Structural characteristics of oak plantation in Danjiangkou reservoir area

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Abstract. In this paper, the frequency distribution of DBH and DBH of oak plantation was simulated by using normal distribution, and the relationship between DBH and tree height, DBH and crown area was fitted by 11 common curve models. The relation between DBH and tree height was well simulated by S model and cubic curve model. The relationship between DBH and crown area was simulated by cubic and quadratic models.

1. Introduction
Danjiangkou reservoir is an important strategic water resource area in China, which is the source and protection area of water resources in the middle route project. Forest vegetation plays an important role in water conservation and water purification. At present, the common forest types in the reservoir area include: masson pine, oak tree, lateral cypress, citrus, etc. As the main forest type of ecological welfare forest, the oak tree is widely distributed in danjiangkou reservoir area. The study on the forest structure of oak plantation can not only understand the current situation of the stand, but also lay a foundation for the further adjustment of the stand structure and give full play to its role in water conservation and water purification.

2. Overview of the research area
This study is located in longkou forest farm of danjiangkou city (110°48’ ~ 111°35’ E, 32°14’ ~ 32°58’ N) in the middle line of the south-to-north water diversion project. The weather is a subtropical semi-humid monsoon climate, and has features as: four distinct seasons, mild climate, sufficient sunlight, rich in heat, rain and heat in the same season, long frost-free period and so on.

The annual average temperature is 15.9℃, the maximum extreme temperature is 41.5℃, and the minimum extreme temperature is 12.4℃. The annual rainfall ranges from 750mm to 900mm, among which January has the least rainfall, June to September has the most. The average annual rainfall is 123d, the annual evaporation is 1979.1mm, the annual sunshine hours are about 2009.6h to 2059.7h, and the frost-free period is 180 to 250d. Landform types are mainly low hills and hills, most of the soil is yellow brown soil and yellow soil, and the parent material of the soil is developed from limestone, gneiss and so on, with loose texture.
The forest type in the reservoir area consists of plantation and secondary forest. The dominant trees are mainly Pinus massoniana, and the secondary dominant trees include Quercus variabilis, Cupressus funebris, Citrus reancao, etc. Species of undergrowth vegetation were basically similar, among which Ziziphus jujuba, Zanthoxylum bungeanum and Sophora davidii were dominant species. Herb in order along the grass (Ophiopogon bodinieri), presses the grass (Oxalis corniculata), Imperata cylindrica (Imperata cylindrica), winding stone (Trachelospermum jasminoides) etc as the dominant population.

3. Research methods
In September 2018, selected typical oak forest in the research area, set 6 20m*20m quadrats, and measured DBH, tree height and crown width of each wood with a measuring scale, a total of 685 trees. SPSS software was used to simulate whether the distribution of DBH and tree height conforms to the normal distribution, and then the relationship between DBH and tree height, DBH and crown width was fitted with different curve models.

Table 1. Curve Models.

| Models      | Equation                          |
|-------------|-----------------------------------|
| Linear      | $Y = \beta_0 + \beta_1 x$        |
| Quadratic   | $Y = \beta_0 + \beta_1 x + \beta_2 x^2$ |
| Compound    | $Y = \beta_0 \beta_1 x$          |
| Growth      | $Y = e^{\beta_0 + \beta_1 x}$    |
| Logarithmic | $Y = e^{\beta_0 + \beta_1 \ln (x)}$ |
| Cubic       | $Y = \beta_0 + \beta_1 x + \beta_2 x^2 + \beta_3 x^3$ |
| S           | $Y = e^{\beta_0 + \beta_1 x}$    |
| Exponential | $Y = \beta_0 e^{\beta_1 x}$      |
| Inverse     | $Y = \beta_0 + \beta_1 / x$      |
| Power       | $Y = \beta_0 (x^{\beta_1})$      |
| Logistic    | $Y = 1 / (1 + \beta_0 \beta_1 x)$ |

4. Results analysis

4.1 Fitting of tree height and DBH distribution in oak plantation

Figure 1: H and DBH frequency of oak plantation
According to figure 1, the DBH and tree height of oak plantation were well in line with normal distribution. Average DBH was 7.8±4cm, skewness 1.7±0.9, kurtosis 3.1±1.8, maximum DBH was
25cm, minimum DBH was 2.5cm. The mean tree height was 8.1±2.7m, and the skewness was 0.43±0.9. The maximum value of tree height is 15.8m, and the minimum value is 1.2m.

4.2 Relationship between tree height and DBH in oak plantation

Through comprehensive comparison of different models, the s-shaped curve was the best simulation result (R²=0.46, P<0.01), beta 0=2.6, beta 1=-3.586. Cubic curve model followed (R²=0.445, P<0.01), beta 0=0.336, beta 1=1.686, beta 2=-0.091, beta 3=0.002.

4.3 Curve fitting of DBH and crown width area in oak plantation

By comprehensive comparison of different models, cubic curve simulation results were the best (R²=0.398, P<0.01), beta 0=0.892, beta 1=-0.355, beta 2=-0.155, beta 3=-0.003. The second is the conic model (R²=0.397, P<0.01), beta 0=-1.787, beta 1=0.605, beta 2=0.058.
5. Discussion
In this paper, normal distribution was used to simulate the frequency distribution of DBH and DBH of oak plantation, and 11 common curve models were used to fit the relationship between DBH and tree height, DBH and crown width area. Diameter and tree height are the most important factors for forest survey, while in field survey, diameter is easy to be measured, with high precision, high speed. Through this study, the relationship function between tree height and DBH is obtained. In the future field investigation, some tree height values can be measured, and the tree height value can be calculated through the research function. Therefore, it is necessary to build a simple and accurate relationship model between tree height and DBH for more effective forestry management. Canopy width is closely related to canopy interception in forest hydrology, and the establishment of the relationship between DBH and canopy width can lay a foundation for further establishment of canopy interception model.

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