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Self-Similarity Pattern Corresponding to the Vegetational Field Data

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Abstract

Background/Objectives: A study was conducted to observe the self-similarity pattern exhibited within the vegetational field due to their nutritional sharing channels. **Methods/Statistical Analysis:** A square grid matrix was chosen in the cultivated fields to draw the sample data of the biological as well as environmental variables. Grid matrix was further divided into one hundred and forty -four subareas of 1.2 by 1.2-meter square. Data were analyzed based on a Box-counting method to determine the fractal dimension in each class. **Findings**: Highest dimension was found to be 2.48 in class one which consists of 144 small grids. Whereas, the lowest dimension found to be 1.03 in class 4. The pattern of the fractal dimension of various classes seems to be self-similar within the vegetational field. **Application/Improvements**: Vegetational fields share several materials through the nutritional channels within the grid matrix. We observed the pattern in different scales using fractal dimension and found to be the self-similar pattern in all scales.

Keywords: Box-Counting Method, Fractal Dimension, Self-Similar Pattern

1. Introduction

Fractal analysis is very worthwhile for the ecologist for describing the ecological processes. Detecting and describing the pattern in the distribution of vegetation can be instrumental in understanding the factors which influence how and where plants grow, and the role played by plants in shaping ecosystems. In[1] general, the pattern can either be due to internal characteristics of the plants or to external environmental factors the occurrence of individual plants can be limited by vegetative propagation, seed dispersal or micro-environmental factors[2].

Detecting patterns through space or time considered a central goal of landscape ecology and to conclude those patterns through multiple scales[3-4]. Self-similarity is the characteristics of Fractal used to distinguish achieving the research goals[5]. These approaches are very fruitful to the field of landscape ecology and address explicitly to measures the symmetry at various scales. Moreover, investigators generalize the process at a wide range of scales to entertain questions concerning the patterns process to look at the appropriate scales[6]. The fractal analysis allows ecologists to map growth pattern of plants and influencing nematode and bacteria without creating an unmanageable deluge of information. Natural fractals can be either statistically self-scaling (the patterns at different scales are qualitatively different but have the same fractal

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dimension 'D'), or this dimension 'D' can change at different scales of measurement.

2. Materials and Methods

The proposed study was conducted within the fertile field cultivated generally seasonal crop (tomato and guar) grown in rotation. A 12 by 12-meter square grid matrix was chosen and further divided into one hundred and forty-four small quadrats of 1.2 by 1.2-meter square each. Grid matrix was further divided into four classes so that to study the self - similar pattern at various scale. Study area consist 432 samples of tomato plants in which nematode soil population and its associated three soilborne fungi (*Fusarium solani*, *Paecilomyces lilacinus* and *Aspergillus* spp.), were recorded in the data matrix. Population distribution of nematode and associated soil fungi showed quietly sparse throughout the field plot of 144 grids. Almost all fields consist non-zero values of nematode and fungi.

The box-counting method was used to determine the fractal dimension of each class. Several fungi were obtained during the study, but the analysis was performed only for the nematodes soil population. The fractal dimension of the species variables such as plant parasitic nematode and its associated soil fungi (*Fusarium Solani, Paecilomyces lilacinus*, and *Aspergillus* spp.), and environmental variables such as soil moisture percentage, organic matter contents, pH, $CaCO_3$, NO_3, P, K were analyzed.

Fractal is a shape made of parts similar to the whole in some way[7,8]. Whereas, box counting is a method which collect the information from the fields into data grid matrices and analyzed the complex patterns by dividing the data matrix into further smaller and smaller scale of block sizes to measure the patterns in larger to small scales. However, the prime essence of this technique is to observe the patterns in very small scale. The fractal dimension 'D', uses the power law technique and it is the quotient of two logarithms (Eq-1,2):

$$N = a^D \qquad [1]$$

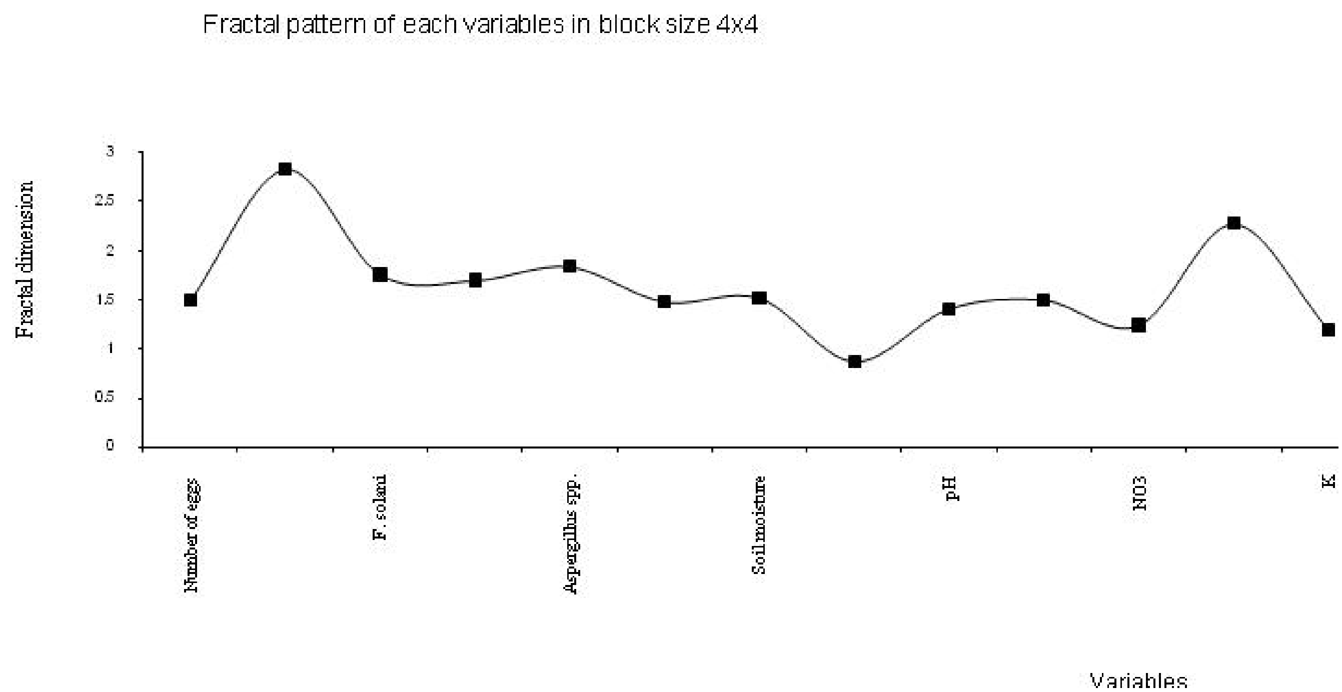
$$\log N = \log a^D$$
$$\log N = D \log a$$

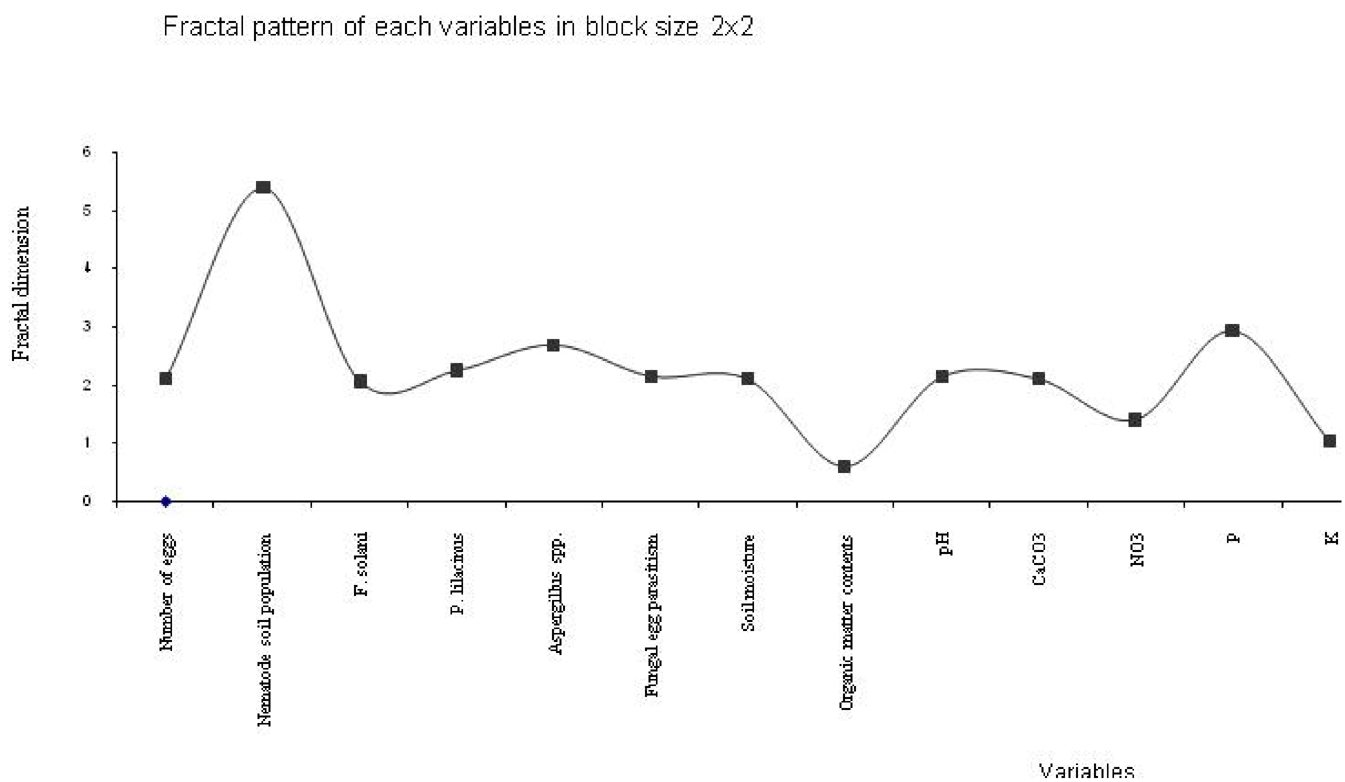
$$D = \frac{\log N}{\log a} \qquad [2]$$

3. Results and Discussion

The fractal dimension of each class was calculated. Highest dimension was found to be 2.48 in class one which con-

Variables	Block Size	No. of grids	Fractal Dimension 'D'	Property
No. of eggs	1 x 1	144	2.48	Regular point pattern
	2 x 2	36	1.97	Random point pattern
	3 x 3	16	1.52	Random clumped pattern
	4 x 4	9	1.03	Aggregated clumped pattern
Nematode	1 x 1	144	2.63	Regular point pattern
soil	2 x 2	36	2.18	Random point pattern
population	3 x 3	16	1.38	Random clumped pattern
	4 x 4	9	1.16	Aggregated clumped pattern


Fractal pattern of each variables in block size 4x4
Fractal dimension
3
2.5
2
1.5
1
0.5
0
Number of eggs
F. solani
Aspergillus spp.
Soil moisture
pH
NO3
K
Variables


Fractal pattern of each variables in block size 2x2
Fractal dimension
6
5
4
3
2
1
0
Number of eggs
Nematode soil population
F. solani
P. lilacinus
Aspergillus spp.
Fungal egg parasitism
Soil moisture
Organic matter contents
pH
CaCO3
NO3
P
K
Variables

(a) (b)

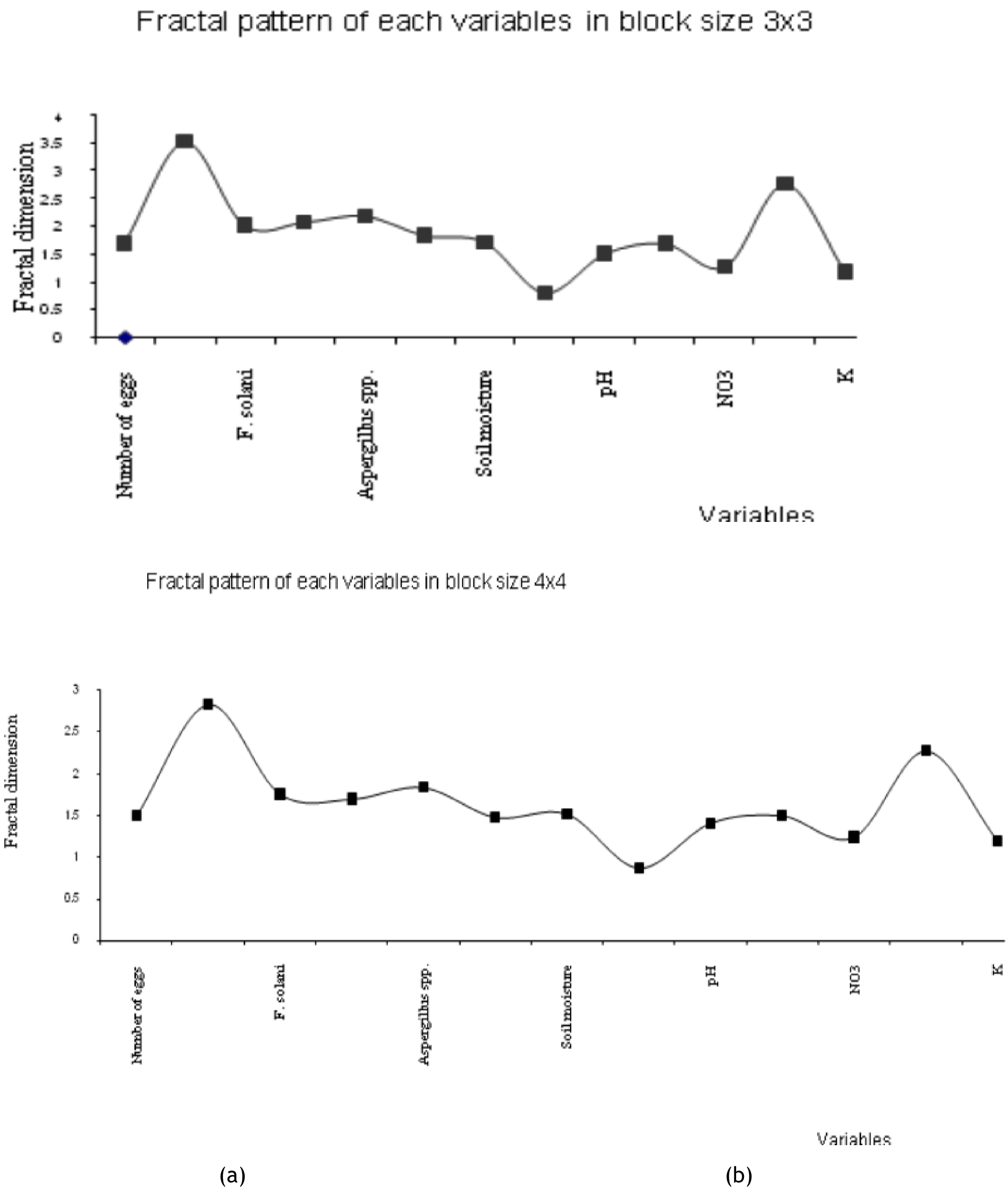


Figure 1. Self-similar pattern of fractal dimension in different block sizes.

sists 144 small grids and lowest dimension as 1.03 was found in class 4. Whereas, 2.63 and 1.16 dimensions from high to low were found to be within the nematode soil population. The pattern of the fractal dimension of various classes seems to be self-similar within the vegetation field (Figures -1a,1b,1c,1d).

4. Conclusion

Our study revealed that the pattern formation of the fractal dimension of the nematode soil population within the vegetational field of various grid sizes produced self-similar pattern regardless of the size of the grid matrix.

5. Acknowledgement

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