply. The requirement of nutrient of nutrient differs in guava due to its perennial nature, fruiting behavior and quality of the fruit. Deficiency of both major and micro nutrients leads to definitive symptoms causing severe yield loss. Fertilizer level can be assessed by characterization of soil based on both physical and chemical properties and based on these recommendation, deficient nutrient cab be maintained. the main objective of experiment is to analyze the nutrient requirement for the orchard, therefore nutrient analysis was done to know about the recommendations and requirements for the soil.

1. INTRODUCTION

Soil is the aggregation of organic and/or inorganic particles which are mostly loose, mixture of materials and mostly covers the surface of the earth (Chesworth, 2006). This layer of soil is where both animals and plants thrive. Soil is composed of two kinds of components, minerals derived from weathering rocks and organic materials derived from plants and micro-organisms. The weathering rock is called parent material which is eroded by water and air in due time and transported to new places (Singer & Munns, 1987). Soil have distinct layers at varying depths with upper layer of usually rich in Organic matters (H. P. Singh & Singh, 2007) Soil provides the livable condition for both plants and animals and the analysis of soil is necessary in order to understand the various aspects of the soil like pH, Electrical Conductivity, Organic Carbon, Available Potassium, Phosphorus and Nitrogen. These aspects determine the production ability of any crop. Soil analysis is a set of various chemical processes that determine the amount of available plant nutrition in the soil, but also the chemical, physical and biological soil properties that are important or plan growth. It is performed in order to determine the level of nutrients needed for plant to thrive in perfect health. Soil pH is the measure of the acidity ad alkalinity in soils. It is calculated by finding the negative logarithm of the concentration of hydrogen ions in the soil and ranges from 0 to 14. Soil pH influences various soil parameters like solubility, ionic form, movements of micronutrients and many more (Fageria, Baligar, & Clark, 2004). Soil pH levels are affected by a number of different factors including temperature, rainfall and the type of vegetation that has grown in the soil (Kaur, 2018).

Electrical Conductivity (EC) is the ability of any material to conduct/transmit an electrical current. Soil EC is the measurement of electrical current in relation to soil properties that includes soil texture, cation exchange capacity (CEC), organic matter concentration, etc. (Grisco, Alley, Holshouser, & Thomason, 2009). It is commonly expressed in miliSiemens per meter (mS/m) or deciSiemens per meter (dS/m).

Soil Organic Carbon is a measurable component of soil organic matter. It refers only to the carbon compound. About 58% of the mass of organic matter exists as carbon (Lefevre, Fatma, Viridiana, & Liesl, 2017)

Potassium (K) is an essential nutrient for plant growth. It is associated with the movement of water, nutrients and carbohydrates in plant tissue along with enzyme activation within plant. It also helps in regulating the opening and closing of stomata. The potassium use efficiency is more than N, P and other elements. Available Potassium constitutes water soluble and exchangeable form. Non-exchangeable form is not considered due to slow dynamics of this form.

Available Phosphorus content of soil consists mainly of Calcium, Aluminum and Iron Phosphates. In soil phosphorus exists in various form of rock phosphate and a very small of these is available to plants at a given time.

Available Nitrogen is the chemical form of nitrogen that can be absorbed by plant roots and used. Nitrogen is available in organic form in soil (maybe 09-95%) (Bartholomew, Clark, & Scarsbrook, 1965). The organic nitrogen is converted to inorganic form through oxidation process; mostly its microbial mediated process, mineralization process. Guava is widely grown fruit crop and ranks fourth in India. Guava is cultivated in around 0.15 million hectare and 1.80 million tons of fruit is produced (Mitra, Gurung, & Pathak, 2008). It excels other fruit trees in production, hardness, adaptability and vitamin C content and used for both fresh consumption and processing (G. Singh & Singh, 2007). Guava is a perennial in nature and provides fruit over a long period of time. With age the productivity declines along with poor management practices and other factors like imbalanced fertilizer use, weed, insects and diseases. However these plants can be brought back in production through a process of Rejuvenation. In this process, the branches are cut back through which imbalance is created in root: shoot ratio; as a result new shoots arise from plant to balance it leading to newer latent buds which later develop to proper shoot (Deshmukh, 2017).

II. MATERIALS AND METHODS

The materials used and methodology followed during present investigation have been described in this part.
Experimental Site
The sample collection was carried out during 15th July 2019 at Guava Orchard, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, which is situated at 25° 15’ 51.12” North latitude, 82° 59’ 17.45” East longitudes and at an elevation of 78 meters above sea level. Guava plantation was done in the site 13 years ago according to the workers present there. The plants were rejuvenated according to the need and consisted of several varieties viz. Lucknow-49, Allahabad Safeda and Lalit. The soil present in the orchard was Clay Loam. No definitive amount of chemical fertilizer was supplied to the plants whereas compost manure was supplied on regular interval.

Experimental Details
The series of tests of soil was carried out by performing various lab tests by using equipment’s and chemicals that were available in the lab. Following tasks were performed:

Soil sampling: The site was first divided into homogenous unit based on the visual observation. As the sampling process was carried out in group each member of our group took sample from different locations of the orchard. The litter and fallen leaves were removed from the land surface. Khurpi was used to scalp the land and take out the soil. ‘V’ shaped incision was made in the land surface of around 18 cm and soil was taken in a plastic bag.

Materials Used for sampling
• Khurpi
• Sampling Bag

Preparation of Soil samples for analysis

Drying of samples: The sample was air dried, in shade at room temperature

Post Drying: After drying the sample was grinded by using a wooden pestle and mortar in order to loose the soil aggregates and not affect the soil particles. During this process other impurities like pebbles and brick pieces were removed to obtain the pure soil.

Lab Tests
1. Soil pH
Materials Used:
• Auto Digital Meter
• Pipette
• Beaker
• Glass Rod

Procedure: 20 gm of soil sample was taken in a beaker after weighing in electronic balance and 50ml of water was added to it. The solution was stirred using a glass rod for 10 minutes and kept in rest for 30 minutes. After 30 minutes of rest reading was taken using pH meter.

2. EC
Materials Used:
• EC meter
• Pipette
• Beaker
• Glass Rod

Procedure: 20 gm of soil sample was taken in a beaker after weighing in electronic balance and 50ml of water was added to it. The solution was stirred using a glass rod for 10 minutes and kept in rest for 30 minutes. After 30 minutes of rest reading was taken using EC meter.

3. Organic Carbon
Materials Used:
• 250 ml Conical Flask
• Pipette
• Burette
• Measuring Cylinder
• Electronic Balance

Reagents Used:
a. Phosphoric acid (85%)
b. Sodium Fluoride Solution (2% of 0.2 mg approx.)
c. Sulphuric Acid
d. Standard K$_2$Cr$_2$O$_7$
e. Standard 0.5M FeSO$_4$ Solution (140 gm of Ferrous Sulphate or 196.1 gm of FeSO$_4$ (NH$_4$)$_2$.6H$_2$O in 800 ml of water; add 20 ml of concentrated H$_2$SO$_4$ and make volume up to 1 liter.)
f. Diphenyl Indicator (Dissolve 0.5 gm of reagent-grade diphenylamine in 20 ml of water and 100 ml of concentrated H$_2$SO$_4$)

Procedure:
1 gm of soil sample was taken in a 500 ml conical flask and 10 ml of 1N K$_2$Cr$_2$O$_7$ was added with the help of pipette. 20 ml of concentrated Sulphuric acid was added using measuring cylinder and shaken for around 2-3 minutes by hand. After shaking, the flask was placed in a dark place for 30 minutes. After 30 minutes of storage in dark place 200 ml of distilled water was added using measuring cylinder. A pinch of Sodium fluoride was added to the solution. 5-10 drops of Diphenyl amine indicator were added and titration was performed with the help of Ferrous ammonium Sulphate till light green colour was obtained.

4. Available Potassium
Materials Used:
• Beaker
• Volumetric Flask
• Whatman Filter paper 1
• Funnel
• Flame photometer

Reagents Used:
a. Neutral Ammonium acetate

Procedure:
5 gm of soil was taken in a beaker and 25 ml of Ammonium acetate was added. The solution was stirred for about 5 minutes and filtered using filter paper. The filtrate was used in Flame Photometer to measure the amount of Potassium.

5. Available Phosphorus

Materials Used:
• Volumetric Flask (25 ml)
• Conical Flask (250 ml)
• Whatman No 1 Filter paper
• Funnel
• Pipette
• Beaker
• Spectrophotometer

Reagents Used:
a. Olsen’s Extractant
b. Activated charcoal
c. Ascorbic acid

Procedure: 2.5 gm of soil sample was placed in a conical flask and 50 ml of Olsen’s extractant was added along with a pinch of charcoal. The content of conical flask was shaked in a mechanical shaker for 30 minutes and the solution was filtered using Whatman No. 1 filter paper. 5 ml of the filtrate was pipetted out into a 25 ml volumetric flask and 4 ml of ascorbic acid was added. After 10 minutes the colour intensity was measured using Spectrophotometer.

Table 1. Methods employed to determine physiochemical characteristics

<table>
<thead>
<tr>
<th>S.N</th>
<th>Physiochemical Characteristics</th>
<th>Method Employed</th>
<th>Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>Digital pH meter (Jackson, 1958)</td>
<td>Principle of potentiometer</td>
</tr>
<tr>
<td>2.</td>
<td>Electrical conductivity</td>
<td>Electrical conductivity meter</td>
<td>Principle of Resistance (EC meter is based on Wheatstone’s bridge)</td>
</tr>
<tr>
<td>3.</td>
<td>Organic Carbon</td>
<td>Hydrochloric oxidation method (Walkley &amp; Black, 1934)</td>
<td>Redox Titration</td>
</tr>
</tbody>
</table>

III. RESULTS AND DISCUSSION

The experimental results obtained from appropriate lab tests conducted after a day of soil sample collection collected on 15th July 2019. During the course of this investigation these data were covering various soil parameters (pH, Electrical conductivity, Organic carbon, Available phosphorus and available potassium) Available nitrogen was calculated using organic carbon. The results obtained are presented under following major heads.

1. pH
2. Electrical Conductivity
3. Organic carbon
4. Available Nitrogen
5. Available phosphorus
6. Available potassium

Table 2. Results of soil analysis

<table>
<thead>
<tr>
<th>S.N</th>
<th>Parameters</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>7.39</td>
</tr>
<tr>
<td>2.</td>
<td>Electrical Conductivity (µS/cm)</td>
<td>2.06</td>
</tr>
<tr>
<td>3.</td>
<td>Organic Carbon (%)</td>
<td>1.43</td>
</tr>
<tr>
<td>4.</td>
<td>Available Potassium (Kg/ha)</td>
<td>1199</td>
</tr>
<tr>
<td>5.</td>
<td>Available Phosphorus (Kg/ha)</td>
<td>9.63</td>
</tr>
<tr>
<td>6.</td>
<td>Total Nitrogen (%)</td>
<td>0.1239</td>
</tr>
</tbody>
</table>

Calculation:

1. Organic Carbon
Sample reading: 11.5
Blank reading: 22

Organic Carbon Percentage
= \frac{BR - SR}{SR} \times 10 \times 0.003 \times \frac{100}{Wt. \ of \ soil \ sample}

= 1.43%

2. Available Potassium
Sample reading: 109
K ppm = 5 \times 109 = 545 ppm
K Kg/ha = 545 \times 2.2 = 1199 Kg/ha
K2O Kg/ha = 13.44 \times 109 = 1464.96 Kg/ha

3. Available Phosphorus
Sample reading: 0.044
Blank reading: 0.001

P conc. In soil = (SR-BR) \times 100
= (0.044-0.001) \times 100
= 9.63 Kg/ha

4. Total Nitrogen
For calculating the amount of Nitrogen first we need to calculate the amount of Organic matter in the soil

Organic Matter = Organic Carbon \times 1.734

Total Nitrogen = \frac{Total OM}{20}

= 0.1239%

Soil Analysis
Guava (Psidium guajava) is an important fruit grown throughout the country for its nutritional benefits. It belongs to the family “Myrtaceae”. Its commercial cultivation is becoming important
in present scenario. It is a rich source of ascorbic acid, pectin, iron, calcium and phosphorus besides riboflavin and thiamine (Singh and Singh 2007). The requirement of nutrient of nutrient differs in guava due to its perennial nature, fruiting behavior and quality of the fruit.

Deficiency of both major and micro nutrients leads to definitive symptoms causing severe yield loss. Fertilizer level can be assessed by characterization of soil based on both physical and chemical properties and based on these recommendation, deficient nutrient cab be maintained. The results obtained through series of tests and analysis are discussed under following major heads

1. **pH:** Guava is mostly grown in soil pH ranging from 5.5 to 8.0 (G. Singh & Singh, 2007). In low pH soil, leaf bronzing is seen for which better health of soil is essential for better health of plant while poor soil will require more attention and maintenance of plant’s health. The pH of the soil sample collected at Guava orchard was found to be 7.39 for this no amendments should be performed in the soil.

2. **Electrical Conductivity**
Guava is salt sensitive plant and water salinity more than 1.5 dS/m can hinder the plant growth and productivity. The sensitivity can be affected by soil texture and other limits. More importantly, salinity in seedling stage can have serious impact in terms of establishment.

<table>
<thead>
<tr>
<th>EC(dS/m)</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 1</td>
<td>Normal</td>
</tr>
<tr>
<td>1-2</td>
<td>Not suitable for germination</td>
</tr>
<tr>
<td>2-3</td>
<td>Critical for growth of salt sensitive crops</td>
</tr>
<tr>
<td>Above 3</td>
<td>Injurious to most crops</td>
</tr>
</tbody>
</table>

(Jackson, 1958)

Result for electrical conductivity (EC) of soil sample of guava orchard was found to be **2.06 (dS/cm)** which is more than normal. For this EC can be reduced by adding organic matter, using mulches, chemical amelioration such as using gypsum and proper drainage facility.

3. **Organic Carbon**
The Organic carbon percentage was estimated to be **1.43%** which is higher than the normal level. Thus the amendments can be made through tillage which will expose the previously protected organic matter for microbial decomposition.

<table>
<thead>
<tr>
<th>OC %</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.5</td>
<td>Low</td>
</tr>
<tr>
<td>0.5-0.75</td>
<td>Medium</td>
</tr>
<tr>
<td>&gt; 0.75</td>
<td>High</td>
</tr>
</tbody>
</table>

(Chopra & Kanwar, 1986)

4. **Available Potassium**
Deficiency of Potassium leads to unhealthy plants and brown spots on the leaves which later on increase and form strips on the small leaves. Higher amount of K leads to decreased Mg content in leaves (Sonsud & Tunsuwan, 2008). Available K content of the soil was estimated **1199 Kg/ha** and K₂O level was **1464.96 Kg/ha** which is very high than the normal recommended level of 120-230 kg of K by ICAR.

The average of our group was recorded **297.87 Kg/ha** which is lower than my value. Higher value of K in my data may be due to sudden application of Potassium in the orchard at my point of sampling. The concentration of K can be maintained by decreasing the application rate of K by 25% of the previous rate of application.

<table>
<thead>
<tr>
<th>Amount of K₂O</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 140</td>
<td>Low</td>
</tr>
<tr>
<td>140-280</td>
<td>Medium</td>
</tr>
<tr>
<td>&gt; 280</td>
<td>High</td>
</tr>
</tbody>
</table>

(Chopra & Kanwar, 1986)

5. **Available Phosphorus**
Lower amount of P leads to stunted growth of the tree, leaves become copper coloured (bronzing) and drop off prematurely under acute deficiency (G. Singh & Singh, 2007). On lower amount the stem also becomes weak and the size of both seed and fruit is reduced along with the quality of the yield. The result of available phorsorus was recorded **9.63 Kg/ha** which is lower than the recommended value. In order to provide the adequate amount of Phosphorus, application rate of P should be increased by 25 % of the previous application.
Table 6. Available Phosphorus Interpretation

<table>
<thead>
<tr>
<th>Amount of $P_2O_5$</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 28</td>
<td>Low</td>
</tr>
<tr>
<td>28-56</td>
<td>Medium</td>
</tr>
<tr>
<td>&gt; 56</td>
<td>High</td>
</tr>
</tbody>
</table>

(Chopra & Kanwar, 1986)

6. Available Nitrogen

Decrease in nitrogen concentration is the major cause of stunted growth and leaf discolouration. Pale green to light yellow colour appears on leaf leading to the fall of older leaf. It also reduces fruiting.

IV. CONCLUSION

Requirement of Guava for mineral nutrients differ from the crops related with perennial nature, fruiting behavior and desired quality of the fruit. Results of the study demonstrated that the guava orchard has considerable amount of pH while the amount of EC is slightly more than normal. Soil organic carbon percentage is found to be higher than the recommended amount for which simple amendments of tillage can be performed. On the other hand, the level of Potassium is very high and necessary step should be performed to maintain K level. Phosphorus level was slightly lower for which 25% extra fertilizer should be applied to meet the required level. In order to maintain the health and productivity of the orchard these parameters should be maintained and taken care of.

V. REFERENCES


