Agriculture, Forestry and Fisheries
2015; 4(3-1): 1-4
Published online May 14, 2015 (http://www.sciencepublishinggroup.com/j/aff)
doi: 10.11648/j.aff.s.2015040301.11
ISSN: 2328-563X (Print); ISSN:2328-5648 (Online)

Spatial Patterns of Nutrient Distribution in Dalingshan Forest Soil of Guangdong Province China

Egbuche C. T.[1, 2, *], Su Zhiyoa[2], Anyanwu J. C.[3], Onweremadu E. U.[4], Nwaihu E. C.[1], Umeojiakor A. O.[1], A. E. Ibe[1]

[1]Department of Forestry and Wildlife Technology, Federal University of Technology Owerri, Imo State Nigeria
[2]College of Forest Ecology, South China Agricultural University Guangzhou, China
[3]Department of Environmental Technology, Federal University of Technology Owerri, Nigeria
[4]Department of Soil Science Technology, Federal University of Technology Owerri, Nigeria

Email address:
ctoochi@yahoo.co.uk (Egbuche C. T.)

To cite this article:
Egbuche C. T., Su Zhiyoa, Anyanwu J. C., Onweremadu E. U., Nwaihu E. C., Umeojiakor A. O., A. E. Ibe. Spatial Patterns of Nutrient Distribution in Dalingshan Forest Soil of Guangdong Province China. *Agriculture, Forestry and Fisheries*. Special Issue: Environment and Applied Science Management in a Changing Global Climate. Vol. 4, No. 3-1, 2015, pp. 1-4. doi: 10.11648/j.aff.s.2015040301.11

Abstract: Spatial nutrients that includes OM, Avail.K, Avail.P and TN distribution and the influences on vegetation patterns in Dalingshan was the cardinal focus of this study. Ecological data (moisture content, bulk density and topography) were considered. One way ANOVA was statistically tested of spatial distribution of major nutrients across 4 plots which indicated non significant at $p = 0.05$ level, TN ($p = 0.0216$), OM ($p = 0.00004$), Avail.K ($p = 0.00216$) respectively. Furthermore one way ANOVA was tested on acidity level (pH) measured against the nutrients distribution TN ($p = 0.0031$), OM ($p = 0.0004$), Avail.K ($p = 0.0216$) respectively at non significance level but available phosphorous was significantly different ($p = 0.6412$). The study revealed unique spatial patterns of soil nutrient distribution in Dalingshan and species abundance while vegetation census posed a new direction of study that may be adapted for a broad range of regional vegetation and floristic modeling. This paper suggests that forest soil nutrients and vegetation interaction can be utilized for further studies on multifactor ecosystem responses towards regional ecological restoration.

Keywords: Spatial Patterns, Soil Nutrient, Vegetation Cover, TWINSPAN, Dalingshan Guangdong Province China

1. Introduction

Soil nutrient spatial distribution and soil fertility is of great concern to the management of forest ecosystems. It is an important concept towards biodiversity and multiple values of soil, vegetation cover and agricultural land management. This has resulted to the quest for more knowledge of soil nutrients distribution within spatial pattern in relation to both local and regional vegetation pattern. Plant/vegetation community structure and variability are often attributes of biotic interactions which [1] reported as one primary cause for failure of grazing management in non-equilibrium systems. Generally, spatial patterns of vegetation and abundance of plant species are important aspects which require evaluation of models that can be adopted to describe vegetation dynamics. These literature reports are vital in the assessment of spatial patterns of soil nutrient distribution in relation to abundance in vegetation cover. Vegetation abundance and canopy are significantly related to spatial nutrient distribution, slope aspects and plant diversity. Studies have been conducted and dedicated to the aspects of temperature, soil moisture availability and tree growth, such studies includes [2], [3] and [4]. However, slope aspects are also considered important factor in distribution of ground-flora species [5], [6]. Generally, more studies are required at this time to understand the spatial patterns of soil nutrients and vegetation variability. Studies designed to investigate soil fertility, nutrient spatial distribution and the effects to vegetation variability are major considerations that are incorporated in the mechanisms of vegetation abundance, species and vegetation canopy. These are important in ecological theories and plant nutrient models. Nutrients in soils can strongly influence the distribution of trees in forest ecosystems and thereby contributes to their health. [7] reported that distributions of soil nutrients in relations to profiles and range of ecological conditions are determinants of plant distribution and domination which is relative to environmental factors such as topography**.** This study in Dalingshan, Guangdong Province China will help in understanding and estimate soil nutrient parameters in relation to plant species. It is important to understand the connections between plant diversity, vegetation growth and plant community within a spatial environment of a region and can be used in plant models and growth simulation. The main objectives of this study were to evaluate the spatial distribution and patterns of soil nutrient in Dalingshan of Guangdong Province China and to assess the distribution of nutrients in relationship to vegetation cover and abundance thereby infer how soil nutrient will influence the availability/abundance of plant species in the study area.

2. Methodology

Soil Sampling

Physical examination and collection of soil samples from the site grid formation of the soil profile and depth design for soil sample collection was taken from 0-25cm, 25cm-50cm, 50cm – 75cm and 75cm-100cm forming 25 spot points. The random soil sample collection was carefully collected across the site to achieve equitable distributive sample constituent, bulked and treated as a single samples for the purposes of laboratory analyses. This field sample collection was completed in October 2005. Biogeochemical parameters were measured from the sample to determine the spatial pattern trend and evaluate the nutrient level across the site. Soil physical and chemical contents were analyzed using methods of [8] that includes variables of soil texture, gravel, moistures, pH, Available phosphorous, Available Nitrogen, Total Nitrogen, Available Potassium, Organic matter and Exchangeable cation, Electrical conductivity and Hygroscopic water. These analyses were conducted at the Forest Ecology laboratory of the South China Agricultural University Guangzhou.

3. Results

Laboratory results of major nutrients of the study site were further tested to determine the spatial distribution over the plots and which gave insight on how it affected the distribution (fertility) and occurrence of vegetation species. All statistics were considered significant at p=0.05.

3.1. Spatial Variability and Distributions of Nutrients Across TWINSPAN Plots

Greater concentration and evaluation of basic nutrients towards spatial vegetation (plant species) distribution were assessed as strategic results. Having assessed the species abundance and cover using the TWINSPAN, four basic nutrients were measured against acidity concentration (pH) and spatial variability (TWINSPAN of 18 grids on 4 plots). The major nutrients evaluated were Organic Matter (OM as in Figure 1), Total Nitrogen (TN), Available Phosphorous (Aval.P), and Available Potassium (Aval.K).

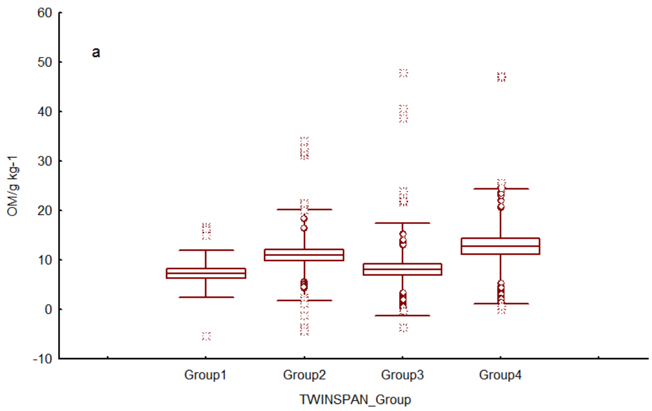

Figure 1. *Organic matter variability measured across TWINSPAN 4 groups*

The evaluation showed no significant difference of organic matter distribution among the groups (p=0.275 and F= 3,194).

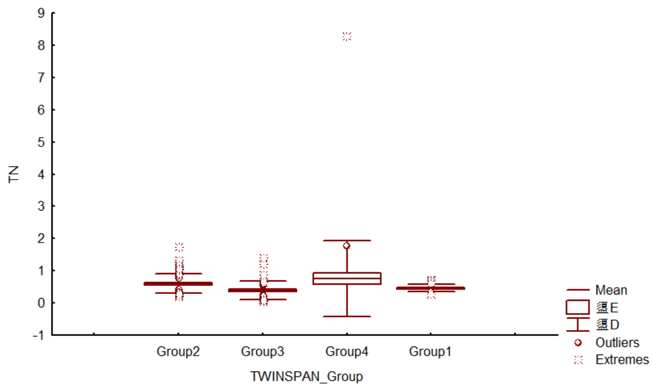

Figure 2. *Total Nitrogen variability measured across 4 TWINSPAN groups*

The evaluation indicates no significant difference of total nitrogen distribution across groups (p=0.00005, F=3,194).

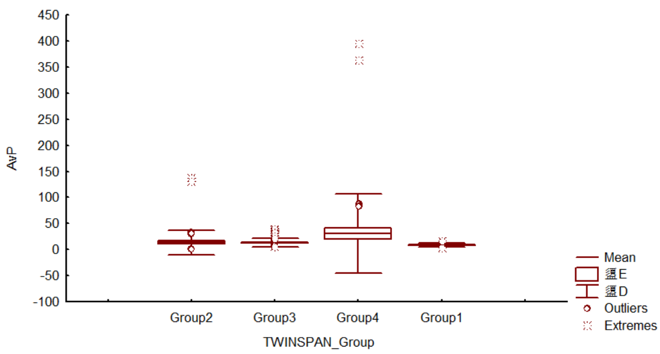

Figure 3. *Variability of available phosphorous across TWINSPAN 4 groups*

Evaluation shows no significant difference of available phosphorous distribution across groups (p=0.0322, F= 3,194)

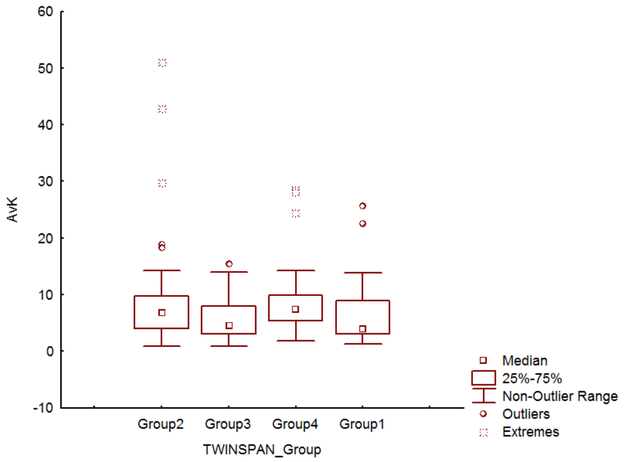

Figure 4. *Available Potassium distributions variability across TWINSPAN 4 groups*

Evaluation shows no significant difference of available phosphorous distribution across groups (p=0.0047 and F=3,194).

3.2. Nutrient Contents and Distribution in Relation to pH

Furthermore the basic nutrients evaluated across the site distribution were tested in relation to site spatial acidity level. The results were shown as pH variability evaluated across four TWINSPAN group nutrients. They are pH against available potassium, pH against available phosphorous, pH against organic matter and pH against total nitrogen.

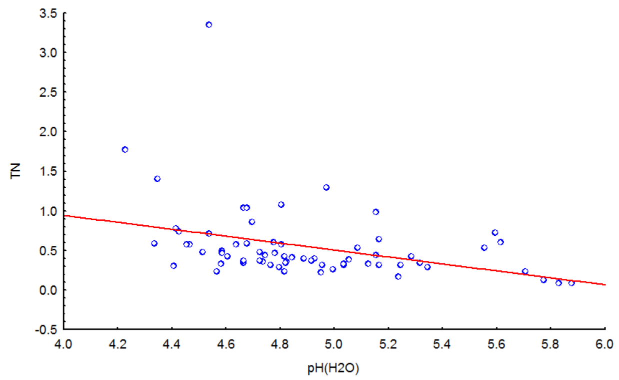

Figure 5. *pH distributions in relation to total nitrogen distribution across TWINSPAN 4 groups. The evaluation indicated no statistical differences among the 4 groups where p= 0.0031*

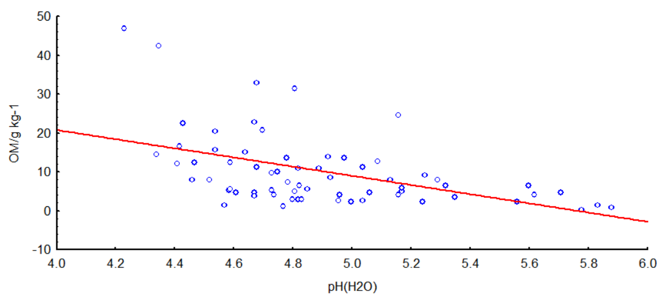

Figure 6. *pH distributions in relations to organic matter distribution across TWINSPAN 4 groups. The evaluation indicated no statistical differences among the 4 groups where p= 0.00004*

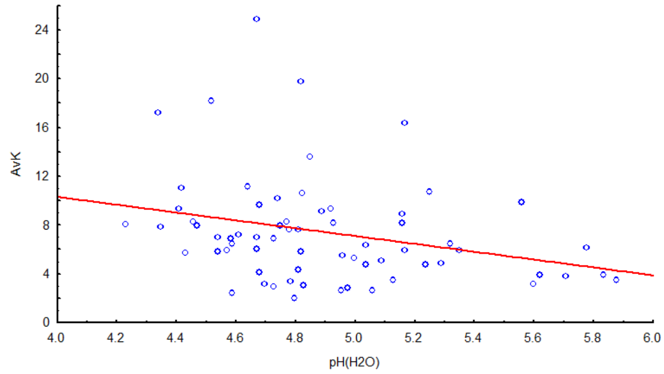

Figure 7. *pH distributions in relation to available potassium across TWISPAN 4 groups*

The evaluation indicated no statistical differences among the 4 groups where p= 0.0216

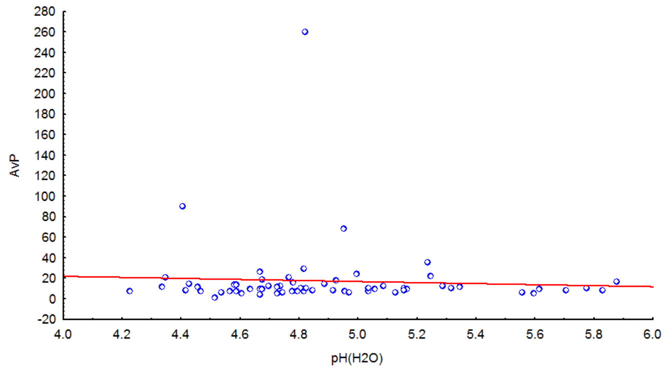

Figure 8. *pH distributions in relation to available phosphorous across TWISPAN 4 groups*

The evaluation indicated statistical differences among the 4 groups where p= 0.6412

4. Discussion

Spatial Nutrients Characteristics

Field investigation and TWINSPAN analysis over 4 grid dendogram conforms to the spatial variability of nutrient patterns. The basic nutrients evaluated are organic matter (OM), Total Nitrogen (TN), Available Potassium (Avail.K) and Available Phosphorous (Avail.P) in distribution indicates non significant difference across the groups. OM (p=0.275), TN (p= 0.00005), Avail.K (p=0.00047) and Avail.P (p=0.0322). This result accounts for shaping the plant species and diversity patterns. The dominance of species and frequencies were associated by ecological regional factors and as well nutrients which accounts for major factors of soil fertility. The four nutrient value (variables) were used to foresee the variability in the site; though proved non significant respectively. Further statistical test of acidity level (pH) evaluated against major nutrients conforms to and similar to those of other researchers that identified pH vary significantly with ground aspects. But in this study TN (p=0.0216), OM (p=0.00004), Avail.K (p= 0.00216) respectively indicates non significant difference, however pH evaluated against Available Phosphorous (p=0.6412) indicated significant difference. This is in line with [9]. Soil spatial nutrient distribution accounts for growth rate and nutrients efficiency is at recent times attracts greater research attention towards understanding soil fertility mechanisms and supported by [9]. It was documented that Nitrogen is a trait that becomes very useful under the conditions of intense competition for soil resources that characteristize diverse late successional communities. The non-significant of nutrients variables measured across the TWINSPAN plot therefore agree to the theoretical fact that there is strong relationship across all species and statistically affirm the influence of pH level on Phosphorous (p=0.6412) at measured p=0.05 level. This study is supported by the fact that available data on spatial distribution of soil resources is limited though there is variability that ranges from the root zone, as reported by [10] and [11a] [11b]. In overall investigation, it was observed that spatial patterns determine the characteristics of plant species abundance. Generally, this investigation of spatial nutrient indicates and emphasized that nutrient supplies and pH-value are closely correlated and may account for species abundance among the low/even gradient [12] and [13] documented influences of pH-value and species richness of ground of ground vegetation. Certain plants species are found on soils where nutrifiers are active due to weak acidic to neutral pH value of the soil, in another perspective [14] reported that calcium is most important exchangeable action in the soil that influences soil pH-value and controls the availability of other nutrients. Soil moisture and other ecological factors are considered not only pre-requisite for the distribution of species but also responsible for site heterogeneity. These are supported by [15], [16] that the impact may differ at regional scale.

5. Conclusion

Soil nutrients are reflected in the site properties and nutrient uptake which are related to changes in nitrogen availability, since nitrogen is considered to be most important growth-limiting factor in most soils though this nutrient spatial distribution investigation in Dalingshang, confirmed most nutrient tested were equilibrium in distribution but available phosphorous differ in plots evaluated in the content of pH level.

Acknowledgements

We acknowledge and grateful to the College of Forest Ecology, South China Agricultural University Guangzhou, China and the graduate students that participated in the various field/ laboratory soil sample evaluation.

References

[1] Oba G., Stenseth N.C and Lusigi W. J: 2000: New perspectives on sustainable grazing management in arid zones of Sub- Saharan Africa. Bioscience 50: 35 – 51

[2] Tajchman, S. J. & Lacey, C. J. 1986. Bioclimatic factors in forest site potential. Forest Ecol. Manag. 14: 211–218

[3] Hicks, R. R. & Frank, P. S. 1984. Relationship of aspect to soil nu-trients, species importance and biomass in a forested watershed in West Virginia. Forest Ecol. Manag. 8: 281–291.

[4] Munn, L. C. & Vimmerstedt, J. P. 1980. Predicting height growth of yellow-poplar from soils and topography in southeastern Ohio. Soil Sci. Soc. Am. J. 44: 384–387

[5] Huebner, C.D., Randolph, J.C., & Parker, G.R. (1995). Environmental factors affecting understory diversity in second-growth deciduous forests. American Midland Naturalst, 134 (1). Retrieved January 21, 2006 from JSTOR database.

[6] Hutchins, R. L., Hill, J. D. & White, E. H. 1976. The influence of soils and microclimate on vegetation of forested slopes in eastern Kentucky. Soil Sci. 121: 234–241.

[7] Esteban G. Jobbagy and Robert B.Jackson (2000) The vertical distribution of soil organic carbon and its relation to climate and vegetation Ecological Applications, 10(2), 2000, pp. 423– 436 q

[8] Ben-Shahar, R. 1990. Soils, vegetation and herbivores in the Sabi-Sand Wildtuin, Transvaal, S.A. Ph.D. thesis, University of Oxford.

[9] Olivero Adele. M. and Hix David. M.: Influence of aspect and stand age on ground flora of South Eastern Ohio forest ecosystems. Plant ecology 139: 177 – 187. Kluwer Academic Publishers.

[10] Palmer M.W. and Dixon P.M. 1990, Small-scale environmental heterogeneity and the analysis of species distributions along gradients. Journal of Vegetation Science 1:57-65

[11] Jackson R. B. and Caldwell M.M. 1996. Integrating resource heterogeneity and plant plasticity: modeling nitrate and phosphate uptake in a patchy soil environment. Journal of Ecology 84: 891-903. b) Jackson R.B. and Caldwell M.M. 1993. The scale of nutrient heterogeneity around individual plants and its quantification with geostatistics, Ecology 74: 612-624.

[12] Brunet, J., Falkengren-grerup, U., Tyler, G., 1996. Herb layer vegetation of south Swedish beech and oak forests. Effects of management and soil acidity during one decade. Forest Ecology and Management 88, 259–272.

[13] Leuschner C, Hertel D (2003) Fine root biomass of temperate forests in relation to soil acidity and fertility, climate, age and species. Prog Bot 64:405–438.

[14] Pausas J. G., Austin, M. P., 2001; Patterns of plant species richness in relation to different environments: an appraisal. J. Veg. Sci 12, 153-166

[15] Christensen, M., Emborg. J., 1996; Biodiversity in natural versus managed forest in Denmark. For.Ecol.manage. 85; 47-51.

[16] Pausas J. G., Austin, M. P., 2001; Patterns of plant species richness in relation to different environments: an appraisal. J. Veg. Sci 12, 153-166.