Research and Application of Poplar Growth Model

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***Abstract*—In order to achieve the quantification analysis and visualization of poplar morphology, the technology framework of poplar simulation based on growth model is made. The paper carries out data collection and field observation, then the morphological structure parameters and knowledge models which can describe different poplar varieties are constructed, in the framework of the poplar growth models we integrate poplar morphological knowledge models and geometric models based on morphological character parameters, make the growth model of poplar can output morphological character parameters and topological structure, and further perform the geometric model reconstruction of poplar growth simulation. Practice has proved that the construction of growth models of poplar can simulate the poplar growth at different growth stages, and provide new ideas and means for growth simulation research of poplar morphology structure.**

Keywords- growth model; poplar; managment

I. INTRODUCTION

Poplar is one of the main fast-growing species, and the characters of poplars growth are the following: the speed of growth is very fast, growth timber is early, the yield is high, so the poplar plays an important role in improving the ecological environment and solving the problem of timber. According to statistics data, in china the poplar area is about 1.2 million acres, and the cultivation area ranks first in the world. Faced with such a wealth of poplar resources, it has become the great problems of forest resource nurture and wood processing and utilization on how to direct cultivation, implement intensive management, improve forest material, carry out rational development and utilization of timber resources, improve the comprehensive utilization of timber and maximize the value of the use of poplars, which requires that we timely monitor, forecast and analyze growth status, forest material and forest potential values during the growth process of poplars[1].

The study is to explore the feasibility that the growth model is applied to the wood production and quality assessment of poplar, and try to build the links of poplar parameters and timber yield and quality, so open up new poplar timber resources quality and economic value assessment way as well as broaden the growth model in the practice of forestry production and ecological construction, which have important theoretical and practical significance[2].

II. RESEARCH OF GROWTH MODEL

Growth model is that establishment of mathematical model is used to describe the growth and development of organs and formation of yield and quality of the relationship with the environment, and simulate growth and development process of poplar from the perspective of system. Research of poplar growth models is not only very important to scientific research, then make better understanding of characters of the poplar, but also is the formulation of policy analysis tools. Poplar growth model uses math equations to describe role process among poplar, soil, climate, and dynamic simulate poplar growth development and yield formation process[3].

The depth of ecological mechanism and the advances of computer technology of poplar greatly promote the development and application of poplar growth model, the poplar simulation models for the numerical simulation accurately express the relationship between growth and climatic factors change, and you can take advantage of the long time series of historical meteorological data, and the controllable factors are used to simulate the process of growth and development of poplar, show powerful features in assessing the impact of climate fluctuations on production yield risk early warning analysis, which has become a good tool for auxiliary of agricultural production decisions.

The poplar growth models have some advantages in the study of climate risk assessment: Machine rational reflects growing process of the poplar, the temperature of the stage production is with fertility, the relationship between precipitation and soil water is dynamic and comprehensive strong, different varieties, production simulation can be achieved in the combination of conditions of different sowing dates and a variety of climate background of different types of dynamic decision-making and climate change management can also provide the basis for new varieties of contingency management[4].

Physiological and ecological model can dynamic simulate poplar growth and yield formation, and accurate express the relationship between the growth and environmental factors, but also the controllable factors are used to regulate the growth development process of poplar, and predict poplar production under specific environmental factors such as poplar photosynthesis, fertilizer, soil respiration, and many of the specific growth mechanism models. The poplar growth process is a dynamic, random process, and is affected by many factors, such changes in poplar growth with age will exhibit complex nonlinear. The

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various theoretical models have their modeling conditions, applicable conditions and the scope, even in the case of meeting these preconditions, a variety of conventional models are also difficult to accurately describe the nonlinear relationship status and age of poplar growth, modeling and prediction results are difficult to achieve the desired results[5].

III. CONSTRUCTION OF SIMULATION MODELS OF POPLAR GROWTH

A. Simulation Model Base

The advanced poplar modeling theory at domestic and international and the basic framework of poplar growth simulation model are considered, combining with different types of varieties, sowing date and nitrogen fertilizer test simulation, a comprehensive growth simulation model based on physiological and ecological processes is built. The entire model consists of following sub-modules: the model of growth and development, morphological development model, the impact model, yield formation model, nutrient model[6].

1)Growth Development Model: Poplar growth and development of the physiological and ecological processes are considered, the canopy, crown varieties parameters are introduced to quantitatively describe the differences between the different varieties, and the interaction between them determines the size of the daily physiological effects, and are accumulated to form the daily physiological development time and physiological development time scales as quantitative reproductive process, build forecast growth stage developmental model.

2)Morphological Development Model: By quantitative leaf, root, stem length or weight and physiological development time or growing degree days are used to ask the relationship, the water impact factors are introduced to regulate organ growth and demise, and we can define the maximum potential growth of the various organs of different species to reaction between species. The genetic differences leaf, root, stem growth sub-model are constructed, achieving comprehensive simulation of poplar morphology.

3) Impact Model: By calculating the photosynthesis of flowers, leaves simple, and effective calculation of each layer of the photosynthetic amount is made and we can daily make canopy assimilation, and the establishment of physiological age, nitrogen, temperature and other factors on poplar photosynthesis impact model are constructed, and respiration and photosynthetic products model of the impact of models are made.

4) Yield Formation Model: The relationship between the growth of poplar organs and developmental processes and environmental factors are made, the physiological development time-scale is used to describe the dynamic changes of the organ allocation index, and then assign index to predict the dynamic allocation of the total dry matter in the various organs of the poplar and predict by calculating assigned to pod of dry matter yield formation.

5) Nutrition Model: The soil and water balance principle are considered, it presents the contribution of shallow groundwater levels which is caused by capillary rise of water and soil hydraulic conductivity changes of soil moisture changes, impact factor and water stress factor by drought stress, simulate drought growth and develop poplars and water, poplar growth model coupled soil water dynamics model is made. Drought stress impact factor depends on the moisture content of soil critical; the water factor algorithm not only take into account different kinds of poplars, high and low soil moisture caused by waterlogged differences, but also consider the water time at different growth stages water sensitivity differences and other factors[7].

B. Model Validation

The model validation considers the three aspects such as development, growth and the final yield, and as index it is very important to detect growth development and estimate the poplar layer productivity, meanwhile it is a key variable in many growth models, these poplar growth models can be used to simulate the growth process of the poplar, calculate the daily growth and growth rate of poplar, then further estimate the dry matter yield of poplar. We use the root mean square error (RMSE) to test the conformance of actual values and measured values, and the RMSE is much smaller, the error of measured and simulated value is more less ,and the degree of consistence is much better[8].

IV. IMPLEMENTATION OF POPLAR GROWTH MODELS SYSTEM

A. Model Management

In order to display the results of the decision-making of intelligent systems, and improve the decision-making capacity of the agricultural expert system, based on the original intelligent system architecture, the poplar growth model based on new type of intelligent system architecture framework is proposed. The system consists of model management module, knowledge base management module, inference engine, and database management module and model library, knowledge base, database, and human-computer interaction interface. There are close contact among model management module, database management module and knowledge base management module. The model management module is responsible for coordinating the work between each models, quantitative reasoning is used to achieve different objectives. Database resource database and user database include the following: The resource database forward of poplar and local basic resource data, such as pest and disease data, meteorological data. The user database storage with system-related data, when the system is running, the users input the data, the middle of reasoning gets the results and the final results. The database management module is responsible for coordination of data and provides the knowledge base. Because of the diversity of knowledge that may exist between the different knowledge, the need for knowledge management module is used to

compare a variety of knowledge, screening, refining, in order to obtain reliable knowledge.

According to user questions and known facts, the inference engine can search in the knowledge base, and match to activate the appropriate knowledge, which is calculated and inferred by the known facts, and user questions can contribute to obtain the relevant knowledge of or reasoning until the final solving problem or known conditions can not be solved so far.

After getting decision results of inference engine, and the external environmental factors are regarded as the input of growth machine model, the interaction of morphogenesis physiological ecology model contributes to calculate the growth conditions of the various stages of poplar under different environmental factors, then reuse animated computer visualization technology to generate three-dimensional graphics that can reflect the poplar current growth status or their growth process, then visually display the decision-making results of intelligent system.

B. Implementation of System

The idea of growth model, physical model, mathematical model, displaying model are followed, and the models of poplar topological structure and organ morphology parameters are generated, so we can picture out the three-dimensional shape of the various organs, achieving reconstruction of different growth stages of poplar individual three-dimensional shape. The number of strains and line spacing and the poplar information are further input, the poplar groups can carry out the canopy of poplar 3D virtual exhibition visual computing. Based on the ideas and methods of the above modeling, the vc and opengl development microcomputer software system are used. The opengl 3D graphical interface program is developed, it provides a series of rendering three-dimensional graphics functions, using the system to achieve three-dimensional visualization of the organs of poplar modeling and canopy with a strong real sense.

V. FUNCTIONS OF GROWTH MODEL

A. Data Management of Poplar Growth Resource

Through the access of properties data we can achieve the all kinds of operation of attribute data and statistical analysis, achieve the display of spatial data and common management functions such as map searching properties, point, line and plane spatial analysis.

B. Knowledge Management of Polar Growth Management

The data mining algorithms are used, and knowledge rules are exacted from the small data extraction, then achieve the operation of knowledge rules in the knowledge base, and provide import and export functions of knowledge. The growth and harvest management carry out management on growth harvest models base, perform the operation of growth and harvest model, and parse function of growth and harvest model.

C. Three-dimensional of Poplar Growth Management

The wooden three-dimensional model of the poplar library is managed, then achieve the displaying, query of three-dimensional model of wood poplar.

D. Decision Making of Poplar Growth Mangement

The poplar species forestation program and selection decisions are achieved, and three-dimensional visual simulation of poplar scene is made on the present growth state and future state of poplars. The three-dimensional scene provides scene sky, light and other environmental effects reality, and scene roaming, enabling users to make scene of poplars from any place and perspective standing scene.

VI. CONCLUSION

In this paper, the integrated growth simulation model is constructed based on the physiological and ecological process, and we can use these models to perform monitoring and analysis on the growth conditions of poplars, material and potential utilization value of timely, evaluate the reasonable use of poplar, at the same time provide basis for poplar management and definite cultivating. The dynamic simulation based on the growth of poplar can reflect the poplar growth and the environmental variables, such as the growth, yield and growth stages of temperature, precipitation and soil moisture dynamic relationship.

The poplar climatic productivity and climate simulation risk analysis are made, and the mechanism is very high, which can provide reliable technical support for poplar production decision making management and climate change management, the poplar simulation models can be used for different varieties, different sowing dates and various climate background combinations yield under conditions of simulation, and which can e achieve dynamic decision and climate change management in different years type, but also provide a basis for the new varieties strain management, presents scientific basis and technical support for production dynamic decision of different regions and different climate year.

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REFERENCES

[1] Reeves WT, Blau R,"Approximate and probabilistic algorithms for shading and rendering structured particle systems,' Computer Graphics, vol3,pp.313-322,1985.

[2] Hu BG, De PR, Zhao X, etal," GreenLab: A new methodology towards poplar functionalst ructural model-Structural aspect," Proceedings of 2003 'International Symposium on Poplar Growth Modeling, Simulation,Visualization and their Application. Beijing, Tsinghua University Press and Springer,2003, pp. 21-35.

[3] Huai Xiaoyong, Xiong Fanlun," Research on new architecture intelligent systems and it system development environment-visual XF61," International Symposium on Intelligent Agriculture Information Technology (ISIAIT2000), Beijing, PR China, 2000, 124.

[4] Ritchie J T," Model for predicting evaporation from a rowcrop with in complete cover," Water Resources Research, vol8,pp.1204-1213,1972.

[5] Baker D N, Lambert J R, MeKinion J M," GOSSYM: Asimulator of cotton crop growth and yield," Tech. Bull, 1089. South Carolina Agric Exp Stn. ClemsonUniversity, Clemson. 1983.

[6] Van Keulen H, Penning de Vries FWT, Drees EM," A summary model for crop growth. In: Penning de VriesF WT, van Laar HH (eds.), Simulation of poplar growth and crop production,"Simulation Monographs, PUDOC, Wageningen, The Netherlands,pp.87-98, 1982.

[7] Penning de Vries F W T, Jansen D M, ten Berge H FM, eta1," Simulation of ecophysiological processes of growth in several annual rops,"Simulation Monographs, PUDOC,Wageningen,The Netherlands,1989,271.

[8] McCown R L, Hammer G L, Hargreaves J N G, eta1,"APSIM:A novel software system for model development, model testing and simulation in agricultural system research,"Agricultural System, vol50,pp.255-271,1996.