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**THE SOIL CONDITIONS OF SIX EXPERIMENTAL SITES IN MACHANG'A,
EMBU, KIREGE, MURUGI, MUCWA AND MUKUUNI**

By

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KENYA SOIL SURVEY SITE EVALUATION REPORT No. P 128

FEBRUARY, 2007

INTRODUCTION

Following a request by Prof. Mugendi of Kenyatta University (KU), six soil profile descriptions were made in KU experimental sites at Machang'a in Mbeere District, Embu Research Station in Embu District and Kirege, Murugi, Mucwa and Mukuuni in Meru South District. The objective of the fieldwork was to demonstrate to two KU students on profile pit descriptions and to sample soils for survey and fertility analysis. The samples were analysed at KARI-Muguga. After soil analysis, the laboratory data (without a report) were forwarded to Kenya Soil Survey for report write-up. This report contains general soils information (around the sites), profile pits descriptions and laboratory data of all the six sites.

METHODS

The soil examination consisted of profile pits observations which were carried out according to FAO (1977) guidelines for soils descriptions. The soils in the area were examined for drainage, depth, colour, mottling, consistence, concretions, soil structure soil texture, pores, horizon boundaries, their widths and topographies among others. Besides the above, other general land attributes such as slopes, stoniness, rockiness, surface sealing and crusting, erosion features and micro relief, among others, were described. For each site, a representative soil profile was described and soils sampled per horizon for survey analysis. A composite fertility soil sample (0 – 20 cm depth) was collected from the vicinity of each profile pit. All soil samples were analysed at KARI-Muguga Soils Laboratories for physical and chemical aspects. The soil classification used is according to FAO (1997) Soil Map of the World. The colour of the soil indicated is in moist state and is according to the Munsell Soil Colour Charts (1975).

SOIL FERTILITY EVALUATION

The current soil fertility status of each experimental site was evaluated mainly according to Landon (1984) as there was no laboratory data report from KARI, Muguga. The soil fertility indicators considered in this evaluation were soil reaction (pH – H₂O), exchangeable acidity (Hp), CEC- soil, %C and macro nutrients N, P, K, Ca, and Mg. The results of soil fertility evaluation are presented under descriptions of each experimental site.

Key to depth classes

- A = 0 -2%, flat to very gently undulating
- B = 2 -5%, gently undulating
- C = 5-8%, undulating
- D = 8-16%, rolling
- E = 16- 30 %, hilly
- F = > 30% mountainous

1 THE SOIL CONDITIONS AROUND MACHANG'A EXPERIMENTAL SITE

| | | |
|----------------------|---|---|
| Parental material | : | Quartz rich Basement System Rocks; predominantly granitoid gneisses |
| Physiography | : | Uplands |
| Macro relief | : | Nearly level to rolling, slope classes: A, AB, B, BC, C, D. |
| Vegetation/ land use | : | Wooded bushland, grazing with scattered cultivation. |
| Soils, general | : | Well drained (in places imperfectly drained), deep, yellowish red to reddish brown, loose, sand to loamy sand |
| Classification | : | Ferralic Arenosols |

A detailed description of the profile with analytical data of Machang'a experimental site is shown below:

Soil profile description for Machang'a experimental site

| | | |
|----------------------|---|---|
| Soil classification | : | Ferralic Arenosols |
| Observation | : | 0° 47' 26.8"S, 37° 39' 45.3"E; 1022m.; Machanga; 6/10/2006 |
| Parent material | : | Granitoid gneisses |
| Physiography | : | Uplands |
| Relief and slope | : | Flat to gently undulating, 0 – 3 % (slope class AB) and regular |
| Vegetation/Land use | : | Open bushed grassland / Experimental site. |
| Erosion | : | Nil; site well conserved |
| Effective soil depth | : | Deep to very deep (>150 cm) |
| Drainage | : | Well drained |

Ap 0-10 cm : Dark yellowish brown (10YR 4/4 dry and 10YR 3/4 moist); Loamy sand; moderate, medium to coarse sub-angular blocky structure; slightly hard when dry, very friable when moist, non sticky and non plastic when wet; many micro pores; few meso pores and very few macro pores; few animal channels; throughout the profile; few very fine and fine roots; pH (H₂O) 4.7; abrupt and smooth boundary to:

BA 10-38 cm : Yellowish red (7.5YR4/6 dry 5YR4/6 moist); sandy loam, moderate, fine and medium sub-angular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many micro, common meso and macro pores; few animal channels throughout the profile; very few very fine and fine roots; pH (H₂O) 4.2; gradual and smooth boundary to:

Bu1 38-75 cm : Yellowish red (5YR5/8 dry, 5YR5/8 moist); sandy loam to sandy clay; moderate very fine to medium sub-angular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many micro, common meso and macro pores; few animal channels throughout the profile; few fine roots; pH (H₂O) 4.0; gradual and smooth boundary to channels; gradual and smooth boundary to:

Bu2 cm 75-102 cm: Yellowish red (5YR 5/8 dry, YR 5/8 moist); sandy loam; moderate very fine to medium sub-angular blocky; slightly hard when dry, very friable when moist; slightly sticky and slightly plastic when wet; many micro, common meso and

macro pores; few fine and medium roots; pH (H₂O) 4.3; clear and smooth boundary to:

BC 102-150+ cm : Pisoferric material (murrum), i.e. iron and manganese concretions with >70 % gravels, 10-15mm in diameter

Laboratory data of soil profile for Machang'a experimental site

| | | | | | |
|--|--------|------------|--------|-----------|------|
| Laboratory No. | 317/06 | 318/06 | 319/06 | 320/06 | |
| Horizon | Ap | BA | BU1 | BU2 | |
| Depth (cm) | 0-10 | 10-38 | 38-75 | 75-102 | |
| pH (H ₂ O) 1:2.5 suspension | 4.71 | 4.16 | 4.02 | 4.33 | |
| EC (mmhos/cm) | 34.90 | 67.30 | 69.50 | 37.20 | |
| % C | 0.62 | 0.32 | 0.32 | 0.32 | |
| N % | 0.05 | 0.04 | 0.05 | 0.04 | |
| C/N | 12.40 | 8.00 | 6.40 | 8.00 | |
| Cat.Ech.Cap (me/100g) | 5.25 | 6.75 | 8.00 | 10.00 | |
| Ca (me/100g) | 0.96 | 0.78 | 0.26 | 0.09 | |
| Mg | 0.22 | 0.22 | 0.49 | 0.54 | |
| K | 0.35 | 0.50 | 0.30 | 0.15 | |
| Na | 0.81 | 0.90 | 0.45 | 0.45 | |
| Sum of cations | 2.33 | 2.40 | 1.50 | 1.22 | |
| Base saturation % | 44.45 | 35.54 | 18.78 | 12.24 | |
| Texture – hydrometer | | | | | |
| Sand % | 78 | 71 | 68 | 67 | |
| Silt % | 15 | 14 | 16 | 11 | |
| Clay % | 7 | 15 | 17 | 22 | |
| Texture class | LS | SL | SL | SCL | |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 4.99 | Na me/100g | 0.81 | Mn me/100 | 0.01 |
| Exc. Acidity | 0.18 | K me/100g | 0.45 | P (ppm) | |
| C % | 0.32 | Ca me/100g | 1.13 | P - Osen | 6.28 |
| N % | 0.04 | Mg me/100g | 0.22 | | |

Soil fertility evaluation for Machang'a experimental site

| Soil fertility indicators | Values | Remarks |
|---------------------------------------|--------|--|
| Soil reaction - pH (H ₂ O) | 4.99 | Very strongly acid |
| Exchangeable acidity (Hp) | 0.18 | Not excess |
| CEC-soil (me/100) | 5.25 | Low |
| % C | 0.32 | Very low. apply >10 tons/ha of manure or compost |
| % N | 0.04 | Apply N fertilizers |
| P (ppm) | 6.28 | Deficient; apply phosphate fertilizers. |
| K (me/100g) | 0.45 | High values |
| Ca (me/100g) | 1.13 | Deficient |
| Mg (me/100g) | 0.22 | Deficient |

2 THE SOIL CONDITIONS AROUND EMBU EXPERIMENTAL SITE

| | | |
|---------------------|---|---|
| Parental material | : | Mt Kenya phonolites (Kenyete) |
| Physiography | : | Uplands |
| Observation | : | 0° 30'53.5"S, 37° 27' 28'.6 E. 1380m.; Embu Research Station, Block B |
| Macro-relief | : | Flat to undulating, 0-8 % (slope class A,B, C) |
| Drainage | : | Well drained |
| Soils general | : | These soils are extremely deep, dark red to reddish brown, friable clay. They have an ABC sequence of horizons with gradual to diffused and smooth boundaries. Clay cutans are present in the B horizon. These soils are well structured. |
| Diagnostic criteria | : | Strongly humic, Umbric A horizon and an argillic B horizon with reddish colours and nitic properties |
| Classification | : | Humic Nitisols |

A detailed description of a representative profile with analytical data of Embu experimental site is shown below:

Soil profile description for Embu experimental site

| | | |
|----------------------|---|--|
| Soil classification | : | Humic Nitisols |
| Observation | : | 0° 30'53.5"S, 37° 27' 28'.6 E. 1380m.; Embu Research Station, block B; 6/10/2006 |
| Geology | : | Phonolites |
| Physiography | : | Volcanic footridges |
| Relief and slope | : | Undulating, 6-8%, linear |
| Land use | : | Research experiments and grazing |
| Effective soil depth | : | Very deep >150cm |
| Drainage | : | Well drained |

A 0-16 cm Very dusky red (5YR 3/3 dry and 2.5YR 2.5/3 moist); clay; many, moderate, very fine and fine crumbs and few weak, fine sub-angular blocky structures; soft to slightly hard when dry, friable when moist, sticky and plastic when wet; few meso pores, many macro pores and many micro pores, many, moderate thick clay cutans; a lot of animal activity throughout the profile, abundant very fine roots and few fine roots; pH (H₂O) 5.0; clear and smooth boundary to:

ABt 16-43 cm Reddish black (5YR3/3 dry, 10R 2.5/1 moist); clay; moderate, fine to coarse sub-angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many moderately thick clay cutans; many micro pores, common meso pores and macro pores; a lot of animal activities throughout the profile; abundant very fine roots and few fine roots; pH (H₂O) 5.1.; clear and smooth boundary to:

Bt₁ 43-80 cm Very dusky red (2.5YR3/4 dry, 10R 2.5/4 moist); clay; moderate, fine to coarse angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many thick clay cutans; many micro pores, common meso

pores and macro pores; few very fine and very few fine and medium roots; pH (H₂O) 5.3; Diffused and smooth transition to:

Bt₂ 80-170+ cm Dusky red (2.5YR3/6 dry, 10R3/4 moist); clay; strong clay cutans; many micro pores, common mesopores and macro pores; a lot of infillings of materials from A horizons; very few very fine to coarse roots; pH (H₂O) 5.2

Laboratory data of soil profile for Embu experimental site

| | | | | | |
|--|--------|-------------|-----------------|-----------------|------|
| Laboratory No. | 312/06 | 313/05 | 314/06 | 315/06 | |
| Horizon | Ap | Abt | Bt ₁ | Bt ₂ | |
| Depth (cm) | 0-16 | 16-43 | 43-80 | 80-170+ | |
| pH (H ₂ O) 1:2.5 suspension | 5.02 | 5.13 | 5.27 | 5.23 | |
| EC (mmhos/cm) | 93.2 | 55.8 | 21.3 | 19.95 | |
| % C | 2.72 | 2.12 | 1.52 | 1.10 | |
| N % | 0.26 | 0.20 | 0.13 | 0.09 | |
| C/N | 10.46 | 10.60 | 11.69 | 12.22 | |
| Cat.Ech.Cap (me/100g) | 19.25 | 39.75 | 21.75 | 17.75 | |
| Ca (me/100g) | 5.49 | 5.84 | 4.09 | 2.87 | |
| Mg | 1.49 | 1.73 | 1.60 | 1.66 | |
| K | 0.90 | 0.50 | 0.10 | 0.05 | |
| Na | 1.08 | 1.08 | 0.45 | 0.90 | |
| Sum of cations | 8.95 | 9.14 | 6.25 | 5.48 | |
| Base saturation % | 46.51 | 23.00 | 28.72 | 30.89 | |
| Texture – hydrometer | | | | | |
| Sand % | 25 | 24 | 21 | 20 | |
| Silt % | 2 | 2 | 2 | 2 | |
| Clay % | 73 | 74 | 77 | 78 | |
| Texture class | C | C | C | C | |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 5.20 | Na me/100g | 1.26 | Mn me/100g | 0.12 |
| Exc. Acidity (me/100g) | 0.08 | K mew/100g | 0.90 | P (ppm) | |
| C % | 2.72 | Ca me/100g | 6.01 | P - Olsen | 2.54 |
| N % | 0.19 | Mg me /100g | 1.52 | | |

Soil fertility evaluation for Embu experimental site

| Soil fertility indicators | Values | Remarks |
|---------------------------------------|--------|--|
| Soil reaction - pH (H ₂ O) | 5.2 | Strong acid |
| Exchangeable acidity (Hp) | 0.08 | Not excess |
| CEC-soil (me/100) | 19.25 | Medium |
| % C | 2.72 | Moderate. Apply 5tons/ha of manure or compost |
| % N | 0.19 | Low. Apply N fertilizers |
| P (ppm) | 2.54 | Acutely deficient; apply phosphate fertilizers |
| K (me/100g) | 0.90 | High value |
| Ca (me/100g) | 6.01 | Not deficient |
| Mg (me/100g) | 1.5 | Not deficient |

3 THE SOIL CONDITIONS AROUND KIREGE EXPERIMENTAL SITE

| | |
|-------------------------|---|
| Physiography | : Volcanic Footridges |
| Parental material | : Lahar complex (volcanic ash and tuff) |
| Macro relief | : Rolling to hilly (slope classes C, D and F). |
| Vegetation and land use | : Cultivation: Coffee, Grevillea, Calliandra |
| Soils, general | : Well drained, very deep, dark red to dark reddish brown, friable, clay with 20-30 cm humic topsoil, shiny ped faces, ABC horizon sequence with gradual to diffused and smooth boundaries. |
| Soil classification | : Rhodic Nitisols |

A detailed description of a representative profile with analytical data of Kirege experimental site is shown below:

Soil profile description for Kirege experimental site

| | |
|----------------------|--|
| Soil classification | : Rhodic Nitisol |
| Observation | : 0° 20' 07.1"S, 37° 36' 50.8"E; 1473m.; 6/10/2006 |
| Geology | : Lahar complex (volcanic ash and tuff) |
| Physiography | : Volcanic footridges |
| Relief and slope | : Undulating, 5-7 %, convex |
| Land use | : Cultivation of Coffee and Calliandra |
| Erosion | : Nil; with well constructed terraces |
| Effective soil depth | : Very deep (>150cm) |
| Drainage | : Well drained |

Ap 0-27 cm Dark reddish brown (2.5YR2.5/4 moist); clay; moderate very fine to medium crumbs and few sub-angular blocky structure, friable when moist, sticky and plastic when wet; many micro and meso pores and common macro pores; moderate animal activity; common very fine and fine, few medium and very few coarse root; pH (H₂O) 4.7; clear and smooth transition to:

Bt₁ 27-58 cm Dark reddish brown (2.5YR3/4 moist); clay; moderate very fine to medium angular and sub-angular blocky structure friable when moist, sticky and plastic when wet; many micro and meso pores; many thick clay cutans; moderate animal activity; very few fine to medium and very few coarse roots; pH (H₂O) 5.4; gradual and smooth transition to:

Bt₂ 58-99 cm Dark red (2.5YR3/6 moist); clay; moderate very fine to medium angular and sub-angular blocky structure friable when moist, sticky and plastic when wet; many micro and meso pores; few patchy clay cutans; moderate animal activity; very few medium and coarse roots; pH (H₂O) 5.9; diffused and smooth transition to:

Bt₃ 99-150+ cm Dark red (2.5YR3/6 moist); clay; moderate very fine to medium angular and sub-angular blocky structure friable when moist, sticky and plastic when wet; many micro and meso pores; few broken clay cutans; moderate animal activity; very few medium and coarse roots; pH (H₂O) 5.9

Laboratory data of soil profile for Kirege experimental site

| | | | | | |
|--|--------|---------------|--------|---------------|------|
| Laboratory No. | 333/06 | 334/06 | 335/06 | 336/06 | |
| Horizon | Ap | Bt1 | Bt2 | Bt3 | |
| Depth (cm) | 0-27 | 27-58 | 58-99 | 99-150+ | |
| pH (H ₂ O) 1:2.5 suspension | 4.67 | 5.43 | 5.85 | 5.9 | |
| EC (mmhos/cm) | 40.00 | 23.20 | 18.85 | 17.26 | |
| % C | 2.24 | 1.46 | 0.54 | 0.54 | |
| N % | 0.17 | 0.11 | 0.06 | 0.05 | |
| C/N | 13.18 | 13.27 | 8.90 | 10.7 | |
| Cat.Ech.Cap (me/100g) | 26.25 | 25.75 | 28.25 | 30.75 | |
| Ca (me/100g) | 5.49 | 4.27 | 2.87 | 4.09 | |
| Mg | 0.53 | 0.90 | 1.26 | 2.08 | |
| K | 0.45 | 0.45 | 1.00 | 0.25 | |
| Na | 1.53 | 1.17 | 1.17 | 1.17 | |
| Sum of cations | 7.99 | 6.79 | 6.30 | 7.60 | |
| Base saturation % | 30.44 | 26.37 | 22.30 | 24.70 | |
| Texture – hydrometer | | | | | |
| Sand % | 20 | 12 | 12 | 8 | |
| Silt % | 2 | 2 | 2 | 2 | |
| Clay % | 78 | 86 | 86 | 90 | |
| Texture class | C | C | C | C | |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 4.78 | Na me/100g | 1.35 | Mn me/100g | 0.15 |
| Exc. Acidity (me/100g) | 0.56 | K me/100g | 0.55 | P (ppm) | |
| C % | 2.90 | Ca me/100g | 9.67 | P - Olsen | 4.34 |
| N % | 0.18 | Mg me/100g | 0.60 | | |

Soil fertility evaluation for Kirege experimental site

| Soil fertility indicators | Values | Remarks |
|---------------------------------------|--------|--|
| Soil reaction - pH (H ₂ O) | 4.78 | Very strongly acid |
| Exchangeable acidity (Hp) | 0.56 | Not excess |
| CEC-soil (me/100) | 26.25 | High |
| % C | 2.9 | Moderate; apply 5 tons/ha of manure or compost |
| % N | 0.18 | Low; apply N fertilizers |
| P (ppm) | 4.34 | Deficient |
| K (me/100g) | 0.55 | High value |
| Ca (me/100g) | 9.67 | Not deficient |
| Mg (me/100g) | 0.60 | Not deficient |

4 THE SOIL CONDITIONS AROUND MURUGI EXPERIMENTAL SITE

| | |
|----------------------|--|
| Physiography | : Volcanic footridges |
| Parental material | : Consolidated pyroclastic rocks |
| Macro relief | : Undulating to rolling (slope classes B, C and D) |
| Vegetation/ land use | : Cultivation; Coffee, Bananas, Maize, Nnappier grass, dairy zero grazing |
| Soils, general | : Well drained, very deep, red to dark reddish brown, friable clay with humic topsoil of varying depth, shiny pen faces and ABC horizon sequence with gradual to diffused and smooth boundaries. |
| Soil classification | : Humic Nitisols |

A detailed description of a representative profile with analytical data of Murugi experimental site is shown below.

Soil profile description for Murugi experimental site

| | |
|----------------------|--|
| Soil classification | : Humic Nitisols |
| Observation date | : 0° 14' 49.35''S, 37° 38' 43.2''E; 1357m.;7/10/2006 (Murugi (bad site) Chogoria |
| Parent material | : Mt Kenya phonolites |
| Physiography | : Volcanic footridges |
| Relief and slope | : Gently Undulating, 4.5 %, regular |
| Vegetation/Land use | : Cultivation of coffee, maize and nappier grass |
| Erosion | : Nil, with well constructed terraces |
| Effective soil depth | : Very deep >150 cm |
| Drainage | : Well drained |

Ap 0-10 cm Dusky red (2.5YR4/6 dry, 2.5YR3/2 moist); clay; moderate, very fine to medium sub-angular blocky and crumbs structure; soft to slightly hard when dry, friable when moist, sticky and plastic when wet; many micro and meso pores and common macro pores; common animal activity; many very fine and and few medium roots; pH (H₂O) 4.2; clear and smooth boundary to:-

Bu 10-29 cm Dusky red (2.5YR4/4 dry, 2.5YR3/2 moist); clay; moderate, very fine to medium angular and sub-angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common , broken to continuous clay cutans; many micro pores, few meso pores, common animal activity; few very fine and fine roots; pH (H₂O) 4.4 ; gradual and smooth boundary to:-

Bt₁ 29-60 cm Dusky red (2.5YR4/4 dry, 2.5YR3/2 moist); clay; moderate, very fine to medium angular and sub-angular blocky structure; slightly hard to hard when dry, friable when moist, sticky and plastic when wet; common , broken to continuous clay cutans; very few micro pores, few meso pores, few very fine and fine roots; pH (H₂O) 4.4; gradual and smooth boundary to:-

Bt₂ 60-101 cm Dark reddish brown (2.5YR4/4 dry, 2.5YR2.5/4 moist) clay; moderate, very fine to medium angular and sub-angular blocky structure; slightly hard to hard when

dry, friable when moist, sticky and plastic when wet; common, broken to continuous clay cutans; many micro and very few macro pores; common animal activity, very few fine and fine roots; pH (H₂O) 4.7; diffused and smooth boundary to:-

Bt₃ 101-150+ cm Like Bt₂ except it has strong structure and many continuous cutans

Laboratory data of soil profile for Murugi experimental site

| | | | | | |
|--|--------|------------|--------|------------|---------|
| Laboratory No. | 322/06 | 323/06 | 324/06 | 325/06 | 326/06 |
| Horizon | Ap | Bu | Bt1 | Bt2 | Bt3 |
| Depth (cm) | 0-10 | 10-29 | 29-60 | 60-101 | 101-150 |
| pH (H ₂ O) 1:2.5 suspension | 4.21 | 4.35 | 4.47 | 4.72 | 4.91 |
| EC (mmhos/cm) | 42.60 | 28.20 | 61.50 | 65.40 | 19.30 |
| % C | 1.52 | 1.52 | 1.22 | 0.92 | 0.92 |
| N % | 0.14 | 0.18 | 0.15 | 0.14 | 0.09 |
| C/N | 10.86 | 8.44 | 8.13 | 6.57 | 10.22 |
| Cat.Ech.Cap (me/100g) | 20.75 | 21.25 | 25.75 | 20.00 | 30.75 |
| Ca (me/100g) | 0.96 | 1.65 | 3.75 | 3.22 | 3.22 |
| Mg | 0.26 | 0.42 | 0.72 | 0.90 | 0.76 |
| K | 0.30 | 0.15 | 0.10 | 0.10 | 0.10 |
| Na | 0.99 | 0.72 | 0.72 | 0.63 | 0.63 |
| Sum of cations | 2.51 | 2.95 | 5.11 | 4.86 | 4.71 |
| Base saturation % | 12.09 | 13.87 | 19.85 | 24.28 | 15.31 |
| Texture – hydrometer | | | | | |
| Sand % | 68 | 20 | 36 | 30 | 22 |
| Silt % | 2 | 2 | 2 | 2 | 2 |
| Clay % | 30 | 78 | 62 | 68 | 76 |
| Texture class | C | C | C | C | C |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 4.38 | Na me/100g | 1.71 | Mn me/100g | 0.36 |
| Exc. Acidity | 1.78 | K me/100g | 0.25 | P (ppm) | |
| C % | 1.52 | Ca me/100g | 0.96 | P – Olsen | 1.80 |
| N % | 0.15 | Mg me/100g | 0.27 | | |

Soil fertility evaluation for Murugi experimental site

| Soil fertility indicators | Values | Remarks |
|---------------------------------------|---------------|---|
| Soil reaction - pH (H ₂ O) | 4.38 | Extremely acid |
| Exchangeable acidity (Hp) | 1.78 | Excess; an indication of Al toxicity; soil liming recommended |
| CEC-soil (me/100) | 20.75 | Medium |
| %C | 1.52 | Very low; apply >10tons/ha of manure or compost |
| %N | 0.15 | Low; apply N fertilizers |
| P (ppm) | 1.8 | Acutely deficient; apply phosphate fertilizers |
| K (me/100g) | 0.25 | Low values |
| Ca (me/100g) | 0.96 | Not deficient |
| Mg (me/100g) | 0.27 | Deficient |

5 THE SOIL CONDITIONS AROUND MUCWA EXPERIMENTAL SITE

These soils are like those of Murugi experimental site except that they are not strongly humic.

A detailed description of a representative profile with analytical data of Mucwa experimental Site is shown below.

Soil profile description for Mucwa experimental site

| | | |
|----------------------|---|---|
| Soil classification | : | Rhodic Nitisol |
| Observation date | : | 0° 18' 48.25"S, 37° 38' 38.8"E ;1373m.;7/10/2006 Chogoria |
| Parent material | : | Volcanic rocks (Mt Kenya phonolites) |
| Physiography | : | Uplands (Volcanic foot ridges) |
| Relief and slope | : | Flat to very gently undulating, 0-2 %, regular |
| Vegetation/Land use | : | cultivation of coffee, maize and bananas. nappier grass |
| Erosion | : | Nil |
| Effective soil depth | : | Very deep >150 cm |
| Drainage | : | Well drained |

Aph 0-30 cm Very dusky red (2.5YR2.5/2 moist) clay, moderate very fine and fine crumbs and weak very fine and fine sub-angular blocky; friable when moist, sticky and plastic when wet; many micro, meso and macro pores; a lot of animal activity; many very fine and fine, few medium and coarse roots; pH (H₂O) 4.9; clear and smooth boundary to:

ABt 30-68 cm Dusky red (2.5YR2.5/2 moist); clay; weak to moderate very fine to fine crumbs and sub-angular blocky structure; friable when moist, sticky and plastic when wet; few thin clay cutans; many micro, meso and common macro pores; a lot of animal activities; common very fine, fine and very few medium and coarse roots; pH (H₂O) 5.3; gradual and smooth boundary to:

Bt1 68-116 cm Dark reddish brown (2.5YR 3/4 moist) clay; moderate to strong angular and sub-angular blocky structures; friable when moist, sticky and plastic when wet; many continuous clay cutans; a lot of animal activities; common very fine and fine roots; pH (H₂O) 5.8; diffused and smooth boundary to:

Bt2 116-150+ cm Dark reddish brown (2.5YR 3/4 moist) clay; moderate to strong angular and sub-angular blocky structures; friable when moist, sticky and plastic when wet; many continuous clay cutans; many animal channels; very few very fine to coarse roots; pH (H₂O) 5.8

Laboratory data of soil profile for Mucwa experimental site

| | | | | | |
|--|--------|------------|-----------------|-----------------|------|
| Laboratory No. | 307/06 | 308/06 | 309/06 | 310/06 | |
| Horizon | Aph | ABt | Bt ₁ | Bt ₂ | |
| Depth (cm) | 0-30 | 30-68 | 68-116 | 116-150+ | |
| pH (H ₂ O) 1:2.5 suspension | 4.85 | 5.32 | 5.78 | 5.83 | |
| EC (mmhos/cm) | 50.00 | 49.6 | 16.45 | 18.45 | |
| % C | 2.12 | 1.82 | 0.62 | 0.62 | |
| N % | 0.21 | 0.15 | 0.11 | 0.09 | |
| C/N | 10.10 | 12.3 | 5.70 | 6.89 | |
| Cat.Ech.Cap (me/100g) | 22.0 | 24.5 | 22.25 | 24.25 | |
| Ca (me/100g) | 4.09 | 5.49 | 4.09 | 4.09 | |
| Mg | 0.61 | 0.87 | 0.99 | 0.99 | |
| K | 0.70 | 0.35 | 0.15 | 0.20 | |
| Na | 0.54 | 0.54 | 0.09 | 0.09 | |
| Sum of cations | 5.94 | 7.25 | 5.32 | 5.37 | |
| Base saturation % | 27.00 | 29.58 | 23.90 | 22.14 | |
| Texrure - hydrometer | | | | | |
| Sand % | 12 | 11 | 18 | 13 | |
| Silt % | 2 | 2 | 2 | 2 | |
| Clay % | 86 | 87 | 80 | 85 | |
| Texture class | C | C | C | C | |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 4.62 | Na me/100g | 1.17 | Mn me/100g | 0.52 |
| Exc. Acidity (me/100g) | 0.46 | K me/100g | 0.60 | P (ppm) | |
| C % | 2.00 | Ca me/100g | 3.57 | P – Olsen (ppm) | 0.9 |
| N % | .20 | Mg me/100g | 0.5 | | |

Soil fertility evaluation for Mucwa experimental site

| Soil fertility indicators | values | Remarks |
|---------------------------------------|--------|--|
| Soil reaction - pH (H ₂ O) | 4.62 | Very acid soil |
| Exchangeable acidity (Hp) | 0.46 | Not excess |
| CEC-soil (me/100) | 22.0 | Medium |
| %C | 2.00 | Low; apply 10 tons/ha of manure or compost |
| %N | 0.2 | Low; apply N fertilizers |
| P (ppm) | 0.9 | Acutely deficient; apply phosphate fertilizers |
| K (me/100g) | 0.6 | High values |
| Ca (me/100g) | 3.57 | Not deficient |
| Mg (me/100g) | 0.5 | Deficient |

6 THE SOIL CONDITIONS AROUND MUKUUNI EXPERIMENTAL SITE

These soils are like those of Mucwa experimental site

A detailed description of a representative profile with analytical data of Mukuuni experimental site is shown below:

Soil profile description for Mukuuni experimental site

| | | |
|----------------------|---|---|
| Soil classification | : | Rhodic Nitisol |
| Observation date | : | 0° 23' 30.3" S 37° 39' 33.7"E.; 1287m.; Mukuuni locations, Chuka; 7/10/2006 |
| Parent material | : | Volcanic rocks (Mt Kenya phonolites) |
| Physiography | : | Uplands (Volcanic foot ridges) |
| Relief and slope | : | Gently undulating, 3-5 %, linear |
| Vegetation/Land use | : | cultivation of coffee, maize and bananas. |
| Erosion | : | Nil |
| Effective soil depth | : | Very deep >150 cm |
| Drainage | : | Well drained |

Aph 0-20 cm Dark reddish brown (5YR2.5/2 moist); clay; moderate, very fine to medium crumbs and sub-angular blocky structures; soft to slightly hard when dry, friable when moist, sticky and plastic when wet; many micro, meso and macropores; many termites channels (termites, earthworms etc); many very fine and fine, common medium and coarse roots; pH (H₂O) 5.8; clear and smooth boundary to:

ABt 20-50 cm Dark reddish brown (5YR3/3 dry 5YR3/3 moist); clay; moderate, very fine to medium sub-angular blocky structures; slightly hard when dry, friable when moist, sticky and plastic when wet; small patchy clay cutans; many micro, common meso and macro pores; many animal channels (termites and earthworms) and Krotovinas 0.5-4 mm in diameter; many very fine and fine and few medium and coarse roots; pH (H₂O) 5.9; clear and smooth boundaries to:

Bt1 50-91 cm Dusky red (2.5YR4/4 dry, 2.5YR3/2 moist); clay, strong very fine to medium angular and sub-angular blocky structures; hard when dry, friable when moist, sticky and plastic when wet; many thick clay cutans; many micro, common meso and macro pores; many animal channels (termites and earthworms) and Krotovinas 0.5-4 mm in diameter; common very fine and fine, few medium and coarse roots; pH (H₂O) 5.9; gradual and smooth boundary to:

Bt2 91-150+ cm Dark reddish brown (2.5YR dry, 2.5YR5/4 moist) clay, strong very fine to medium angular and sub-angular blocky structures; hard when dry, friable when moist, sticky and plastic when wet; many thick clay cutans; many micro, common meso and macro pores; many animal channels (termites and earthworms) and Krotovinas 0.5- 4 cm in diameter; few very fine and fine and very few medium and coarse roots; pH (H₂O) 5.6

Laboratory data of soil profile for Mukuuni experimental site

| | | | | | |
|--|--------|------------|--------|------------|-------|
| Laboratory No. | 328/06 | 329/06 | 330/06 | 331/06 | |
| Horizon | Aph | Abt | Bt1 | Bt2 | |
| Depth (cm) | 0-20 | 20-50 | 50-91 | 91-150+ | |
| pH (H ₂ O) 1:2.5 suspension | 5.83 | 5.87 | 5.93 | 5.59 | |
| EC (mmhos/cm) | 95.10 | 42.20 | 42.40 | 77.20 | |
| % C | 2.12 | 1.34 | 0.68 | 0.92 | |
| N % | 0.24 | 0.15 | 0.09 | 0.09 | |
| C/N | 8.83 | 8.93 | 7.56 | 10.22 | |
| Cat.Ech.Cap (me/100g) | 26.00 | 20.50 | 23.25 | 37.00 | |
| Ca (me/100g) | 7.58 | 4.44 | 2.87 | 10.54 | |
| Mg | 1.07 | 1.08 | 1.31 | 1.32 | |
| K | 3.10 | 1.15 | 0.85 | 1.05 | |
| Na | 2.96 | 2.07 | 1.53 | 1.71 | |
| Sum of cations | 14.70 | 8.73 | | 14.61 | |
| Base saturation % | 56.55 | 42.60 | 28.20 | 39.49 | |
| Texture – hydrometer | | | | | |
| Sand % | 31 | 20 | 32 | 18 | |
| Silt % | 2 | 2 | 2 | 2 | |
| Clay % | 67 | 78 | 66 | 80 | |
| Texture class | C | C | C | C | |
| Available nutrients 0 – 20 cm | | | | | |
| pH (H ₂ O) 1:1 | 5.90 | Na me/100g | 2.51 | Mn me/100g | 0.44 |
| Exc, Acidity | 0.01 | K me/100g | 2.65 | P (ppm) | |
| C % | 2.72 | Ca me/100g | 4.44 | P – Osen | 20.95 |
| N % | 0.24 | Mg me/100g | 1.44 | | |

Soil fertility evaluation for Mukuuni experimental site

| Soil fertility indicators | Values | Remarks |
|---------------------------------------|--------|--|
| Soil reaction - pH (H ₂ O) | 5.9 | Moderately acid; inside preferred range for most crops |
| Exchangeable acidity (Hp) | 0.01 | Not excess |
| CEC-soil (me/100) | 26.00 | High |
| % C | 2.72 | Moderate; apply 5tons/ha of manure or compost |
| % N | 0.24 | Medium; apply nitrogen fertilizers |
| P (ppm) | 20.95 | Adequate |
| K (me/100g) | 2.65 | Medium values |
| Ca (me/100g) | 4.44 | Not deficient |
| Mg (me/100g) | 1.44 | Deficient |

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