Summery

The secret of leaves

Abstract

1.The restatement and clarification of the problems

1.1 relational information

Leaf is the main organ of photosynthesis and transpiration in higher plants, usually consisting of a flat green blade attached to the stem directly or by a stalk-related[1].

1.1 The problem to be solved

Problem 1:Explain why the leaves have different shape.

Problem 2:Try to make out whether the shape of the leaves had have made to maximize exposure rate tendency.The number of leaves in the trees and their branch distribution would affect the shape of the blade.Make it clear that the profile of tree or branch structure for the influence of the blade shape.

Problem 3:The study how to determine a relationship between the quality and shape of the vane and the tree of the tree leaves the basic characteristics (height, mass, volume).

In addition to one page summary sheet we need to prepare a one page letter to an editor of a scientific journal outlining your key findings.

2.The analysis of the problems

2.1 Analysis of the problem one

In general, different types of trees have different shapes of planting has the leaves are not identical. This article from the inner and outer two aspects to illustrate the blades having different shapes. Internal causes a different gene, and the external cause is due to the blade in which the different environment.

2.2 Analysis of the problem two

For question two, we select similar to oval leaves as the object of study, research and idealized as elliptical leaves. In order to facilitate research, we consider only the idealized two forked trunk core shaped both the structure of the tree, and assume that the leaves grow parallel to the ground, the sun light is illuminated vertical leaves. The structure of the tree as the independent variable, and exposure as the dependent variable, when the maximum exposure when the tree has the structure to get the most likely structure of the tree. We consider a variety of blade exposure, and exposure with a given exposure closest blade shape in this tree structure can be

considered the most likely for the exposure and the structure of the tree are a certain tree, having a blade shape.

2.4 the analysis of problem three

When the leaves of the shape and structure of the tree is determined by computer simulation can calculate the total number of a the ideal tree structure under the leaves, so as to determine the total area of the leaves. To determine the total mass of the leaves, it must first determine the total volume and density of the leaves. after finding relevant literature, we suggest that the density can be taken in $0.78g/cm^3$ to estimate the total mass of the leaves. When the need to accurately determine the total mass of the leaves, we recommend the experiment to determine the density of the leaves of a particular tree.

3.The basic assumption of the problems

3.1 Foliage is assumed parallel to the ground Growth
3.2 Assuming the sun just vertical leaves irradiation
3.3 Assuming blade shape identical with planting trees growth

3.4 Suppose the tree is grown naturally, without human trimmed the tree lighting is not subject to interference from surrounding buildings or other adjacent tree

3.5 Assuming the leaves are long on the last node

4.Notations

5.Analysis and solution of the problem

5.1 problem one

5.1.1 genetic influence

Leaves are formed from a group of initial cells within the meristem. One of the earliest markers of leaf initiation is the down-regulation of KNOX genes in initial cells. Polar auxin activity, MYB and LOB domain transcription factors function to keep KNOX out of the initiating leaf. If KNOX genes are expressed in initial cells, leaves fail to form. As the leaf grows away from the meristem, its shape is determined by growth in three axes, proximal–distal, abaxial–adaxial and medial–lateral. HD-ZIPIII, KANADI and the small RNA pathway play a significant role in the latter two axes. KNOX proteins play a role in the proximal–distal axis. Although genetic networks are conserved between monocots and dicots, the outcome in leaf shape often differs[1].

5.1.2 environment influence

Environment for the shape of the leaves is extremely complex. Environmental factors may affect plant traits by temperature, light intensity, the pH of the soil and nutrient elements content. Biological shape is determined by genes, gene mutation is a universal law of nature, environmental factors can be selected gene mutation genotype screened able to adapt to the environment, eliminated can not adapt to the environment genotype. According to the central dogma genes control protein synthesis, and the presence of the protein determines the expression of the trait.

This is the mechanism of the influence of environmental factors for the blade shape.

5.2 problem two

5.2.1 modeling creation

Blades equation

As shown in the figure is a node on the length of an oval-shaped leaves， The angle between each leaf with the adjacent leaves 90^0 。 The major axis of the blade AC length L , Semi-minor axis BD length $\frac{L}{2}$, Petiole OC length $\frac{L}{3}$. OC with the X -axis is θ .

Then $\theta = 0$ elliptical surface equation can be expressed as:

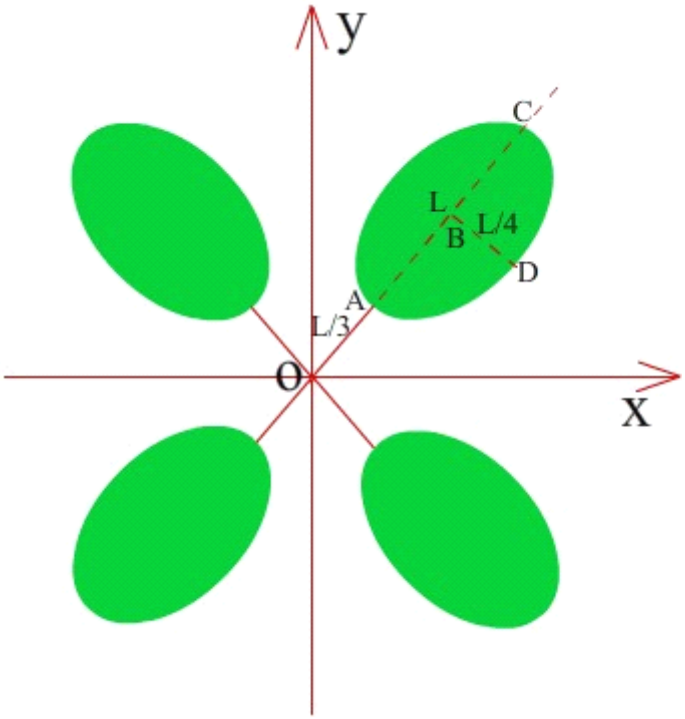
$$\frac{(x-\frac{5}{6}L)^2}{(\frac{L}{2})^2}+\frac{y^2}{(\frac{L}{4})^2}\le 1$$

Wherein, (x, y) represents the coordinates of the two-dimensional arbitrary point

Rotating coordinate transformation formula:

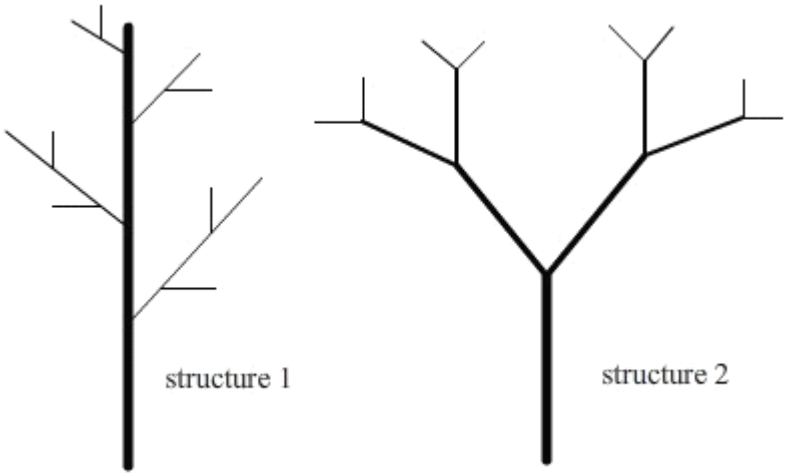
$$\begin{cases} y^{'} = x\sin\theta + y\cos\theta \\ x^{'} = x\cos\theta - y\sin\theta \\ y^{''} = y^{'} + y_1 \\ x^{''} = x^{'} + x_1 \end{cases}$$

Wherein, $(x^{'}, y^{'})$ in the two-dimensional Cartesian coordinates of the midpoint (x, y) coordinates after the rotation θ Angle, (x_1, y_1) represents the coordinates of the node O in the three-dimensional Cartesian coordinate system , $(x^{''}, y^{''})$ represents the midpoint of the two-dimensional Cartesian coordinates (x, y) coordinates in the three-dimensional Cartesian coordinates.



The idealized structure of the tree

Different trees its structure is generally different, this article select two representative structure diagram analysis, then describes how to match the structure of the leaves, the shape of the tree or contour. As shown below is a configuration diagram of two trees. A first configuration diagram collateral around the backbone of the growth of the second structure is a binary tree structure chart. Different trees its structure is generally different, this article select two representative structure diagram analysis, then describes how to match the structure of the leaves, the shape of the tree or contour.



We assume that the backbone of its collateral dry each section are cylinder.The first section of a length of 1.4m, and the section n branches are divided into a section of the branches of the two first $n+1$, the length of the section $n+1$ with the length of the section n have the following relationship:

$$L_{n+1} = 0.8L_n$$

Best tree structure and leaves shape matching

When the leaves on each node is 4, the branch node series n for 5,6,7,8,9,10 when, using $Matlab$ program can get the maximum exposure table is as follows:

Structure 1			Structure 2		
NODE	N	EX	NODE	N	EX
5	4	0.8135	5	4	0.8143
6	4	0.7209	6	4	0.6754
7	4	0.836	7	4	0.852
8	4	0.842	8	4	0.836
9	4	0.768	9	4	0.657
10	4	0.658	10	4	0.732

5.3 Problem three

5.3.1 the total volume of the leaves

The leaf area density (LAD) of a forest is an important indicator of forest biomass and is therefore pertinent to monitoring carbon sequestration and change. Quantitative physical models were used to estimate forest LAD from radar and hyper spectral airborne remote sensing observations. A parameter-estimation technique based on physical models minimizes the need for in situ observations and thereby facilitates global remote sensing of forest structure. Using data from the NASA Airborne Synthetic Aperture Radar (AIRSAR) and the NASA Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) over three forest plots in Central Oregon, parameters were estimated separately from the radar and hyperspectral data and then combined to form LAD. Gaussian relative LAD profiles were estimated from multialtitude interferometric and polarimetric AIRSAR data. Leaf area indices (LAI) were estimated from AVIRIS data and used to normalize the relative density profiles to produce LAD as a function of height. LAD was also determined from field measurements of geometric tree properties and LAI. LADs in the three forest plots were in the 0.02–0.18 m^2m^{-3} range[2].Obtained according to the leaf shape best match tree structure, and then the number of obtained leaves, so that is obtained by the total area of the leaves S. Then the total volume of the leaves V can be expressed as:

$$V = LAD \times S$$

5.3.2 the leaf mass of a tree

We denote M as the leaf mass of a tree， ρ as the average density of the leaves.we can get M：

$$M = \rho V$$

When estimating M， we can choose 0.78g/cm^3 to replace ρ， 0.1 would be a proper value for LAD.

6.References

[1].http://www.sciencedirect.com/science/article/pii/S1369526610001147

[2].http://cceo.gsfc.nasa.gov/veg3dbiomass/Treuhaft_InSAR_Profiles.pdf