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The study of under different competition index the density of Larix principis plantation

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***Abstract*—Stand density is the number of trees standing in the process of tree growth on the unit area, it stands to grow development, stability, forest production, quality and other factors have important links. Based on a survey of different densities of *Larix* principis plantations，the thesis adopts the Hegyi model which using a single wood competition index model to calculate the competition index，proposing crown width competition index. Then fit the crown width, diameter at chest height and relative crown width competition index and derive the equation. It suggests that when the competition index were 0.8,0.6,0.4,0.2, management density of *Larix principis* plantation. It can provide some basis. for management of *Larix principis* plantations.**

Keywords-Larix principi;:competition index; planting density;

[1]Planting density is the number of indicators of plantation community structure, forest stand density is constraining the key factors during the development of plantation ecosystem stability and an important impact on biological productivity[1] 。Numerous of scholars[2-4] have been conducted in-depth discussion about plantation stand density and plantation growth。The complexity of the forest is mainly embodied in its density and species composition, horizontal and vertical structure, stand density and distribution patterns of forest community ecology become to the most basic of elements[5] 。Under different competition index *Larix principis* perennial object of study, analysising the current forest land within the community characteristics and individual growth status of *Larix principis* to clarify what kind of density in the *Larix principis* plantation to achieve its maximum ecological and economic benefits for local forest management to provide information。

I. COMPETITION INDEX

In the study of forest ecosystems， biology and environment relationship between the amount of forest quality to determine the level of the important factors By a variety of tree species composition of forests, species within the species and the environment constitute a complex relationship，On this vast and complex forest ecosystem research and knowledge base start from the individual trees。Competition is the common phenomenon in forest ecosystem; it shapes the plant morphology, life history, and is one of the main driving force, having a profound impact on plant community structure and dynamics. The concept of tree competition was formed in the late 19th century, the methods are mainly qualitative description and quantitative analysis of two。Kraft raised forest classification method from the1884as described by competition between qualitative form counting, qualitative methods have l00 years of history, From 1951 GR. Staebler was first proposed tree competition index a mathematical method of counting quantified the relationship between competition and quantitative methods are only 50 years。

According to competition indicators whether the timber contains objects of wood and competition between the relative position of the index, it can be divided into two categories competition index， That is independent of distance and distance competition index of competition index. With the distance of individual tree competition index to predict the best model Hegyi, so this paper proposed Hegyi's (1974) single tree competition index model to calculate the competition index，the calculation formula:

$$CI_i=\sum_{j=1}^{n}\frac{dj}{dl\times Lij}$$

In the formula, Cl_i competition for the object index of wood i; L_{ij} and competition for the objects of wood i j the distance between the wood; d_i is for the object's diameter wood; d_j competition, the diameter of wood j; n is wood for the competition, number of trees, as and to crown competition index for the variable distinction in mind as Cl_D。

Canopy characteristics plays an important role on stand density, competition of the crown will directly affect the growth of trees. This study is the introduction of crown competition index for the analysis of crown size, competition index and the relationship between diameter at breast height。Modify the variable di and d_j to CW_i and CW_j, the competitive index formula becomes:

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$$CI_{CW}=\sum_{j=1}^{n}\frac{CWj}{CWi\times Lij}$$

The formula, Cl_{cw} competition for the object index of wood i; CW_i the crown for the object timber i; CW_j j wood for the competition's crown; L_{ij} and competition for the objects of wood i j the distance between the wood; n is the number of plant competition in wood. Select the object wood, wooden competition the competitive index calculated.

In ecology, Logistic equation is the most commonly used model of population dynamics simulation.

$$Y=\frac{A}{1+me^{-rt}} \quad (A, m, r>0)$$

In the formula, A is a maximum tree growth parameters, $A = Y_{max}$; m with the initial value of the parameter; r is intrinsic rate parameters. As the nutritional stand in tree growth is limited, forest tree growth process will be limited competition, while the size of y increases with the stand, competition makes tree growth rate ($\frac{1}{y}\frac{dy}{dt}$) is on the y (t) the linear decrease function。

Logistic Curve is a typical initial value symmetrical "S" shaped growth curve. However, the equation have y maximum inflection point in the half (A / 2) Service, the equation of growth rate decreased linearly with its size。All studies show that the Logistic equation is suit for description slow-growing species of tree growth, while rapid growth of other species of its low accuracy. On the crown, DBH and competition index the relationship structure equation:

$Lr=AD^{b(1-Ci)}$ in this formula, Lr is crown, D is diameter, C_i is relative competitive index stands, A, b is a parameter。

II. THE STUDY AREA AND RESEARCH METHODS

A. *Overview of the region*

Magnolia State Forest Administration in the Luan River area, located in the paddock Manchu and Mongolian Autonomous County, Hebei Province, geographic coordinates, 116°32 '~ 118°14'E, 41°35' ~ 42°40'N,east to west, 128km, north-south width of 96km total operating area is 102666.7hm^2.MA Lin-wood south is Beijing and Tianjin area, north is Inner Mongolia sandy land, not only is downstream "Panjiakou reservoir" source of water conservation and the principal source of Luan River, but also is the upper hand in Beijing area and ecological impact of Beijing important environmental quality sand channel。 Flora of the Northeast District Department of Inner Mongolia, fauna and flora of the intersection with North China, is divided into 7 vegetation types 53 formations, there are 382 vascular plant families are 693 kinds。Trees are mainly *Larix principis*, pine, spruce, birch, poplar, oak, elm, etc.; shrubs mainly apricot, sea buckthorn, Lespedeza bicolor, Spires, etc.; herbs mainly Elymus, sheep beard grass Artemisia etc。

B. *Community survey methods.*

Sample set in Hebei magnolia forest. The distribution of the vegetation to plantations was mainly distributed in the shallow hills and low mountain areas, the main tree species are *Larix principis*, pine, acacia, and orientalis, etc., the forest coverage rate reach to 80%.。Because of tree competition and tree density problem, it needs to select the representative and without bringing the forest，First of all, Our sample area is 50m x 50m, l0 blocks in total. First of all, we locate the place where each tree grows, and then measure the tree height, crown width, and branch of Higher. Table 1 Basic condition for the *Larix principis.*

TABLE Ⅰ STATISTIC OF DESCRIPTION FACTOR OF SAMPLE-PLOT

Sampe plot	breast diameter(cm)			crown width(m)			tree height(m)		
	D	Dmin	Dmax	C	Cmin	Cmax	H	Hmin	Hmax
1	7.5	4.5.	10.5	4.3	3.0	6.5	6.8	5.5	9.0
2	7.2	3.6	9.2	4.0	3.0	6.0	6.2	5.0	8.5
3	8.2	4.6	10.8	4.3	3.5	6.8	8.5	6.2	12.0
4	9.5	4.9	12.5	5.0	4.0	8.0	8.6	5.0	12.8
5	9.9	5.0	12.8	6.0	4.2	8.8	9.3	6.7	13.5
6	10.9	7.6	14.3	7.8	4.0	11.0	9.2	6.0	13.0
7	12.4	8.3	15.6	7.5	4.5	10.0	12.5	8.0	15.6
8	12.6	8.5	15.0	8.0	5.0	12.0	13.5	9.6	17.5
9	14.8	10.5	17.5	8.0	5.4	13.0	14.5	8.4	16.5
10	17.7	12.4	23.6	8.5	5.0	12.0	15.8	9.5	18.7

Firstly, it should calculate the competitive index of wood per plant object, which measured from the application of ArcGIS to complete the distance measurement function, the single *Larix principis* tree competition index points between the average diameter class competition index, will be the competition in a single sum of sub-species and the average, are groups of competition index, the individual competition index。

Although *Larix principis* crown competition index tended to be stable in the larger diameter, but compared to other competitive index is still large, because the crown is a forest occupied the upper room, easier to overlap between individuals, easily in competition。*Larix principis* is for the population, due to high initial planting density, plant size is closer to its strong intraspecific competition。Forest, the understory seedlings and saplings in addition to the updated tree with the age-class competition, but also to compete with the upper tree, the competition indices, competitive; the upper tree has been occupied since the growth of certain space for larger plants competition intensity decreases, competition tends to weaken and long-term stability。

A. *Competition and stand density index*

Stand density is the unit area of standing trees number of trees on forest land。The significance of the stand density is to fully understand the interaction between group and individual law, Growth and development in the process of trying to stand by artificial measures such as thinning, stand density control, So that is always in a reasonable density among the groups, This group structure makes each individual not only sufficient conditions for growth and development, but also maximize the use of space resources, So as to enhance the quality and efficiency of the entire forest purposes.

Selecting the number of *Larix principis* wood to do analysis, Analysis of wood on the relationship between the age and diameter at breast height, using the Logistic equation fitted, By age and diameter *Larix principis* regression equation, Theoretical diameter calculated according to equation times the entire class of acts, variance analysis and correlation test.

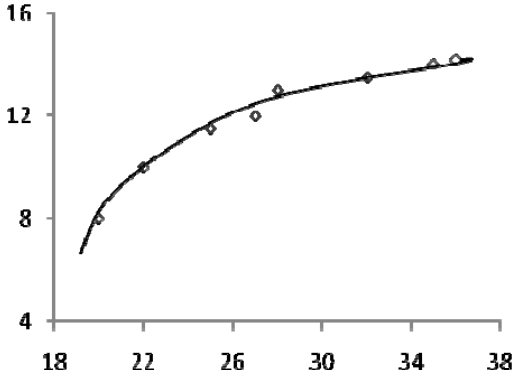

Fig.1 Regression curves of age and DBH of *Larix principis*

After fitting the crown, DBH, and competition index, we obtained this formula: $Cr=0.8D^{0.55(1-Ci)}$. In this equation, Cr stands for the crown, D stands for diameter, Ci stands for crown competition index. We calculate the crown area as a similar circle. The number of trees forecast per hectare equates 10,000 divided by the crown area. Under different competition index, we get the optimum management density.

TABLE Ⅱ ANOVA OF CROWN WIDTH COMPETITION INDEX EQUATION

	sum of squares	Df	mean square	F value	Significance
regression analysis	179.3	2	89.6328	470.89	<0.0001
residual	6.4719	34	0.1903		
total	185.8	36			

TABLE Ⅲ COEFFICIENTS

						correlation test	
F value	F test	Significance	|T|value	T test	Significance	Partial	Part
1.385	1.757	0.17	0.082	1.994	0.993	0.85588	<0.0001

TABLE Ⅳ THE STAND DENSITY

Diameter Class	Competition index =0.8		Competition index =0.8		Competition index =0.8		Competition index =0.8	
	crown width	density	crown width	density	crown width	density	crown width	density
8	1.16	9467	1.45	6058	1.83	3804	2.41	2193
10	1.19	8996	1.53	5442	1.96	3316	2.68	1774
12	1.21	8701	1.60	4976	2.08	2944	2.91	1504
14	1.23	8420	1.64	4736	2.20	2632	3.13	1300
16	1.25	8153	1.70	4408	2.30	2408	3.33	1149
18	1.26	8024	1.74	4208	2.39	2230	3.52	1028
20	1.28	7775	1.78	4020	2.47	2088	3.69	936
22	1.30	7537	1.82	3845	2.55	1959	3.86	854
24	1.31	7423	1.85	3722	2.63	1841	4.02	788

When it is the same diameter, *Larix principis* crown increases as competition index decreasing, stand density decreases with the increase of crown. In the same competition index, stand density increases with the decrease of DBH. This indicates that the index of the competition and the stand density has the same trend: when the competition index increases, stand density also increases. When competition index drops to a more stable number, stand density is relatively fixed.

III. CONCLUSION

From the survey and data analysis to draw，Part of a larger density of larch plantation forest，In order to achieve the optimal stand density, thinning need to take appropriate measures，Adjust the stand density in order to eventually get both high-quality trees，help foster a large diameter timber，They can also be obtained in the course of forest management thinning wood, improve the efficiency of forest utilization, increase economic efficiency, to achieve ecological and economic win-win situation. Study the distribution of competition index，The establishment of the competition exponential number of trees in the prediction model，Important to help us understand and grasp the differentiation and growth of forest，To formulate a reasonable basis for thinning programs。On the same stand, the tree seed source, age, site conditions, the same。Individual tree growth depends on the size of the state of competition among trees，Will stand in the size of tree diameter growth divided by the growth stage，Given the scope of the growth level. From a single tree growth model calculated the corresponding anti-competitive threshold for or directly competitive index divided by the growth of class. Exponential number of trees predicted by the model competition and easily estimate the number of trees of various growth levels and the proportion of trees，It provides basis for the strength and estimate time of planting and cutting scheme of the forest.

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