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Research Article

NUTRIENT STATUS AND THEIR RELATIONSHIP WITH SOIL PROPERTIES OF CASSAVA (*Manihot esculenta* Crantz.) GROWING AREAS OF *REWA* DISTRICT IN FIJI

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Abstract- Present study was conducted during 2015-2016 in *Rewa* district of Fiji. Cassava (*Manihot esculenta* Crantz.) growing farmers' fields were selected to know nutrient status and their relationship with soil properties. From selected farmers' fields fifty-seven representative soil samples were collected to determine soil properties and nutrient status. The soils of the study area were found acidic in nature with normal electrical conductivity (EC). Organic carbon (OC) of the soils varied from 0.8 to 4.3 %. Total nitrogen (TN) of the soils varied from 0.07-0.53 %. Available phosphorus and potassium in soils varied from 0.75-79.5kg $ha^{-1}$and 20.52-586.5Kg ha^{-1}respectively. Study revealed that soils of *Rewa* were acidic in nature and with low electrical conductivity and organic carbon. Most of the soils indicated low to medium level of primary major nutrients. The total nitrogen, phosphorus and potassium content were low in all soils. However, the studied soils contain high amounts of calcium and magnesium.

Keywords- Soil properties, Cassava, Available nutrients, Rewa.

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Introduction

Sustained and consistent yields are governed by nutrient supplying capacity of the soil to the growing plants. Soil testing is a vital tool to assess nutrient supplying capacity of soil. Deficiency of nutrients has become major constraint to productivity, stability and sustainability of soils [1]. 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 [2].
Soil properties cannot be measured directly, but soil properties that are sensitive to changes in the management can be used as indicators [3]. 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 favorable 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 balance of plant available nutrients in the soil [4].

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

Materials and Methods

Location

The study was conducted during 2015-2016 in *Rewa* district of Fiji. The geographical reference of the study area is 18° 05' 00" S, 178° 20' 00" E and elevation ranges from 6 to 23 m above mean sea level. The climate is tropical temperature is moderate (21°C- 26°C) with annual average rainfall of about 3,000 mm [5]. 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}) [6].

Soil sampling and analysis

57 cassava growing farmer 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. Standard analytical methods [7&8] 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).

Statistical analysis

The relationship between different soil physicochemical properties and available nutrients content were determined using descriptive statistics and SPSS – 17.0, 2009. Where "r" is correlation coefficient,

$$r = \frac{n\sum xy-(\sum x)(\sum y)}{\sqrt{n(\sum x^2)-(\sum x)^2}\sqrt{n(\sum y^2)-(\sum y)^2}}$$

where n is the number of pairs of data (x.y). Simple correlation coefficient (r).

between different soils properties and availability of nutrients were determined.

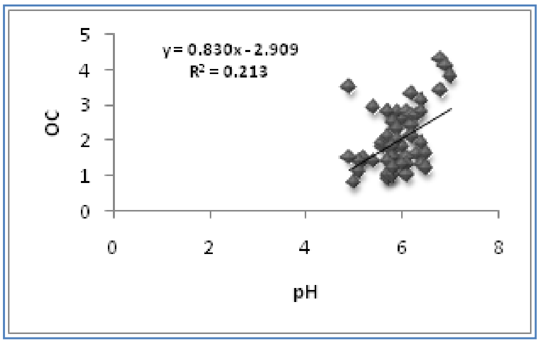
Results and Discussion

The soil pH varied among sites from 4.9 to 7.0. The soils of the study area are acidic in nature with the mean pH of 5.9 [Table-1] which falls under moderately acidic rating of soil pH (5.6-6.0) [8]. Relative low values of soil pH are due to acidic parent material of these soils [10]. Regression line between pH and K and pH and Ca indicated a positive trend of increase in their content with increase in pH [Fig-1C] and [Fig-1D].

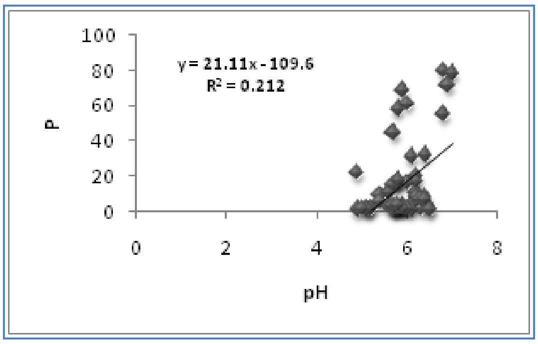
Table-1 *Physico-chemical properties of cassava growing areas of Rewa district*

Soil parameter	Minimum	Maximum	Mean	Standard Deviation
Physico-chemical properties				
pH (1:5)	4.9	7.0	5.9	0.47
EC (dSm^{-1})	0.02	0.70	0.10	0.09
Organic Carbon (%)	0.8	4.3	2.1	0.85
Texture	**scl*	***cl*	-	-
Available plant nutrients				
Total Nitrogen (%)	0.07	0.53	0.17	0.09
Available Phosphorus (Kg ha^{-1})	0.75	79.50	15.15	21.72
Available Potassium (Kg ha^{-1})	20.5	586.5	130.9	113.17
Calcium (ppm)	1.98	28.34	11.40	7.04
Magnesium (ppm)	1.41	9.13	4.37	2.00

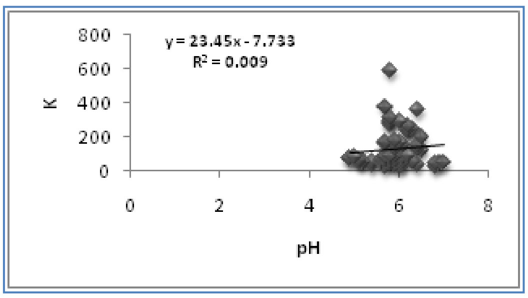
scl: sandy clay loam ;cl: clay loam*



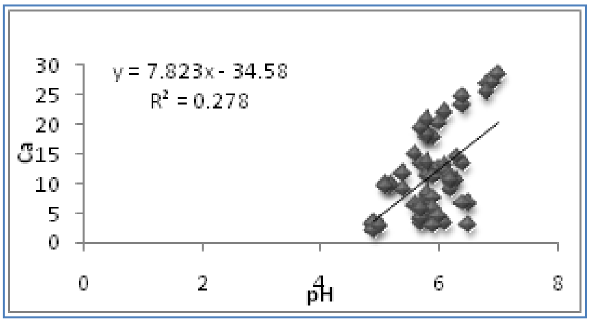
1A-Soil pH and organic carbon (OC)



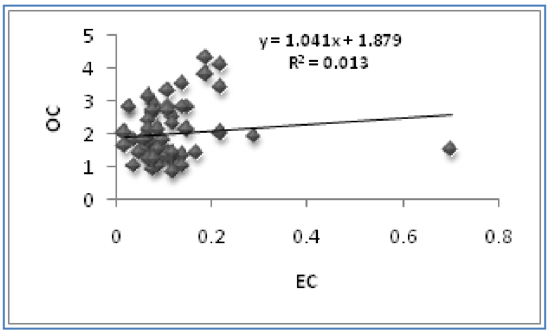
1B-Soil pH and phosphorus (P)



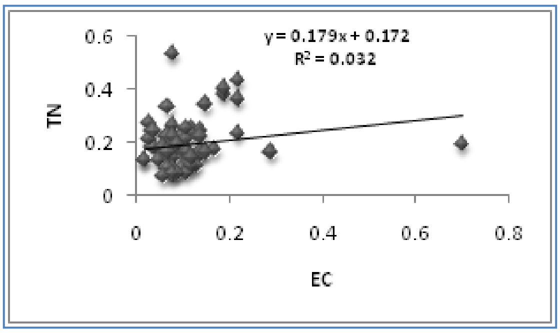
1C- Soil pH and potassium (K)



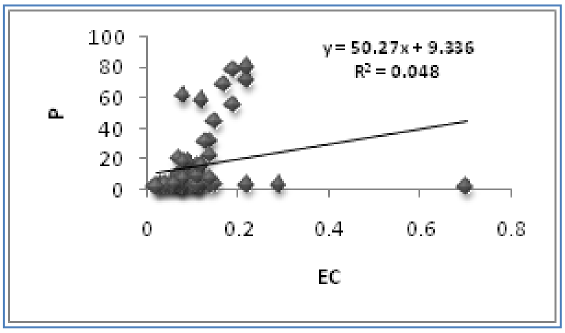
1D-Soil pH and calcium (Ca)



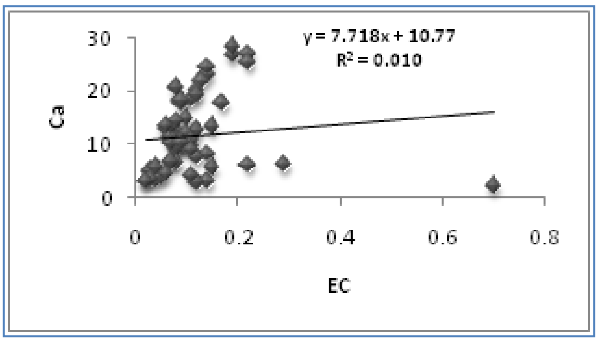
1E-Soil EC and organic carbon (OC)



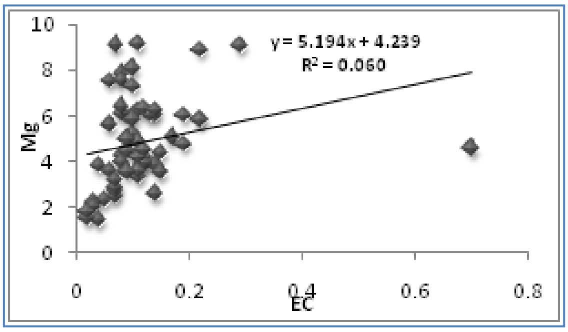
1F-Soil EC and total nitrogen (TN)



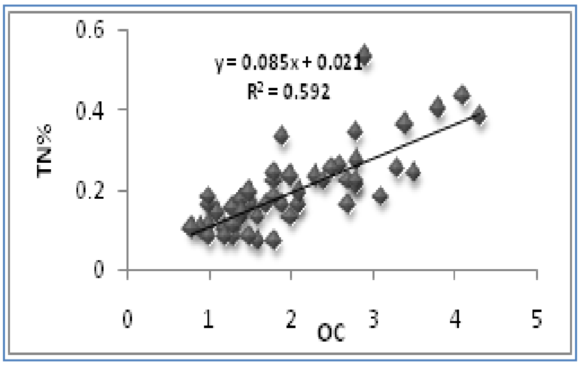
1G-Soil EC and phosphorus (P)



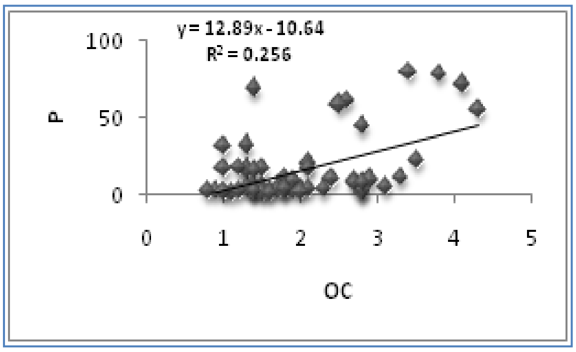
1H-Soil EC and calcium (Ca)



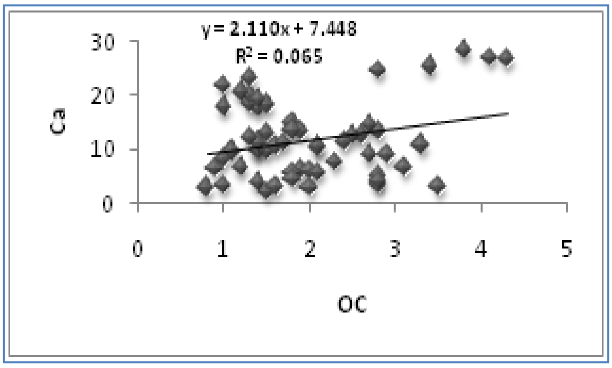
1I-Soil EC and magnesium (Mg)



1J-OC and total nitrogen (TN)



1K-OC and phosphorus (P)



1L-OC and calcium (Ca)

Fig-1A-1L Regression analysis among important soil properties

Electrical conductivity of the soils varied from 0.02-0.70 $dSm^{-1}$with a mean value 0.10 dSm^{-1}[Table-1]. On the basis of limits suggested for judging soil salt problems [11], all samples were found normal (EC <1.0 dSm^{-1}). This normal electrical conductivity may be ascribed as lower base concentration and leaching of salts from the soils. EC values showed a positive correlation with P, Ca and Mg [Table 2].The linear regression showed a positive trend (R^2 = 0.04) of EC with available phosphorus [Fig-1F].

Table-2 *Correlation coefficient values of important soil parameters.*

Soil parameter	Correlation coefficient (r)	Coefficient of determination (R^2)
pH-EC	-0.168	0.020
pH-OC	0.462	0.213
pH-P	0.461	0.213
pH-K	0.098	0.009
pH-Ca	0.520	0.278
pH-Mg	-0.086	0.007
EC-OC	0.116	0.014
EC-TN	0.180	0.033
EC-P	0.220	0.0484
EC-K	-0.195	0.038
EC-Ca	0.104	0.011
EC-Mg	0.246	0.060
OC-TN	0.769	0.592
OC-P	0.506	0.256
OC-Ca	0.255	0.065
OC-Mg	0.132	0.017
TN-P	0.513	0.263
TN-K	0.076	0.006

Where pH: pH of the soil ; EC: Electrical conductivity; OC=Organic matter
TN: Total nitrogen; P:Phosphorus; K:Potassium; Ca: Calcium; Mg: Magnesium

Organic carbon values of the soils varied from 0.8 to 4.3 % with the mean value of 2.1%. 96 percent soil samples recorded organic carbon below the range (4-10%) and found deficient [Table-1]. A positive correlation was obtained between organic carbon and total nitrogen content (r = 0.59) [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. OC content showed a positive trend with increase in soil pH and EC [Fig-1A] and [Fig-1E]. Similar results were reported by [12].

Total nitrogen of soils varied from 0.07-0.53 %with a mean value 0.17% [Table-1]. These soils are of medium level of total nitrogen status. Total nitrogen content of 84 percent soils ranged from low to medium.

C:N ratio of the soils varied from 8-13 with a mean value of 11. This ratio is normal (10-12) for arable soil with a good rate of organic matter decomposition.66 percent of samples recorded in the medium range (10-15) of C:N ratio and 33 percent were reported in low (8-10) range of C:N ratio.

Available phosphorus in soils varied from 0.75-79.5kg $ha^{-1}$with a mean value 15.15Kgha^{-1} [Table-1]. The range is considerably large which might be due to variation in soil properties *viz.* pH, organic matter content, texture, land use, various agronomic and management practices.67% soils were found low and 16% soils were found medium in available phosphorus. This might be due to less Ca^{2+} and more Al^{3+} and Fe^{3+} in solution that results in precipitation of phosphate ions as insoluble aluminum and iron phosphates. Again, these phosphorus compounds have very low solubility, resulting in a low concentration of phosphate ions in solution [13]. The availability of phosphorus showed a positive correlation with pH (r = 0.46), OC (r = 0.50) and CEC (r = 0.22) [Table-2]. This indicates that the presence of organic carbon increases the availability of phosphorus in soil. 50% of soil phosphorus found in organic form and decomposition of organic matter produces humus that works as chelating agent which forms complex with Al^{3+} and Fe^{3+} and protects the P fixation [14].

Available potassium in the soils varied from 20.5-586.5Kg ha^{-1} with a mean value 130.93Kg ha^{-1} [Table-1]. According to rating limits these soils are of low potassium level. Considering the rating limits for low (135 -335 Kg ha^{-1}) and (135 -335 Kg ha^{-1}) medium, 63% and 31% samples were found in low and medium range.

Exchangeable calcium in the soils varied from 1.98-28.34 ppm with a mean value 11.40 ppm. These soils are of high exchangeable calcium [14]. The values of exchangeable magnesium in the soils varied from 1.41-9.13 ppm with a mean value 4.37 ppm. These soils are of moderate exchangeable magnesium [15].

Conclusion

The study revealed that soils of Rewa are acidic in nature. These soils are having low values of electrical conductivity and organic carbon content. Most of the soils indicated low to medium level of primary major nutrients. The total nitrogen, phosphorus and potassium content were low in all samples. Carbon and nitrogen (C: N) ratio of the soils varied from 8-13 with a mean value of 11, normal for arable soils. However, the studied soils contain high amounts of calcium and magnesium. This study recommends that such type of soils can be better utilized by optimizing soil pH by adding ameliorants, applying adequate primary nutrients by correct application methods and planting improved cassava varieties that can grow well in the specific pH range.

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