Nutrient status and their relationship with soil properties of dalo (Colocasia esculenta (L.) Schott) growing areas of Rewa district in Fiji

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ABSTRACT
This study was conducted in dalo (Colocasia esculenta (L.) Schott) growing areas of Rewa district in Fiji to know nutrient status and their relationship with soil properties. Representative soil samples were collected to determine soil properties and nutrient status. The soils of the study area were found acidic in nature with the mean pH of 5.6. The electrical conductivity varied from 0.07-0.31 dSm$^{-1}$ with a mean 0.17 dSm$^{-1}$. Organic carbon varied from 0.30 to 5.5 % with the mean value of 2.1%. Total nitrogen varied from 0.07-0.43 % with a mean of 0.19%. The values of available phosphorus (mg kg$^{-1}$) varied from 1.0-44.0 mg kg$^{-1}$ with a mean value 12.9 mg kg$^{-1}$ and that of potassium varied from 27.37-762.45 mg kg$^{-1}$ with a mean of 169.56 mg kg$^{-1}$. It was concluded that soils of the dalo growing areas of Rewa district are moderately acidic, having low electrical conductivity and are characterized as non-saline soils. Soils are high in organic carbon, medium in total nitrogen and low in available phosphorus and exchangeable potassium.

Key words: Available nutrients, Dalo, Soil properties.

INTRODUCTION
Soil fertility is one of the important factors that controls yield of agricultural crops. It is the nutrient pool that plant utilizes for their growth and development. It determines the sustainable productivity of agro-ecosystems. The sustainable productivity of soil mainly depends upon its ability to supply essential plant nutrients to the growing plants.

Deficiency of nutrients has become major constraint to productivity, stability and sustainability of soils (Bell and Dell, 2008). The concept of soil health and soil quality has consistently evolved with an increase in understanding of soils and soil quality attributes. The quality of soil is controlled by physical, chemical and biological components of a soil and their interaction (Pependick and Parr, 1992).

Soil properties cannot be measured directly, but soil properties that are sensitive to changes in the management can be used as indicators (Andrew et al., 2004). Attraction for growing high yielding varieties without considering fertility of soils could result in depletion of soil organic matter reserves and reduce quality of soils.

Addition of appropriate doses of organic matter and lime helps in maintaining better and favourable physical conditions of soils for sustainable farm productivity. Determination of physico-chemical properties and available nutrients status of the soil of an area is vital for improving sustainable productivity. Soil pH is a good indicator of plant available nutrients in the soil (Kinyangi 2007).

Soils are acidic in nature with very low organic carbon and nitrogen. The available phosphorus and potassium are deficient to marginal. There is necessity to apply organic manure and liming material, with appropriate nitrogenous and phosphate fertilizer doses for enhancing farm productivity in the fields of Koronivia (Singh, et al., 2013).

The present study provides information on availability of plant nutrients in relation to physico-chemical properties of soils of dalo growing areas of Rewa, Fiji. The study helps in understanding the future scope of dalo cultivation in the region.

MATERIALS AND METHODS
The study was conducted at Rewa district of Fiji which comprises of three sub districts (Rewa, Vutia and Toga). The geographical reference of the study area are 18° 05’ 00” S, 178° 20’ 00” E and elevation ranges from 6 to 23 m above mean sea level. The climate is tropical and the temperature is moderate (21°C- 26°C) with annual average rainfall of about 3,000 mm (Fiji Met, 2013). Soils are acidic in nature and pH varies from 5.1 - 6.6 with low to medium organic carbon and low electrical conductivity (0.01 - 0.08dSm$^{-1}$) (Bell 1988).

From these three sub district 57 dalo growing farmer’s fields were selected for soil sampling. Representative soil samples were collected considering the heterogeneity of soils by keeping in view the variation in soil type, slope and land use to determine chemical properties.
and nutrient status. Collected samples were prepared as per standard methods and stored in properly labeled plastic bags for analysis. Standard analytical methods as described by Richards (1954) and Jackson (1973) were followed for measuring various soils attributes like pH, electrical conductivity (EC), organic carbon (OC) and important plant nutrients (total nitrogen, available phosphorus and available potassium) at Fiji Agricultural Chemistry Laboratory, Koronivia Research station (KRS).

The relationship between different soil physicochemical properties and available nutrients content were determined using descriptive statistics and SPSS – 17.0, 2009. Simple correlation coefficient (r) between different soils properties and availability of nutrients were determined. Where “r” is correlation coefficient,

\[ r = \frac{\sum x \sum y - (\sum x \sum y) / n}{\sqrt{\sum x^2 - (\sum x)^2 / n \cdot \sum y^2 - (\sum y)^2 / n}} \]

where n is the number of pairs of data (x,y).

RESULTS AND DISCUSSION

The soil pH varied among sites from 4.3 to 7.1. The soils of the study area are acidic in nature with the mean pH of 5.6 (Table 1) which falls under moderately acidic ratings of pH (5.6-6.0) (Bruce and Raymond, 1982). Relative low values of pH are due to acidic parent material of these soils (Miyauchi et al., 1985). Regression line between pH and K and pH and Ca indicated a positive trend of increase in their content with increase in pH (Fig. 1D and Fig.1B).

The electrical conductivity values of the soils varied from 0.07- 0.31 dSm\(^{-1}\) with a mean value 0.17 dSm\(^{-1}\). These soils have low electrical conductivity and characterized as non-saline soils (Hazelton and Murphy, 2007). EC values showed a positive correlation with P and K (Table 2). On the basis of limits suggested by Muhr et al., (1965) for judging soil salt problems, all samples were found normal (EC <1.0 dSm\(^{-1}\)). The normal electrical conductivity may be ascribed as lower base concentration and leaching of salts from the soils.

![Fig 1: Regression analysis among some important soil properties.](Image)

1A. Soil pH and phosphorus  
1B. Soil pH and calcium  
1C. Soil pH and organic carbon  
1D. Soil pH and potassium  
1E. Soil EC and phosphorus  
1F. Soil EC and calcium
Table 1: Physico-chemical properties of dalo growing areas of Rewa district.

| Soil parameter                  | Minimum | Maximum | Mean   | SE of mean |
|---------------------------------|---------|---------|--------|------------|
| pH (1:5)                        | 4.3     | 7.1     | 5.6    | 0.072      |
| EC (dSm\(^{-1}\))               | 0.07    | 0.31    | 0.17   | 0.013      |
| Total Carbon (%)                | 0.30    | 5.5     | 2.1    | 0.141      |
| Texture *                       | scl     | cl      | -      | -          |

Available plant nutrients

| Soil parameter                  | Minimum | Maximum | Mean   | SE of mean |
|---------------------------------|---------|---------|--------|------------|
| Total Nitrogen (%)              | 0.07    | 0.43    | 0.19   | 0.01       |
| Available Phosphorus (mg kg\(^{-1}\)) | 1.0     | 44.0    | 12.9   | 1.515      |
| Available Potassium (mg kg\(^{-1}\)) | 27.37   | 762.45  | 169.56 | 20.81      |
| Calcium (meq/100g)              | 2.62    | 801.5   | 75.91  | 18.24      |
| Magnesium (meq/100g)            | 111.7   | 923.1   | 606.7  | 234.80     |

*Textural class as per Soil Taxonomy (1975)scl: sandy clay loam ; cl: clay loam

Table 2: Correlation coefficient values of important soil parameters.

| Soil parameter | Correlation coefficient (r) | p-Value |
|----------------|----------------------------|---------|
| pH vs EC       | -0.190                     | 0.156   |
| pH vs OC       | -0.087                     | 0.519   |
| pH vs P        | 0.298                      | 0.024   |
| pH vs K        | 0.180                      | 0.180   |
| EC vs OC       | 0.411                      | 0.001   |
| EC vs P        | 0.249                      | 0.062   |
| EC vs K        | 0.217                      | 0.104   |
| EC vs Ca       | 0.111                      | 0.411   |
| OC vs N        | 0.860                      | 0.000   |
| OC vs P        | 0.162                      | 0.229   |
| N vs P         | 0.288                      | 0.029   |
| N vs K         | 0.062                      | 0.646   |
| P vs K         | 0.379                      | 0.004   |

The organic carbon values of the soils varied from 0.3 to 5.5 % with the mean value of 2.1 % ( Muhr et. al., 1965). A positive correlation was obtained between organic carbon and total nitrogen content (r = 0.86) (Table 2). Since most soil nitrogen is available in organic form such as decomposed plant parts, litter, crop and animal residues that released gradually for growth of plants by mineralization process and therefore this relationship was observed. However, OC content showed a decreasing trend with increase in soil pH (Fig. 1C). Similar results were reported by Verma et. al. (1980).

The total nitrogen values of the soils varied from 0.07-0.43 % with a mean value 0.19% (Table 1) categorized as medium in total nitrogen status (Bruce and Rayment, 1982).

The available phosphorus in the soils is low varied from 27.37-762.45 mg kg\(^{-1}\) with a mean value 12.9 mg kg\(^{-1}\) (Table 1) as low exchangeable potassium (Nicholas, 2004). Considering the suggested critical range (108-280 kg ha\(^{-1}\)), 48% samples were found deficient and 19% were marginal.

Data on extractable calcium indicated that calcium varied from 2.62-801.50 meq/100g with mean value of 75.91 meq/100g and more than 80 per cent samples were high in calcium. Data on extractable magnesium indicated that all samples have higher values than the critical range and found sufficient.

CONCLUSION

It was concluded that soils of the dalo growing areas of Rewa district are acidic in nature which falls under moderately acidic ratings of pH. These soils are having low electrical conductivity and are characterized as non-saline soils. Soils are having high organic carbon values with medium level of total nitrogen status. Available phosphorus and exchangeable potassium are low. However, the studied soils contain adequate amounts of calcium and magnesium. Application of P and K through chemical fertilizers is recommended. In addition, use of organic manures will be highly beneficial not only to enhance the fertility status of soils but also to improve the physical conditions of the soils.

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