COURSE CODE: FRM509

COURSE TITLE: FOREST SOILS

NUMBER OF UNITS: 2 Units

COURSE DURATION: Two hours per week

COURSE DETAILS:

Course Coordinator: PROF. A.M. ADURADOLA

Email:

Office Location:

Other Lecturers: MR. A. O. OLADOYE

COURSE CONTENT:

Understanding of soil dynamics and influence upon forest composition stand regeneration, tree vigour and tree growth rate, forest soil physics, chemistry and microbiology, soil moisture movement, forest nursery soil management, forest soil fertility determination, maintenance and improvement with special reference to tropical conditions

COURSE REQUIREMENTS:

This is a compulsory course for all students in the Forestry option. In view of this, students are expected to participate in all the activities and have minimum of 75% attendance to be able to write the final examination.

READING LIST:

LECTURE NOTES

SOIL FACTOR IN ROREST PRODUCTNITY

INTRODUCTION

Forest trees depend directly upon the soil for physical support, temperature moderation, nutrition and water but soil in forested area contribute in many other ways to both the lives of tree, associated plants, microbes, animals and human. However, the over whelming important of soil in the life and health of the forest has not been understood until recent years (Meeker, 1921).

Soil are critical to forest productivity and provide 24 of the 26 element required by plants and animals (excluding carbon and oxygen). Soils are important not only because of their immediate effect on the productivity of plants and animals, but also because they are the storehouse that supports future forest (Amaranth's, M.P. et al, 1990).

Forest soils are composed of an assortment of material and organism that when viewed in whole function as a living ecosystem. This ecosystem performs several key functions that are essential to healthy forest ecosystem. The soil ecosystem helps to:

(i) Sustain biological nativity, diversity, and productivity by providing habitants for plants, animals and other organisms.

(ii) Regulate water flow

(iii) Filter, buffer, mobilize and detoxify potential pollutants

(iv) Store and cycle nutrients

(v) Provide structure support for plants

The maintenance of these soil functions requires careful consideration of the entire soil ecosystem; soil floral and commodities, which are composed of bacteria, fungi, protozoa, nematodes, anthropoids, earthworm's insect small vertebrates and plants. As well as the physical and chemical properties of the soil (Atzet, T. et al, 1990).

Soil quality is the most important factor in forest productivity. Soil will determine which tree species yields the greatest timber volume, the tinker of harvest and ultimately the investment of landowner must make to yield and acceptable economic return from forest (Fox, T.R et al, 1995).

Soil vary greatly in their ability to produce merchantable volumes of pulpwood, sawn timber, veneer, poles piling or other wood products in a reasonable period of time. In order determine forest productivity, forest productivity, a forest must be aware of soil factors that affect forest production (Miller, M.H. et al 1990).

The collective influence of soil factor will determine the total height to which dominant trees of given specie will grow at a given site of some index age and this is known as site index.

Soil, in concert with climate, is of primary importance in determining in the potential for forest to present in a particular area as the potential productivity or growth rates of those forests. Soil supplies many of the growth requirements, including water and nutrients (Bal mew, W.E. 1978).

In addition, soil offers a support medium for growing trees and a buffer extreme of temperature. Therefore, all soil properties which relate to any of these are important to tree growth (Coiled, T.S. 1952). These are commonly expressed as physical, chemical and biological properties. Water available is one of the primary controlling factors for the presence of trees as well as vigor and growth rates. The problem with water on most forest area is that there is either too little or too much (Stone, E, 1973).

Other soil factors which affect forest productivity include:

1. **Compaction**

Forest soil is a mixture of mineral particle, air water, living and dead organic matter, and nutrients. Surprisingly, only about half of contents of soil is solids, the rest is pre space containing air water. Soil is compacted when the area between soil particles and clods are pushed closer together, thereby reducing pore space. Soil porosity influences forest productivity directly by influencing the movement of eater and oxygen into the soil and the penetration, growth and distribution of roots (Adams, P.W. 1983).

Soil is most easily compacted when machinery applies ground pressure and aeration to the soil during forest harvest operation and mechanical site preparation (Froehlich, H.A. 1979). The resultant packing of mineral particles reduces the pore pace for root growth, soil drainage, and aeration and can reduce forest productivity for decades.

Compaction also greatly increases the risk of erosion problems. Water movement into and throat a compacted soil is reduced, which increases the risk of water run-off across the soil surface. Concentrated run-off can move soil particles off-site, decrease water quality and damage fish habitat.

2. Soil Fertility

Soil fertility is determined by the amount and available of nutrients at a given site. Most available nutrients are in the surface organic litter and the upper mineral layer of soil. Erosion, severe fire, and mechani9cal operations can displace some of this layer and result in the loss of nutrients and productivity (Atzet et al 1990; Grier 1975).

Soil is full of beneficial soil organisms profoundly affecting productivity; for example, mycorrhizal fungi and nitrogen-fixing organisms change atmo0spheric nitrogen into chemical from useable by plants. These organisms capture and take in nutrients and water, protect roots against diseases, and promote soil structure. Severe disturbance, such as intense fire or the piling and removing of surface organic matter, can reduce or eliminate beneficial soil organisms (Amaranths et al, 1990).

3. Harvesting

Harvesting activities can have long term adverse effect productivity when improperly applied. Main roads, skids roads, and landing can reduce soil productivity by:

(a) Scalping (removing vegetation including the roots near the surface and displacement of organic and upper mineral soil layers.

(b) Ensuring space that could grow tree and other plants.

(c) Compacting by heavy equipment or dragging of logs

(d) Exposure of infertile sub-soil

(e) Channeling water and causing erosion

Significant growth reductions can result from both thinning and final harvest operations and last for decades (Froehlich, 1979). Highly disturbed surfaces are the primary cause of soil and water impaction on forest by reducing tree stocking and growth.

Other soil factors which affect forest productivity and site include:

(i) Top soil depth: it is the depth of the uppermost soil layer and is a critical factor affecting tree growth.

Top soil is highest inorganic matter and nutrients, is usually well aerated and drained, and allows maximum root growth and root penetration.

(ii) Soil texture: the proportion of sand, silt and clay in the topsoil and sub-soil layer is called texture. Sandy soils are normally well drained and often lack nutrients leaching loss. At the other end of the spectrum are the pure clay soil comprised of very small, soil particles.

(iii) Sub-soil Consistence Class: Consistency of the sub-soil layer is another important factor of soil in forest productivity. The combination of soil-sized particles and the physical and chemical properties of each individual particle type in a given soil determine the soil consistence class.

(iv) Limiting Layers: A layer which restricts the downward penetration of a tree root system will reduce tree growth in direct relation to the depth of layer. In some instances, a limiting layer may increase site productivity. Such as on sandy soil where the layer may retard leaching of nutrients and increase available moisture.

Soil factor in forest productivity could be classified as:

(a) Effect of soil on plantation

(b) Effect of soil on germination

(c) Effect of soil on seedlings

(d) Effect of soil on High forest productivity

(e) Effect of soil on plantation.

(v) <u>EFFORTS TO SOIL ON PLANTATION DEVELOPMENT</u>

Extensive plantations of *Gmelina arborea* Roxb and Tectona grandis L.F. (TEAK) have been established in Nigeria for the production of pulpwood and timber. These plantations were established to replace natural forests. Although, most of the first rotation stands are healthy, changes in soil micro floral and consequences of such change on long term site productivity are little known. Observations from other religions have shown that whatever the natural forest ‘consisting of heterogeneous plant population is converted to monoculture plantations, the microbial population is also affected (Lane and Witicher 1967; Lane, 1975). Dommevgues (1979) observed that in tropical soils, most microbial life is located on or around the root system of the plant (rhisopere).

An experiment carried out by M.A. Amakiri and E.E. Okoegwale of the Department of Forest Resources Management, University of Ibadan gave the following physical and chemical characteristics of soil collected from teak plantation, Gmelina plantation and Natural forest at Gambari. Forest resources located at 07o10’N, 03o52’E, about 20km south of Ibadan.

Table 1

Plant cover	Field capacity %	PH	Organic Matter %	Total N %	Available p Ppm	Exchangeable K Ca Mg Mg/100g		
Teak	39.7	6.3	2.6	0.12	6.6	0.22	39.2	5.7
Gmelina	40.9	6.6	4.0	0.16	5.5	0.17	46.8	5.2
Natural forest	45.9	6.6	4.0	0.19	4.6	0.15	50.4	4.6
Standard error ±	1.1	0	0.28	0.01	0.33	0.01	1.9	0.18

Available phosphorous (p) determined after extraction with Bray and knite phosphorous extractant

(0.03 N – NII4F + 0.1 N - IICI).

Source: Department of Forest Resources Management, University of Ibadan.

Table 1 above shows physical and chemical characteristics of soils collected from three experimental sites. The soil under teak has the lowest organic matter, total nitrogen and exchangeable calcium. The values were 2.8%, 0.12% and 39.2 meg/100g soil respectively. Gmelina soil generally had middle values between teak and the natural forest. The natural forest has the highest organic matter, total nitrogen and calcium (50.4meg/100g soil). The experiment further review that teak soil has the lowest population of microflora (bacting, fungi and actinomycetess). The natural forest also had significantly the higher population o0f bacteria and fungi. Actinomycetess were most abundant in Gmelina soil. The experiment further showed that bacteria population was significantly correlated with Nitrogen (N), phosphorous (p) and calcium (Ca). Actinomycetess counts was significantly correlated with Phosphorous (p), calcium (Ca) and Organic matter while fungi population was also positively correlated with Nitrogen (N), Phosphorous (p), Calcium (Ca) and organic matter although not significantly. It could be inferred from the experiments above that soil under plantation experience reduction of some chemical properties and a decrease in soil micro flora population consequently leading to decrease productivity of such plantation if the best soil management system is not adopted e.g. for efficient microbial number and activities of teak Gmelina plantations, the introduction of shade tolerant annuals rich in calcium and Nitrogen and which are easily established under such plantations would be an advantage.

(vi) EFFECTS OF SOIL ON GERMINATION

The effects of soil on seedling emergence and germination could be assessed under the effect of soil ammonium concentrations and asmotic presence non seedling emergence.

It has been established that with ammonium toxicity (1, 2, 4, 8) and asmotic pressure (3, 5, 9) exerted by a fertilizer can affects the germination of seed and crop establishment (Bennett A, C. And Adams, F. 1969). It is not possible to distinguish the absolute effect of ammonia toxicity from the osmotic effect because the ammonium from which the ammonia is generated from the soil solution also creates an osmotic pressure. In compound fertilizers containing ammonium, the effects of ammonium toxicity and osmotic pressure combine to affect germination and establishment.

However, the effects of ammonium toxicity and osmotic pressure varies from different species (Woodstock, L.W and lsao, H. 1986)

The rate of emergence of seeds after sowing can be a significance factor in the performance of crops. Slow emergence can expose germination seeds not seedlings to greater risk of disease, insect attack and moisture stress. Increase in osmotic pressure alone can significantly increase emergence time and the effect is species dependent (Dubetz et al, 1959).

Other factors of soil which affects germination include soil texture which is the proportion of sand, silt and clay in the topsoil and subsoil layer. *Tecton grandis* seeds require soil rich in nutrient e.g. a mixture of sandy and clay soils alone, they will not survive because sandy soil often lack nutrients due to constant leaching loss.

Another factor is the depth of the top soil which is the depth of the uppermost soil layer. It is a critical factor affecting germination of seeds. Top soil is higher in organic nutrients and matter, is usually well aerated and drained, and allows median root growth and root penetration.

(vii) EFFECTS OF SOIL ON SEEDLINGS

The soil factor which affects seedlings deals with the uptake and transfer of nutrients from the soil to the seedlings. Nutrients are transferred mainly through the roots and the soil supplies 24 out of the 26 elements needed by tree seedlings. When a nutrient is deficient in soil solution, the central root parameter controlling its uptake is surface area. Hyphae of mycorrhizal fungi have the potential to greatly increase the absorbing area of the root. For example, Rousseau et al (1994) found that while extrametrical mycelia (aggregates of hyphae) accounted for less than 20% of the total nutrient absorbing surface mass, they contributed neatly 80% of the absorbing surface area of pine seedlings. It is also important to consider the distribution and function of extrametrical Hyphae (Sylvia, D.M. 1990). If the mycorrhizal is to be effective in nutrient up-take, the Hyphae must be distributed beyond the nutrient depletion zone that develops around the root. A nutrient depletion zone develops when nutrients are removed from the sol solution more rapidly than they can be replaced by diffusion. For a poorly mobile ion such as phosphate, a sharp and narrow depletion zone develops close to the root. Hyphae can neatly bridge the depletion zone and root can grow into soil with an adequate supply of phosphorous (Miller, R.M and J.D Jastrow, 1992). Uptake of micronutrients such as zinc and copper is also improved by mycorrhizal because these elements are also diffusion limited in many soils. For more mobile nutrients such as nitrates, the depletion zone is wide and it is less likely that Hyphae grow extensively into the zone that is not influenced by the root alone. Another factor contributing to the effective absorption of nutrient by mycorrhizal is their narrow diameter relative to roots. The steepness of the diffusion gradient for a nutrient is inversely related to the radius of the absorbing unit. Therefore, the soil solution should be less depleted at the surface of a narrow absorbing unit such as Hyphae. Furthermore, narrow Hyphae can grow into small soil pores inaccessible to roots or even root hairs (Sylvia D.M 1994).

Another advantage attributed to mycorrhizal fungi is access to pools of phosphorus not readily available to the plant. One mechanism for this recess is the physiochemical release of inorganic and organic phosphorous by organic seeds through the action of low molecular weight organic onions such as oxalate which can (Fox et al, 1990) (i) replace phosphorous sorbed at metal hydroxide surfaces through ligand exchange reactions. (ii) Dissolve metal oxide surfaces that sorbs phosphorous and (iii) complex metals in solution and thus prevents precipitation of metal phosphate.

Assuming that the major benefits of the mycorrhizal symbiosis are improved phosphorous uptake, the management of mycorrhizal fungi will be most critical when soil phosphorous is limiting.

Many tropical soils fix phosphorous and proper mycorrhization of plant is essential to obtain adequate phosphorous nutrition (Haussling, M. And H. Marschner, 1989).

Another factor to consider is the interaction of water stress with nutrient availability. A soil dry, phosphorous may become limiting even in soils that tests high in available phosphorous.

(viii) EFFECTS OF SOIL ON THE PRODUCTIVITY OF HIGH FOREST

Soil is a unique and complex bend of minerals, living organisms and the organic products of organisms. It provides habitat of physical support as well as sustenance for teeming array of creatures from bacteria and fungi, termites, earthworms and plants. The soil and its living community store and cycle nutrients, regulate water flows, and also filter, buffer, degrade, immobilize, or detoxify myriad organic and inorganic materials (USDA NRCS, 1996)

High forest consists of diverse species of trees which require different soil factors for optimum growth. Soils under high forest perform three critical ecological functions. One is nutrient cycling, a process carried out by invertebrates and microbes that decompose dead organic matters and release until plants nutrients such as nitrogen and phosphorous for re use. This activity accounts for majority of nutrients taken up by plant in high forests, second, they enable the forest to maintain some productivity (tree growth) during periods of shortage especially drought. Third, soils are capable of retaining fertility and thereby facilitating plant recovery following disturbance such as fire and timber harvesting. The latter capability quickly degrades. However, when plant cover is removed and the soil is left bare (Perry, 1989).

Other factors of soil which significantly affects high forest productivity include soil structure and organic matter. A significant concern in the effects of soil on high forest productivity is in assuring the replenishment of surface and soil organic matters ad avoiding compaction of the soil (Powers et al, 1990).soil organic matter include highly decomposed material called humus, decomposed leaf and other detritus, and large woody debris such as branches and stems. This organic materials stores nutrients and water and supplies the carbon to nourish the myriad below the ground organisms, many of which performs the critical tasks of releasing the mineral nutrients necessary for continued plant growth. As long as plant community regrow region vigorously afters timber harvesting, losses of soil carbon derived from fine litter will be replenished. Regrowth actually depends on the status of soil nutrients, soil carbon, and soil biology after harvest from high forest. Components of soil carbon is replenished by leaving large woody debris, especially tree stems on forest sites after harvesting (Harmon et al, 1986)

Further more a major factor of soil in high forest productivity is maintenance of pools of essential plant nutrients and assuring that they are steadily available in forms the trees can use undisturbed forest seldom experience significant losses of nutrient stocks.

Nitrogen as been considered the most important nutrient limiting growth until recently and majority of resources has focused on nitrogen losses associated with timber harvest and site preparation (Johnson 1992). Losses from harvested site take three forms: removal of nitrogen contained in harvested woods, nitrogen leached and aerated from disturbed soil, and nitrogen volatilized and lost to the atmosphere during slash burning. The extent and impact of their losses vary depending on site-specific factor such as nitrogen availability in the soil and climate also management practices (Cole1995). In Nitrogen-poor forests, losses in wood removal and slash burning far exist those in leaching, while in more Nitrogen rich forests, leaching losses can be quite high. Forest ecosystem with higher level of nitrogen mineralization (release of nitrogen from decomposing soil organic matter) have been shown to exhibit higher rates of nitrates production and loss, and those losses are fur her increased by the removal of trees and corresponding elimination of nitrogen uptake by the trees (Hornbeck et al, 1996).

CONCLUSION

It can be observed from the seminar paper that soil contributed in no little way to the productivity of forests world-wide and it effects can not be over emphasized. In order to meet diverse and changing demands for the goods and services that forest provides, the forest must be viewed as a complex ecosystem and research towards better functioning of the forest components must be immense.

THE EFFECT OF FIRE ON FOREST SOILS

The effect of forest fires on the physical, chemical and biological properties of soils are directly related to the severity of the farm. The intensity and duration of soil treating by prescribed fires, such as those used for hazard reduction, are significantly less than those generated by slash burning or wild fires and consequently, the effects of controlled burning on soil properties are generally less than the effect of hot wild fires.

EFFECT ON SOIL PHISICAL PROPERTIES

Soil temperature: changes in the temperature at different dept in soils as a result of burning are functions of thermal conductivity of the soil and the temperature duration of the fire.

Highest temperature observed2.5cm below the surfaces was 66^0C.while temperature of 100^o C were not common below 10cm,50^0C was occasionally recorded at depths of more than 39cm soil temperature following a burn are influenced by the alteration in the insulating capacity of the liter larger and heat absorption pattern of the surface layer as a result of a dark ash deposit.

Forest floor material acts as an insulator against soil temperature and soil moisture charges and the removal of this materials expresses the mineral soil to the various of whether.

The darker surface of a turgid site effectively also be solar radiation.

Consequently, the surface layers of soil in burned sites are warmer than those of unburned sites.

Soil moisture: The effects of fire on soil moisture are indirect and are often ill defined. Where the majority of the forest floor is renewed by burning, water absorption and retention by the burrows layer may be significantly reduced. The elimination of this organic mulch results in increased evaporation. The higher temperature of a burned site also tend to increase evaporation. Ash and liter charred materials may filter had to the mineral soil on severely burned sites and reduce the rate of water infiltration and increase run-off. Water repellent soils can develop from hydraulic substances vapourized during burning of surface litter on sandy soils. When OT between 100^0C and 200^0C persist for a sufficient period, organic substances can distilt downward into the soil and precipitate to form a non volatile or hydrophobic layer of soil. Dryness (1976) reported that burning increases the water repellency of sandy soil at depths of 2.5 to 23cm which persisted for up to five years after the fire. This condition reduces the water infiltration rate and moisture storage capacity which are of particular importance on the dry sandy sites where repellent layers often develop many sandy soils in forested areas are different to forest once they become excessively dry. Fortunately, they seldom completely dry under a forest floor.

Soil erosion or after fire: Fire generally affects soils erodability if the mineral soils is exposed, either by hot wildfire or by repeated burning over long time periods. Porosity and infiltration used decreased and bulk density increases following fires on many soils. Soil aggregated are dispersed by beating rains and pores may become clogged by fire particles that decrease macropore spaces infiltration and aeration. The action of worms and water soil fauna contributing to soil porosity also may be significantly reduced on frequently burned soils where grazing is permitted, trampling of cattle on burned areas increased soil bulk density more than equivalent trampling on areas with an accumulated litter layer. Generally, the amount by erosion folowng a fire depends on the inherent erodibility by the soil, steepness of slope, time, amount and intensity of rainfall, severity of fire and plant cover remaining on the soil.

EFFECT ON SOIL CHEMICAL PROPERTIES

Organic matter, while layer percentages by the standing biomass and organic matter may be destroyed in a severe wildfire, the materials consumed in a controlled burn are confined to the understorey vegetation and forest floor debris, and only in small part of the total of these may b burned. The amount of material consumed in a prescribed fire depends primarily on the kind and amount of fine present and the whether conditions. It may b as little as 2000 to 4000kg per hectare in an annually burned forest or as high as 4000 to 9000kg per hectare in an annually burned forest or as high as 4000 to 9000kg per hectare in infrequently, burned areas (Wels, 1971).

In spite of obvious losses of organic materials during prescribed burning reports generally leave indicated or significant long term decreased in total organic matter to the soil-forest floor system: Heyword and Psornette 1934 reported that there was no evidence that fire depleted soil nitrogen or soil inorganic matter in wingleaf pine stands of coastal plant. The explanation the apparent maintenance or organic mater in the ecosystem in spite of the various losses during prescribed burning may lie in increases of organic matter in animals soil layers equivalent to that lost from the forest flood (Olsen, 1981). For example organic matter in the 0-5cm of a soil in annually burned wholly pine was burnt 30% more than in unburned plots after 20years (Wells, 1971).

Maintenance soil organic matter started not be expected in all burned areas. Certainly hot fires from burning may significantly reduce both organic matter and total nitrogen in the underlying mineral split as well as in the active ground materials.

Total nitrogen violattilities at 200^0C and thus is easily loss during most fires Knight (1966) found that 25 to 64% of forest floor nitrogen lives lost as fire OTs varied from 300^0C too 700^0C.

Actual losses have been reported to vary from 75kg per hectare during heavy slash burns.

Total nitrogen in mineral soil planning fire has been variously reported to increase, decrease and stay the same (Wright and Bailey, 1988). Wells (1977) reported that while total nitrogen content decreases in the forest floor during controlled burning, it accumulated at about the same rate in the 0 to 10cm of the mineral soil. Heyward and Barnett (1994) reported that there was no evidence that repeated controlled burning of virgin long leaf pine forest depleted soil nitrogen.

While 100 to 300kg nitrogen per hectare are generally violatilized during a controlled turn, it appears that increased biological nitrogen fixation may too a significant extent replace the nitrogen lost from burned areas. There are suggestions (Well, 1971) that increased soil OT, moisture, nutrient supply and pH resulting from a reduction in ground cover and deposition of ash in burned surface may favour both symbiotic and symbiotic fixation of nitrogen. Leguminous plants are often more prevalent in burned areas (Cooper, 1978), and the activities of some nitrogen-fixing bacteria and blue-green algae are though to increase in the pH volume of the surface soil increases. Burning decreases activity of the human layer and this may encourages mineralization of nitrogen. The ordinarily mineralization of nitrogen in the human layer is very slow. Burning of the rate of mineralization deposit the loss in the total maount of nitrogen, burning greatly increases the mineral nitrogen.

Soil acidity: In general, the hydrogen ion concentration decreases after burning. This rises the soil pH value, at least in the upper 10cm. such changes last for various lengths of time depending on soil exchange capacity and rainfall.

CATION-EXCHANGE CAPACITY

CEC often decreases after burning. The amount of decrease varies with the severity of the fire and with soil type. The decrease in CEC is most likely due to reduction in humus content of the mineral soil. The destruction of colloidal humus begins at OTs between 100^0C and 250^0C. During severe fires up to 20% of the CEC in sole highly dependent an humus for their CEC may be lost. Medium and light fires often have little effect on the CEC. All fires tend to increase base saturation, although the increase may be short-lived if in the absence of vegetation there is excessive leaching.

Available nutrients: The forest flour contains a substantial portion of the nutrient receive in most forests. It has been printed out that in unturned forests, forest floor organic matter slowly decomposes and nutrients are made available for use by higher. Plants through biological oxidation. Fire drastically speeds up the process of oxidation, and some of the mineral nutrients thus released are dissolved and rapidly leached into the mineral soil. Ash deposit from a fire increases the available phosphorus, potassium, calcium and magnesium. These increases in available nutrients are greatest directly after a fire, but increases in some elements often persist for 5 years or longer.

Nitrogen, even though a considerable amount may be voltilized, is added to surface soil after a fire. Much of this may be in the form of ammonium ion side nutrients decompose at OT in excess of 150^0C (Raisan, 1979). If the soil is moist, there may be significant uptake of nitrogen before nitrification begins (condition favourably nitrification) raised pH volume and base saturation are also created by lowering.

Once free nitrate is formed, it is highly mobile and can be easily lost from the ecosystem or used by grassing organisms.

Only when insufficient plant growth follows a fire will excessive amounts of nitrate accumulate or be lost from the system.

EFFECT OF FIRE ON SOIL ORGANISMS

Most soil organisms are sensitive to changes in soil OT, soil moisture and nutrient supplies, yet there appears to be little agreement among researchers on the effects of fire on those important contributors to the forest ecosystem. Reasons for the differences largely relates to differences in environmental requirements among the various microflora and mesofauna and to differences in experimental techniques.

Soil microbes: Heat can cause immediate reductions in bacteria populations (Ahlgren, 1974), but the extent of the changes in microflora populations depends on the intensity and duration of the fire, soil moisture and texture, and depth at which the organism resides within the soil.

Heating the soil for one hour at 100^0C produces an initial depression in numbers of bacteria, followed by a sharp increase.

The population decline may last the first positive rainfall and after a few months populations in the upper 4cm of soil on burned land may be higher than on unburned area. Jorgensen and Hodges (1971) reported few indications that presented burning of a, pine plantation adversely altered the qualitative or quantitative composition of fungi or bacteria, plus actinomycetes to the extent that soil metabolic process were impaired.

Ahlgren (1974) suggested that fungus species comprising the population can burned land might be expected to differ from those on unburned land of the habitat requirement of the organisms. Since surface soil reaction varies from alkaline soown is the ash minerals are leached out, the species of fungus found in an area probably vary with age of turn.

Little is known the effects of fire on algae, but they are reduced in surface soils in a manner similar to other microorganisms. However, this reduction is apparently temporary. They generally thrive under alkaline conditions and are often the first organisms to colonize burned wetlands. Increased populations of algae should be expected under these conditions.

The activity of blue-green algae and nitrogen fixation by other organisms may be enhanced by increases in available nutrients, decreases in soil acidity and increases in light intensity at the soil surface are to burning and reduction in ground vegetation.

Soil Animals soil known include those animals living in the forst floor and the mineral soil for al or part of the year.

Many of them move back and front between the low strata, the preferred startum depending on their stage of development or environmental conditions. The effects of fire on soil animals, thereafter, depend on their habitat and mobility as well as the tolerance of the organisms to heat and denication. In prescribed burns, the heat of the fire may be less important in reducing insect population, than their environmental changes brought about by fire. In fact, most organisms in the top 2.5cm of mineral soil apparently survive moderate fires. Buffingtor (1969) attributed the decrease in soil animals after firest to loss of both incorporated and unincorporated organic matter that reduces for the supply for the smaller organisms and, in turn, for their predators.

Fellin and Kenoredy (1972) reported that those were generally more arthropods, present in order prescribed to burns than recent burns in forest.

Ants are less affected by fire than other groups of insects because of their adaptations to the hot, characteristics conditions of early post fire tap soil.

Furthermore, their cryptic habits enabled them to survive fore below the level of intense heat and their social organization adapts them to rapid reestablishment on burned land.

Earthworm populations are apparently significantly markedly reduced by most fires. There are some indications that the earthworm population moisture be more influenced by post burn adverse moisture conditions and food supply than by excessive OTs during burning.

FOREST FLOOR

Properties of forest floor

Many factors such as soil characteristics, climate and trees species that influence tree growth and rate of organic matter development also affect the physical and chemical properties of the forest floor humus.

Physical properties

The stage of litter affect the physical and compaction emerge other things floor. Mean bulk denote field and saturation capacity vary with type and age by forest (tree) and Baci (1965). Wooldridge (1970) reported the maximum water holding capacity of forest floor to range from 1.9cm under pine forest to 3.2cm under mixed longer forests in central Washington. Water holding capacity is also known to increase with compactness of the litter.

In addition too greater water holding capacity, the greater hydrologic conductivity of the forest floor is important in a flouring water to filtrate the soil. The high percentage of large pores in the forest floor leads to increase aeration on wt sides, but causes the larger to dry quickly on exposed sites.

Chemical properties

Fresh litter is composed of a large number of complex organic compound, the relative percentage of which vary in different plot plant and in different species ages of materials and the soil on which they were produced. However same general comments can be made on the changes/composition of the forest floor. The relation ash content of plant parts is lowest for whole wash and highest for leaves. Supposed normally has higher ash content than heart washed Bray and Garhton (1964) reported that ash content is higher in litter of hundred species generally contain higher concentrations of N, P, K, Ca and Mg than to leaves at the foresters. The age of the leaves at the time theory reach the parent floor also influence their composition. In most species, percentage of N, P and K decreases as the gravity season progress, a although miry not always mean a decrease in absolute amount. The PH value, C:N ratio C:P ratio and concentration of invest constitute in the unions organic larger are influenced by both the know of soil and type of vegetation. These influence soil development and stand composition.

The C: N ratio gives an indication of availability of N in the floor and by its rate of decay. In general the ratios of C: N are wide in forest floors and decreases as decomposition produces. It is generally lower to those agricultural soils.

The concentration of K, Ca, and Mg generally decreased from the spray litter to that of the lower humus under same stands, while aluminum concentrations increased with depth. This indicates that the bases are elevated to a greater extent than same other elements. On the other hand, the increases in aluminum concentration, as well as that of iron and manganese in more decomposed largest; reflect a concentration of these elements a contamination from the minerals soil.

Relatively large quantities of nutrients are stored in the forest floor. Regardless of whether the forest floor is development under cool or area climate, it is the home of most soil organization, the reflection of most nutrients involved in lynching process and the very life of the soil itself. The total intent of nutrients is honoured dictated by the amount and composition of the forest floor which is influence by forest vegetation climates mineral soil and the accumulation period following a major disturbance of the forest floor.

CONDITIONS INFLUENCING BIOLOGICAL ACTIVITY IN SOIL

1. Level of inorganic materials and soil acidity

Soil animals include both primary consumed and predators which return their energy by consuming plant part or preying in other organism. Soil acidity and level of inorganic and activity affects animal number and activity as a consequence of affecting their feed. Animal proportion is long in fertile soils capable of producing abundant food supplies.

2. Moisture affects microbial activity because as a component of protoplasm, it must be available for vegetative development. An over attendance of H_2O, however restricts gaseous exchange, lower the available O_2 simply and treated anaerobic conditions. Because microbial population are sensitive to soil moisture conditions community size and composition in a given soil vary with fluctuation in moisture. Aerobic predominant in well aerated soils, but this change to a largely anaerobic population under water tagged conditions. The maximum density of micro organism however, is usually formed at 50 to 70% of the water holding capacity of the soil (Alexander 1977).
3. Temperature affects the acidity of all soil organisms, but not to same extent. Each microorganism has an optimum temperature for growth and a range outside of which development causes. Most soil organism grows best in 25-35^{0}C range, but can bourse and develop at both higher and lower temperature. Temperature affect population size and rate of biochemical processes carried out by the micro flora up to the optimum temperature for the transformation.
4. **Nature of soil organic matter:** The addition of carbondioxide materials directly affects the chambers and activities of all heterotrophic organisms and indirectly affects autotrophic organisms. The application of saw dust, the forming under of green manure crop in a nursery can stimulate population and activities resulting in nutrient mobilization. Highly acid conditions inhibit activities of many common bacteria, algae and actinomy Cates but most fungi are able to function over a wider PH range;

consequently, the microbial population of acid forest soil is commonly dominated by fungi. This is not necessarily because fungi respond better to acidic conditions but rather, as a consequence of lack of microbiological competition for the available food supply.

5. **Season:** The season of the year influences temperature moisture and food supplied and indirectly regulates microbial activity. Microorganism is usually most active in spring and fall in the temperature zone. Generally, the numbers of organisms' fluctuation closely with seasonal changes in temperature and moisture.
6. **Soil depth:** This is a secondary ecological variable that influences soil microorganism. The greatest concentration is in the top few centimeters of forest soils with a rapid decline in numbers of most organisms with depth. The decline is in microbial activities with depth is mostly due to the decrease in organic matter and oxygen.

TROPICAL FOREST SOILS

Tropical soils are extremely variable and have less well studied than temperate soils. Furthermore the dissemination of information concerning their properties and management has been impeded by their large classification.

Sanchez (1976) summarized the distribution of tropical soils at the subside level from a generalized map based on the U.S Taxonomy.

Orisons and Ultisols Sanchez (1976)

Calculate that those two orders of acidic infertile soils make up only about one-third of the total land area of the tropics. However, they are the most abundant soils of the humid tropics where they carer almost two-thirds of the area. Oxisoils are deep, well-drained, red of yellowish soils, with exullent granular structure and little contrast between horizons. Oxisols generally have good physical properties but their poor chemical properties are direly responsible for the fact that a large percentage of these soils are devoted to forestry. They are formed on the Gnyune and Bridjilinu Shrield of the Amerizen Baffin and along the western coast of Colombia. In Africa, they are located in parts of Cameroun, Gelon, central Zaire eastern Madagastar, Literia and Sierra Leone. They make up 3% of site of tropical Asia.

The Oxisols and Ultisols because of their abundance and relatively poor chemical properties for agricultural use, must be regarded as the most important forest soils of the tropics. They are similar in that they are both highly acidic and are often deficient in one or more of the following elements: P, K, Ca, Mg, S and various micronutrients. They generally are high in exchangeable aluminum, but low in effective cation exchange capacity resulting in a high leaching potential. They often have a high capacity to mobilize phosphorus especially those soils with clayey surface horizons. While physical properties are good, some oxisols have low water holding capacity and many ultisols are particularly prism to erosion.

Aridisols: These soils of arid regions belong to the second most prevalent soil order in the tropics. They cover apart 18% of the tropical land area mostly in Desert regions of Africa and Southern locations in the Americas and Asia. Aridisoils are generally considered forest soil and are disorderly in terms of afforestation for prew and conservation pruposes.

Aridisoils vertsols and Mollisols

Those high base status soils a prevalent in well-drained tropical are vertisols and mollisols are of minor important alfisols occupy about 18% of the tropical area. Nearly all of these soils are devoted to agriculture, the alfisols are similar culture and most other characteristics to a ultisols and oxisols, but they less acidic and inherently mere most are deep, well-drained, red and yellow soil. Frequently, as in the Amagan Basis, the occur as small inclusions in areas by oxisols and ultisols. Alfisols are four the drier areas of Brazil and along humid coast of Ecuador. They occur in areas of the Philippines and Jorn and are indespread in the forest zone of West African, Ivory Coast to Eastern Nigerian latter areas not only experience in excess dry season each year, but also have a sandy to general surface layer underlain by gravelly materials, resulting in, soil moisture deficits unfavourable to agricultural use.

Inceptisols and Entisols: These young soils each cover about 8% of the tropics. They are generally, excellent forest soils, but because of their relatively high fertility, they are frequently used for agriculture. For example, the inceptisols, young soils with limited horizons differentiation, include the poorly drained aquepts that are widely used for low land rice production in Asia. However, there are Aquepts in tropical Africa that are used porosity for forest production because disease problem limit human habitation.

Well-drained inuptisols of volcarnic origin (Ad depts.) are generally fertile and have excellent tropical properties although they have a high a high P-sorption capacity, they are excellent agriculture as well as forest soils. They are found in Philippines, Jorn and part of central Americans. In Asia they are used for rice production. They are not extensive in tropical Americas or Africa.

Entisols are soils of such recent origin that they do not show significant horizon differentiation. They include well-drained agricultural soils (Fluents), deep acid sands (Psamonents) and shallow soils in steep slopes or even rock entesols (orthentai). The fluent highly productive soils and most are undercultivation, but the psamments and the litter Entisols are limited by poor fertility, low in holding capacity, or shallow rooting zones, making them generally unsointable for agriculture and best left uncleared.

Spodosols: These soils derived from coarse sandy materials are also known a podzols. They are found throughout the Arizon Basin, except in hordophins, at the elevations in Central, America and some Indonesian islands. They probably occupy less than 1% of tropical lands because they are acidic infertile, an generally posses poor physical properties that should be maintained in forest.

What is a forest Soil

In the broadest sense a forest soil is any soil that his developed under the influence of a forest cover. This view recognise the unique effects of rating by trees specific organisms associated with forest vegetation the litter longer and elevation promoted by the products of its decomposition on by genes.

By this deposition forest soil can be considered to cover approximately ½ of the earths land surface. Essentially all soil except that of tundra, anarstra grassland and desserts were developed under a forest and have acquired some distinctive properties as a result of that association Kenny (1964) estimated that about 30% of the worlds land surface is covered by forest of various types.

Distinction between forest soils and cultivated soils

1) The forest cover and its resultants forest floor provide a favourable soil nutrient climate which promote a more diverse and active microflora and found them are found in agricultural soils. The role of these organisms as mixers of the soil and intermediaries in nutrient cycling is of much greater importance in forest soils than in agricultural soils
2) The deep-rooted character of tree leads to another unique feature of forest soils. Although the great majority of rocks occur at or near the soil surface, deep roots also take up both moisture and nutrients. Thus, deep soil horizons, of little importance to agronomic crops, are of considerable, importance in determining forest site productivity.

3) The physics of both overland and subsurface low of water are quite different in deep steep forest soils from those in cultivated soil. Steep slopes under forests have their surface protected by the litter layer, their streams strength increased by the preserve of roots and their infiltration capacity enhanced by the root channels.
4) Agricultural soils may be described as products of human activities in contrast to forest soils which are natural bodies and exhibit a well-defined sucssion of natural horizon.