are estimated. For micronutrients, a critical level is generally used to decide whether an application of that nutrient is needed. Table 2 provides a generalized idea of the relation of available nutrient status to expected yields (without external addition) for a soil of medium CEC (10-20 cmol/Kg). The values in the final column of the table indicate the approximate yield level that the existing soil fertility level could support.

In most cases, soil nutrient status is stated as low, medium or high. This needs to be done for each nutrient. For nutrients other than N, P, K, a single critical level is usually designated below which a soil is considered to be deficient in that nutrient, hence requiring its application. These figures represent general norms but can vary widely with the type of soil, crop and methods used. Therefore, only locally developed fertility limits should be used for specific soils and crops, even within a country or region.

On the basis of soil testing, nutrient supply maps can be drawn for farms, larger regions and countries. Such maps provide a useful generalized picture of the soil fertility of an area. However, the extent to which soil fertility maps can be used for planning nutrient management strategies depends on how through, recent and representative the soil sampling has been on which such maps are based. Macro level maps are more useful as an awareness and educational tool rather than for determining out nutrient application strategies.

vii. Exchangeable acidity

Exchangeable hydrogen (H) together with exchangeable aluminum (Al) are known as soil exchangeable acidity. Soil acidity occurs when acidic H+ ion occurs in the soil solution to a greater extent and when an acid soluble Al3+ reacts with water (hydrolysis) and results in the release of H^+ and hydroxyl Al ions into the soil solution (Rowell, 1994; Brady and Weil, 2002).

As soils become strongly acidic, they may develop sufficient Al in the root zone and the amount of exchangeable basic cations decrease, solubility and availability of some toxic plant nutrient increase and the activities of many soil microorganisms are reduced, resulting in accumulation of OM, reduced mineralization and lower availability of some macronutrients like N, S and P and limitation of growth of most crop plants (Rowell, 1994) and ultimately decline in crop yields and productivity (Miller and Donahue, 1995; Tisdale *et al.*, 1995; Foth and Ellis,1997; Brady and Weil, 2002). Foth and Ellis (1997) stated that during soil acidification, protonation increases the mobilization of Al and Al forms serve as a sink for the accumulation of H^+. The concentration of the H+ in soils to cause acidity is pronounced at pH values below 4 while excess concentration of Al^{3+} is observed at pH below 5.5 (Nair and Chamuah, 1993). In strongly acidic conditions of humid regions where rainfall is sufficient to leach exchangeable basic cations, exchangeable Al occupies more than approximately 60% of the effective cation exchange capacity, resulting in a toxic level of aluminum in the soil solution (Buol *et al.,* 1989). Generally, the presence of more than 1 parts per million of Al^{3+} in the soil solution can significantly bring toxicity to plants. Hence, the management of exchangeable Al is a primary concern in acid soils.

viii. Exchangeable potassium and sodium

Soil parent materials contain potassium (K) mainly in feldspars and micas. As these minerals weather, and the K ions released become either exchangeable or exist as adsorbed or as soluble in the solution (Foth and Ellis, 1997). Potassium is the third most important essential element next to N and P that limit plant productivity. Its behavior in the soil is influenced primarily by soil cation exchange properties and mineral weathering rather than by microbiological processes. Unlike N and P, K causes no off-site environmental problems when it leaves the soil system. It is not toxic and does not cause eutrophication in aquatic systems (Brady and Weil, 2002).

Wakene (2001) reported that the variation in the distribution of K depends on the mineral present, particles size distribution, degree of weathering, soil management practices, climatic conditions, degree of soil development, the intensity of cultivation and the parent material from which the soil is formed. The greater the proportion of clay mineral high in K, the greater will be the potential K availability in soils (Tisdale *et al.*, 1995). Soil K is mostly a mineral form and the daily K needs of plants are little affected by organic associated K, except for exchangeable K adsorbed on OM. Alemayehu (1990) described low presence of exchangeable K under acidic soils under intensive cultivation.

Normally, losses of K by leaching appear to be more serious on soils with low activity clays than soils with high- activity clays, and K from fertilizer application move deeply (Foth and Ellis, 1997). Exchangeable sodium (Na) alters soil physical and chemical properties mainly by inducing swelling and dispersion of clay and organic particles resulting in restricting water permeability and air movement and crust formation and nutritional disorders (decrease solubility and availability of calcium (Ca) and magnesium (Mg) ions) (Szabolcs, 1969; Sposito, 1989). Moreover, it also adversely affects the population, composition and activity of beneficial soil microorganisms directly through its toxicity effects and indirectly by adversely affecting soil physical and as well as chemical properties. In general, high exchangeable Na in soils causes soil sodicity which affects soil fertility and productivity.

ix. Exchangeable calcium and magnesium

Soils in areas of moisture scarcity (such as in arid and semi-arid regions) have less potential to be affected by leaching of cations than do soils of humid and humid regions (Jordan, 1993). Soils under continuous cultivation, application of acid forming inorganic fertilizers, high exchangeable and extractable Al and low pH are characterized by low contents of Ca and Mg mineral nutrients resulting in Ca and Mg deficiency due to excessive leaching (Dudal and Decaers, 1993). Exchangeable Mg commonly saturates only 5 to 20% of the effective CEC, as compared to the 60 to 90% typical for Ca in neutral to somewhat acid soils (Brady and Weil, 2002). Research works conducted on Ethiopian soils indicated that exchangeable Ca and Mg cations dominate the exchange sites of most soils and contributed higher to the total percent base saturation particularly in Vertisols (Mesfin, 1998; Eyelachew, 2001). Different crops have different optimum ranges of nutrient requirements. The response to calcium fertilizer is expected form most crops when the exchangeable Ca is less than 0.2 cmol(+)/kg of soils, while 0.5 cmol(+)/kg soil is reported to be the deficiency threshold level for Mg in the tropics (Landon, 1991).

x. Micronutrients (Fe, Mn, Zn and Cu)

The term micronutrients refer to a number of elements that are required by plants in very small quantities. This term usually applies to elements that are contained in plant tissues in amounts less than 100 mg/kg (Foth and Ellis, 1997). According to the same authors, the four essential micronutrients that exist as cations in soils unlike to boron and molybdenum are zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) (Table 3).

Adsorption of micronutrients, either by soil OM or by clay-size inorganic soil components is an important mechanism of removing micronutrients from the soil solution (Foth and Ellis 1997). Thus, each may be added to the soil's pool of soluble micronutrients by weathering of minerals, by mineralization of OM, or by addition as a soluble salts (Foth and Ellis, 1997). Factors affecting the availability of micronutrients are parent material, soil reaction, soil texture, and soil OM (Brady and Weil, 2002). Tisdale *et al.* (1995) stated that micronutrients have positive relation with the fine mineral fractions like clay and silt while negative relations with coarser sand particles. This is because their high retention of moisture induces the diffusion of these elements (Tisdale *et al.*, 1995). Soil OM content also significantly affects the availability of micronutrients. According to Hodgson (1963), the presence of OM may promote the availability of certain elements by supplying soluble complexing agents that interfere with their fixation. Krauskopf (1972) stated that the main source of micronutrient elements in most soils is the parent material, from which the soil is formed. Iron, Zn, Mn and Cu are somewhat more abundant in basalt. Brady and Weil (2002) indicated that the solubility, availability and plant uptake of micronutrient cations (Cu, Fe, Mn and Zn) are more under acidic conditions (pH of 5.0 to 6.5) (Table 3).
Table 3 below presents some critical data for a range of crops based on various sources. In most cases, these correspond to 90% of maximum yield. These are approximations compiled from various sources. Specific situations require further refinement. For example, critical concentrations in the case of oil-palm are different for young palms and for older palms (Fairhurst and Hardter, 2003). A selection of critical plant nutrient concentrations for any crops has been compiled by the international Fertilizer Industry Association (IFA, 1992) among others.

Table 3. Critical nutrient concentrations for 90% yield for interpretation of plant analysis data

Element	Wheat & rice	Oilseed rape	Sugar cane	Alfalfa (Lucerne)	Grass	Citrus
(%)						
N	3.00	3.50	1.50	3.50	3.00	2.50
P	0.25	0.30	0.20	0.25	0.40	0.15
K	2.50	2.50	1.50	2.00	2.50	1.00
Mg	0.15	0.20	0.12	0.25	0.20	0.20
S	0.15	0.50	0.15	0.30	0.20	0.15
(μg/g)						
Mn	30.0	30.0	20.0	30.0	60.0	25.0
Zn	20.0	20.0	15.0	15.0	50.0	20.0
Cu	5.0	5.0	3.0	5.0	8.0	5.0
B	6.0	25.0	1.5	25.0	6.0	25.0
Mo	0.3	0.3	0.1	0.2	0.3	0.2

Source: FAO, 1980

GSJ: Volume 7, Issue 3, March 2019
ISSN 2320-9186

SUMMARY

Soil properties affect different aspects of crop in agriculture. These are factors that are essential in effective crop production. Soil physical properties play an important part in the growth of plants. Since the soil serves as an anchorage for plant roots, it should possess the favourable physical conditions that promote root growth. That will allow the roots to move easily with in the soil in search for moisture and nutrients. It is necessary for a farmland to have a good soil tilth. A soil with a good soil tilth has a condition with its ease of tillage and penetration for seed emergence and crop root growth. This condition is directly affected by soil texture, porosity, bulk density and water holding capacity.

On the other hand, chemical properties also dictate the fertility of a given land. Soil nutrients except Nitrogen are inherent in the soil. However, due to continuous cropping and cultivation and the natural nutrient depletion process, the natural soil fertility of the farmlands are dramatically declining. The destruction of soil physical properties and depletion of chemical properties, together, has caused the imbalance of the natural soil system resulting in the decrease of produce from the farmlands and favouring the prevalence of pest and diseases.

REFERENCE

Ahmed Hussein, 2002. Assessment of spatial variability of some physicochemical properties of soils under different elevations and land use systems in the western slopes of Mount.

Assefa Kuru, 1978. Effects of humus on water retention capacity of the soil, and its role in fight against desertification. M.Sc. Thesis, Department of Environmental Science, Helsinki University. 68p.

Asgelil Dibabe, 2000. Effect of fertilizer on the yield and nodulation pattern of Faba bean on a Nitosol of Adet North Western Ethiopia. Ethiopian J. Natural Resources, 2: 237-244.

Binkley, D. and P. Sollins, 1990. Factors determining differences in soil pH in adjacent conifer and alder-conifer stands. *Soil Science Society of America Journal.* 54: 1427-1433.

Binkley, D., K.A. Dunkin, D. DeBell and M.G. Ryan, 1992. Production and nutrient cycling in mixed plantation of Eucalyptus and Albizia in Hawaii. *Forest Science.* 38: 393-408.

Bohn, H.L, B.L. McNeal and G.A. O'Connor, 2001. Soil chemistry, 3rd Ed. John Wiley and Sons, Inc., New York. 307p.

Brady, N.C. and R.R. Weil, 2002. The nature and properties of soils, 13th Ed. Prentice- Hall Inc., New Jersey, USA. 960p.

Carter, M.R., D.A. Angers, E.G. Gregorich and M.A. Bolinder, 1997. Organic carbon and nitrogen stocks and storage of profiles in cool, humid soils of eastern Canada. *Can. J. Siol Sci*.77(1-4): 205-206.

Curtis, P.E. and R.L. Courson, 1981. Outline of soil fertility and fertilizers, 2nd Ed. Stipes Publishing Company, Champaign. 250p.

Eylachew Zewdie, 1987. Study on phosphorus status of different soil types of Chercher highlands, south-eastern Ethiopia. Ph.D. Dissertation, University of Jestus Liebig, Germany. 168p.

Eylachew Zewdie, 1999. Selected physical, chemical and mineralogical characteristics of major soils occurring in Chercher highlands, eastern Ethiopia. *Ethiopian Journal of Natural Resource*. 1(2): 173-185.

Eylachew Zewdie, 2001. Study on physical, chemical and mineralogical characteristics of some Vertisols of Ethiopia. pp. 87-102.

Guerts and J.R.Francisco, 1998.Assessment of soil fertility depletion in Mozambique. Agriculture, Ecosystem and Environment, 71: 159-169.

Fisher, R.F. and D. Binkley, 2000. Ecology and management of forest soils, 3rd Ed. John Wiley and Sons, Inc., New York. 489p.

Folmer, E.C. R., P.M.H. Guerts and J.R. Francisco, 1998. Assessment of soil fertility depletion in Mozambique. Agriculture, Ecosystem and Environment, 71: 159-169.

Foth, H.D., 1990. Fundamentals of soil science, 8th Ed. John Wiley and Sons, Inc., New York, USA. 360p.

Foth, H.D. and B.G. Ellis., 1997. Soil fertility, 2nd Ed. Lewis CRC Press LLC., USA. 290p.

Gregorich, E.G., B.H. Ellert and C.M. Monreal, 1995. Turnover of soil organic matter and storage of corn residue carbon estimated from natural 13C abundance. *Can. J. Soil Sci.* 75:161-164.

Gupta, P.K., 2004. Soil, plant, water and fertilizer analysis. Shyam Printing Press, Agrobios, India. 438p.

Hillel, D., 1980. Fundamentals of soil physics. Harcourt Brace Jovanivich Publisher, Academic Press, Inc. San Diego. 413p.

Hoyt, P.J. and R.C. Turner, 1975. Effect of organic material added to very acid soils on pH, Al, exchangeable NH4+ and crop yields. *Soil Sci*. 19: 119-237.

Hue, N.V. and I. Amien, 1989. Aluminum deterioration with green manures. *Commun. Soil Sci*. *Plant and Anal*. 20: 1499-1511.

Jordan, C.F., 1993. Ecology of tropical forests. pp.165-195. *In*: L. Panxel (Ed.). Tropical forestry handbook.

Kimmins, J.P., 1997. Forest ecology: A foundation for sustainable management, 2nd Ed., New Jersey. 596p.

Lal, R., 1989. Land Degradation and Its Impact on Food and Other Resources; Food and Natural Resources, pp: 85-140.

Lal, R., 2001. World cropland soils as a source or sink for atmospheric carbon. *Adv. Agron*.71: 145–191.

Landon, J.R. (Ed.), 1991. Booker tropical soil manual: A Handbook for Soil Survey and Agricultural Land Evaluation in the Tropics and Subtropics. Longman Scientific and Technical, Essex, New York. 474p.

McDonagh, J.F., T.B. Thomsen and J. Magid, 2001. Soil organic matter decline and compositional change associated with cereal cropping in southern Tanzania. *Land Degradation and Development.* 12: 13-26.

Mengel, K. and E.A. Kirkby, 1987. Principles of plant nutrition. Panima Publ. Corporation, New Delhi, Bangalore, India. 687p.

Mesfin Abebe, 1998. Nature and management of Ethiopian soils. Alemaya University of Agriculture, Ethiopia. 272p.

Miller, R.W. and D.T. Grardiner, 2001. Soils in our environment, 9th Ed. Prentice-Hall Inc., Englewood Cliffs, New Jersey. 671p.

Mulugeta Lemenih, 2004. Effects of land use changes on soil quality and native flora degradation and restoration in the highlands of Ethiopia: Implication for sustainable landmanagement. PhD Thesis Presented to Swedish University of Agricultural Sciences, Uppsala. 64p.

Murphy, H.F., 1968. A report on the fertility status and other data on some soils of Ethiopia, Experiment Station Bulletin No. 44, College of Agriculture Haile Sellassie I University, Dire Dawa, Ethiopia. 551p.

Nega Emiru, 2006. Land use changes and their effects on physical and chemical properties in Senbat sub-watershed, western Ethiopia. M.Sc.Thesis Submitted to School of Graduate Studies, Alemaya University, Ethiopia. 72p.

Oldman, L.R., 1993. The extent of human induced soil degradation. Annex 5- World map of the status of human induced soil degradation. An explanatory note ISRIC. Wageningen.

Steiner, K.G., 1996 (Ed.). Cause of soil degradation and soil development approach to soil management. Margrafvelag, Weikersheim, Germany. 95p.

Pieri, C., 1989. Fertilite´ Des Terres De Savanes; Ministe`re De La Cooperation et CIRAD-IRAT: Paris.

Poritchett, W.L. and R.F. Fisher, 1987. Properties and management of forest soils, 2nd Ed., John Wiley and Sons, Inc., New York. 494p.

Rhoades, J.D., 1982. Cation Exchange Capacity. In: Methods of soil analysis. Part 2. Chemical and Microbiological Properties (A.L. Page, R.H. Miller and D.R. Keeney), (Eds.) American Society of Agronomy, Inc. Soil Science Society of America. Inc. Madison, Wisconsin, pp: 149-157.

Rowell, D.L., 1994. Soil science: Methods & Applications. Addison Wesley Longman Singapore Publishers (Pte) Ltd., England, UK. 350p.

Sanchez, P.A., 1976. Properties and management of soils in the tropics. John Wiley and Sons,Inc., New York, USA. 618p.

Sanchez, P.A., C.A. Palm, C.B. Davey, L.T. Szott and C.E. Russell, 1985. Trees as soil improvers in the humid tropics. pp. 327-358. *In*: Cannell, M.G.R. and. Jackson, J.E (Eds.).

Sanchez, P.A., 2002. Soil fertility and hunger in Africa. Sci., 295(5562): 2019-2020.

Smaling, E.M.A., 1993. An Agro-ecological Framework for Integrated Nutrient Management with Special Reference to Kenya; Agricultural University: Wageningen, pp: 250.

Sposito, G. (Ed.), 1989. The Chemistry of Soils. pp. 226-245**.** Oxford Uni. Press, New York.

Science (Vol 5) New York, USA: Springer-Verlag Nelson, D.W. and L.E. Sommers, 1982. Total carbon, organic carbon and organic matter: In: A.L. Page, R.H. Miller and D.R. Keeney) Methods of soil analysis. Part 2 Chemical and Mirobiological Properties, pp: 539-579.