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Study on Biological characteristics of maize plant

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Abstract: *By dividing the structural parts of the maize plant, the morphological parameters of the maize plant height, minimum ear bearing height, ear length, ear big end diameter, stalk length, and stalk diameter were measured and counted, and the regression fitting model of maize plant height and minimum ear bearing height was obtained; The analysis method of frequency distribution histogram is used to count and analyze the diameter of different nodes of corn stalk, and the moisture content at different positions of corn stalk is measured according to the determination method of GB/T1931-2009, which provides a basis for the determination of parameters of ear picking device of corn combine harvester.*

Key Word*: Maize plant, Biological characteristics, Moisture content, Determination*

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I. Introduction

With the improvement of Agricultural Mechanization in China, China's corn output surpassed rice in 2012 and became the largest grain crop in China. According to the statistics of China Statistical Yearbook [1], the sown area of corn in China in 2019 was $4.13\times10^7 hm^2$, a year-on-year decrease of 2%; In the same year, the corn yield was as high as $2.61\times10^8 t$, with a year-on-year increase of $3.6\times10^6 t$. On the one hand, the diversified development of the corn seed industry has expanded the space for the substantial increase of corn yield per unit area; On the other hand, it benefits from the rapid development of the whole process mechanization of modern maize [2-5]. In the process of corn ear picking, the shape structure and shape size of corn plant affect the design parameters of ear picking device, such as stem diameter, ear setting height of corn, and large end diameter of the ear with bracts, which have the most direct impact on the parameter design of ear picking device[6-8]. According to reference[9], the material characteristics of corn stalk and corn ear are two important indexes for studying corn plants. The premise of the rapid development of corn harvesting machinery is to master the basic biological characteristics of the corn plant. To explore the characteristics and internal connections of each structure of corn plant and master some biological characteristics of the corn plant, The material properties of maize plants were studied.

Shape and structure of maize plant

As shown in Fig. 1, the corn plant is mainly composed of the heel, supporting root, stem, ear, and other parts. The corn stem is mainly composed of nodes and internodes, and the diameter size and strength of internodes are less than those of nodes [10-12]. The diameter of internodes and nodes below the ear setting part of the whole stem is significantly larger than that above the ear setting part. Therefore, the research on maize stem in this study is mainly the part below the ear setting part.

According to the agricultural machinery design manual [6-8], stem diameter, corn ear setting the height, and large end diameter of the ear with bracts have the most direct impact on the parameter design of ear picking device. At the same time, to facilitate the description of follow-up research, Fig. 1 divides and names the parts of the corn plant. The whole corn plant can be divided into two parts above and below the ear setting part, The first node on the surface of the corn stalk is defined as the first node (i.e. the node where the material is taken manually), the node above it is defined as the second node, and so on, that is, from the root of Maize to the stamen of maize, it is defined as the first node, the second internode, the second node and the third internode…

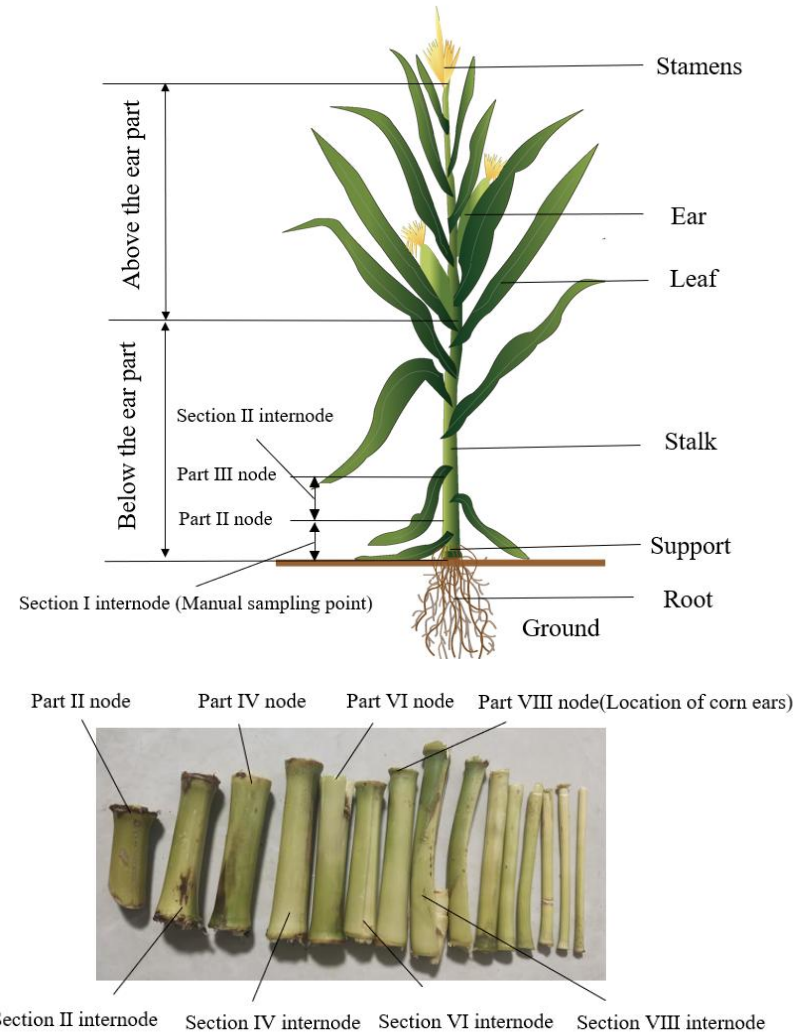


Fig. 1 Division diagram of each section of whole plant maize

Determination and analysis of maize plant morphological parameters

According to the five-point sampling method, the plants with spikes with similar diameter, straight, no wormhole, and no bending damage are cut down manually in the same field as samples. In the sampling process, a very small number of corn plants have two ears. Because one ear is not mature and the grain characteristics are not obvious, these kinds of plants are ignored during sampling. The samples are all corn plants with one ear.
Several maize plants were randomly selected from the sample, and the morphological parameters such as plant height, minimum ear height, ear length, ear big end diameter, stalk length and stalk diameter of maize plants were measured with vernier caliper, meter ruler and other tools, and the average value and coefficient of variation of each parameter were calculated. The measured values are shown in Tab. 1.

Tab. 1 Morphological parameters of maize plants

Unit:mm

Serial number	Plant height	Minimum panicle height	Ear length	Ear big end diameter	Fruit stalk length	Petiole diameter	Top straw diameter	Ear setting position
1	2310	927	250	24.6	99	17.3	4.5	7
2	2270	921	241	23.7	117	15.6	5.6	8
3	2270	925	255	21.5	120	14.5	5.7	9
4	2210	846	251	20.7	91	16.1	6.1	8
5	2200	811	248	21.4	141	13.7	6.1	9
6	2200	895	235	21.9	134	12.1	5.2	8
7	2200	961	261	23.7	126	12.9	5.2	9
8	2120	840	233	21.2	95	14.7	5.3	8
9	2100	979	249	23.4	120	15.1	5.3	8
10	2080	931	231	22.6	121	13.9	5.4	9
11	2060	893	255	22.3	125	14.2	5.6	8

12	2030	934	230	22.3	115	14.3	6.8	8
13	2000	834	246	21.3	115	15.8	6.8	8
14	2000	897	262	20.1	113	15.9	4.6	8
15	2000	927	257	23	110	13.4	4.7	7
16	1995	933	238	23.3	96	16.6	5.1	8
17	1980	885	257	20.7	100	17.6	7.1	9
18	1950	884	242	23.9	95	12.5	6.7	8
19	1950	939	243	25.3	115	12.9	6.8	9
20	1930	889	265	23.5	90	16	6.4	9
21	1910	816	236	20.5	93	14.4	6.4	8
22	1910	838	212	22.5	94	15.7	6.5	7
23	1910	899	240	24.2	98	14.5	6.5	8
24	1900	1013	243	22.5	92	14.6	6.7	9
25	1870	833	227	22.1	130	13.8	5.4	8
26	1870	898	236	23.8	113	16.3	5.5	8
27	1850	812	235	20.8	115	16.4	5.4	9
28	1850	842	221	21.5	100	12.4	5.4	9
29	1800	893	230	21.4	105	16.3	6.6	8
30	1780	847	205	20.6	110	13.3	5.1	9
Average value	2016.83	891.40	241.13	22.34	109.60	14.76	5.84	8.33
Coefficient of variation	7.392	5.77	5.93	6.14	12.76	10.14	12.80	7.28

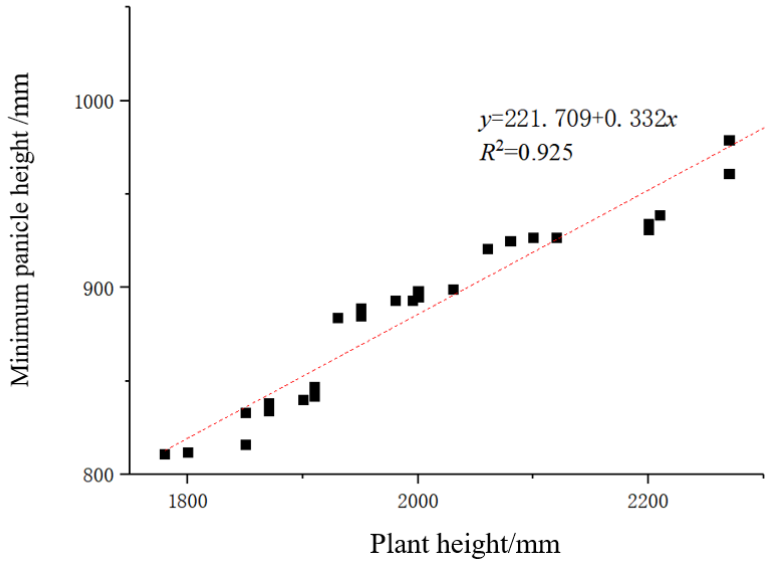


Fig. 2 Relationship between plant height and Minimum panicle height

The least-square method is used for linear regression fitting of plant height and minimum ear setting height of maize plant, and the fitting curve shown in Fig. 2 is obtained. The parameter values of the fitting model are shown in Tab.2.

Tab.2 Fitting model and parameters

Unit:mm

Parameter	Value
Fitting equation	$y=a+bx$
Intercept a	221.709±35.38361
Slope b	0.332±0. 0175
Pearson's R	0.963
R^2（COD）	0.928
After adjustment R^2	0.925

It can be seen from Tab. 2 that the fitting regression equation is

$$y = 221.709 + 0.332x \quad (1)$$

The R^2 of the fitting curve is 0.925, which indicates that the goodness of fit of the model is high and can better reflect the relationship between the plant height with the panicle and the minimum panicle height.

Pearson's R is 0.963, which indicates that there is a positive correlation between the plant height and the minimum panicle height. As shown in Fig. 1, the manual sampling process is to cut down the first section of the ground stem. In addition, considering that the corn is cut from the second section of the stem during

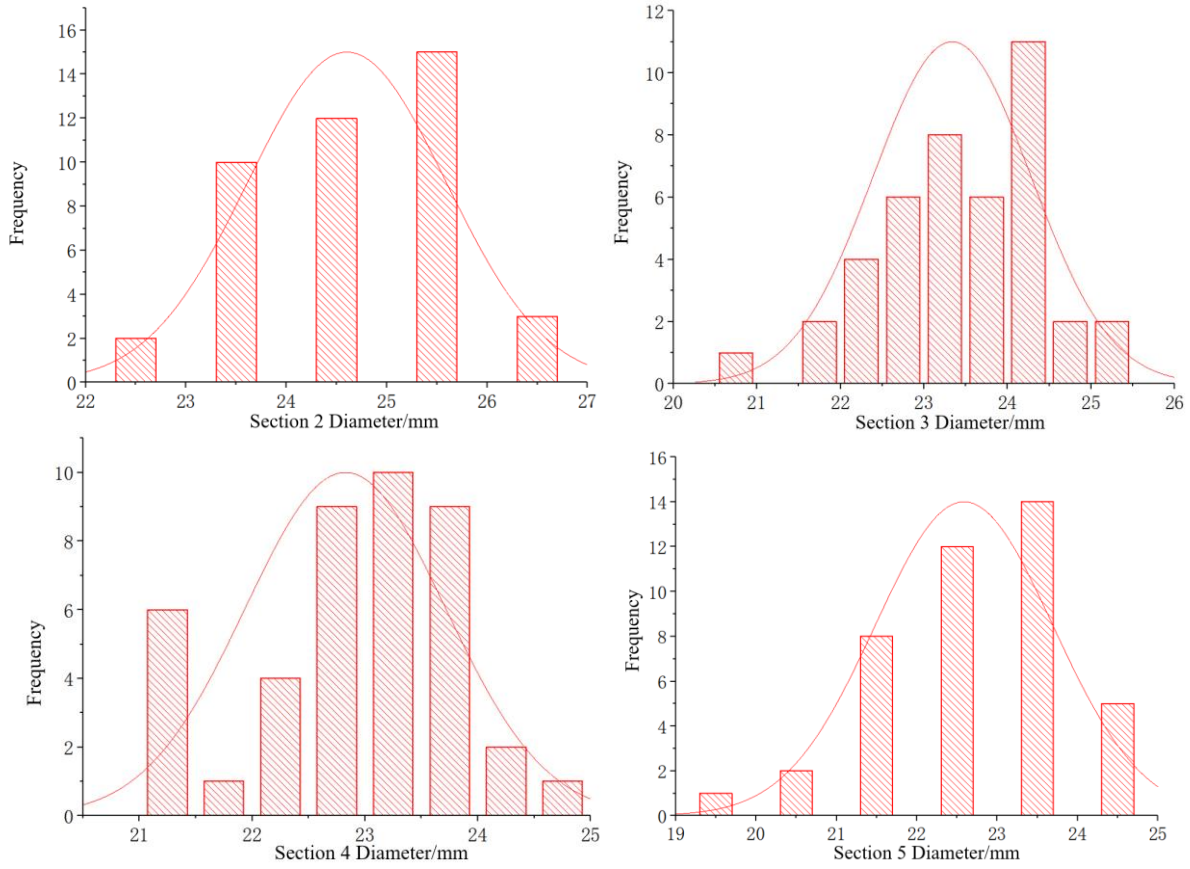
mechanical harvest [13], the first section of the internode is not taken as the research object. In addition, the stem is peeled and the leaves are removed. It is observed that most of the ears bear ears at the nodes of sections 8 and 9 of the corn stem, Moreover, the stem diameter above the heading node is significantly smaller than that at the lower part, and it is very easy to break. Therefore, the stem above the heading node is not taken as the research object, and only the stem diameter of the internodes and nodes below the heading node and above the node of section 2 (including the node of section 2) is measured and studied.

Because the cross-section of the corn stalk is irregular and oval, only counting the long axis or the short axis of the stalk can not represent the parameters of the corn stalk diameter. Consult the relevant literature [14], and the stalk diameter parameters can be mastered by taking the average value. Therefore, the long axis diameter of the measured stem is defined as the long diameter, and the short axis diameter of the measured stem is defined as the short diameter. Repeat the measurement for 6 times, Establish an excel table and calculate its average value through formula (2).

$$d = \frac{1}{12}\sum_{n=1}^{6}(D_{1n} + D_{2n}) \qquad (2)$$

Where D_{1n} represents the length and diameter of the stem measured for the nth time, mm; D_{2n} represents the short diameter of the stem measured for the nth time, mm; N represents the number of measurements.

To obtain the corn stalk diameter parameters of different internodes, the corn stalk is measured in sections according to the section division method shown in Fig.1. The measurement results are counted by the section division method to obtain the frequency distribution histogram of corn stalk diameter, as shown in Fig.3. From the curve in the figure, the internode diameter has a normal distribution trend.



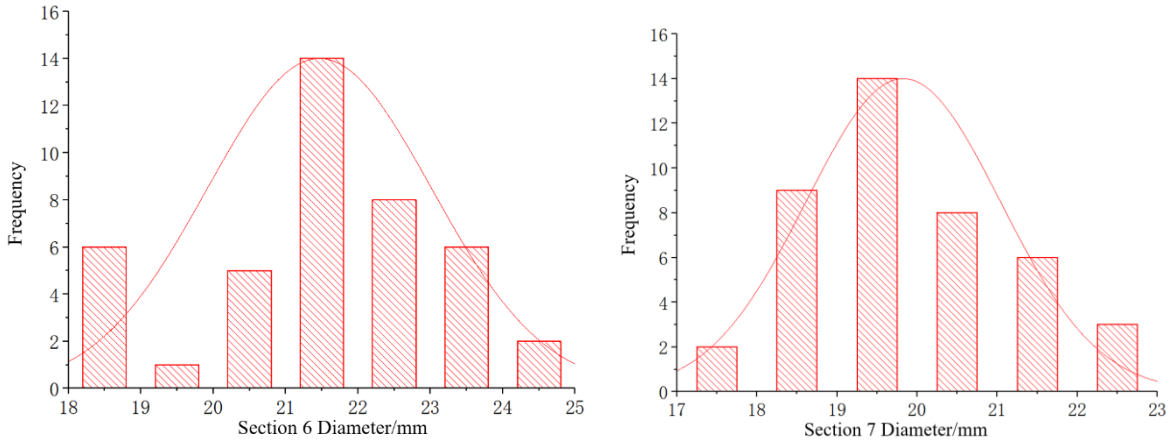


Fig. 3 Histogram of frequency distribution of stalk diameter of maize

The main distribution range of parameters of corn stalk diameter and the measurement and statistical results of average diameter of each node are shown in Tab. 3.

Tab. 3 Statistical table of stalk diameter of corn

Unit:mm

parameter	Main distribution range	Maximum	minimum value	average value/mm	Coefficient of variation/%
Section 2 stem diameter	22.20~26.75	29.50	20.00	24.60	4.31
Section 3 stem diameter	20.80~25.10	28.20	22.20	23.33	4.67
Section 4 stem diameter	21.00~24.75	27.00	18.50	22.82	4.41
Section 5 stem diameter	19.90~24.50	27.00	18.40	22.59	5.39
Section 6 stem diameter	18.50~24.05	26.00	17.00	21.47	7.39
Section 7 stem diameter	17.50~22.70	24.60	16.00	19.83	6.12

Determination of moisture content of corn stalk

The moisture content of agricultural materials generally refers to the percentage of the mass of moisture contained in the materials and the mass of materials after drying. It is one of the important indicators to reflect the humidity of materials. Relevant studies show that the moisture content of the stem will affect its composition and structure, and then affect the shear strength and shear power consumption of the stem [15-16]. Chen Zhengguang [17] and others verified that the internal structure of the stem skin is relatively soft under the state of high moisture content, resulting in the gradual decrease of its shear strength in the tensile and shear test of the corn stem skin in 2012, It is confirmed that the moisture content has a significant impact on the shear strength of corn stalk, and the moisture content of the same node of different stalks and different positions of the same stalk is also different. The impact of moisture content on the harvest of corn ears and the treatment and processing of corn stalks should be considered [18].

Fig. 4 Partial sample diagram of moisture content measurement

Cut off the stalks of the second section below the heading section and different sections above, divide the stalks into sections, cut each section into small pieces and put them in the drying test tube, as shown in Fig. 4. According to the determination method of GB/T1931-2009 [19], in order to avoid the contingency of the determination results, determine them for many times and take the average value. Finally, the moisture content of section 2, section 3 and section 7 of the corn stalk are 88.30%, 85.74%, 82.58%, 78.71%, 78.02% and 77.87% respectively. The broken line trend of the moisture content is shown in Fig. 5. The results show that the moisture content of the corn stalk decreases gradually from the bottom to the top. The measurement results are consistent with the description in document [18]. Of course, this does not rule out the possibility of water moving downward under the action of gravity.

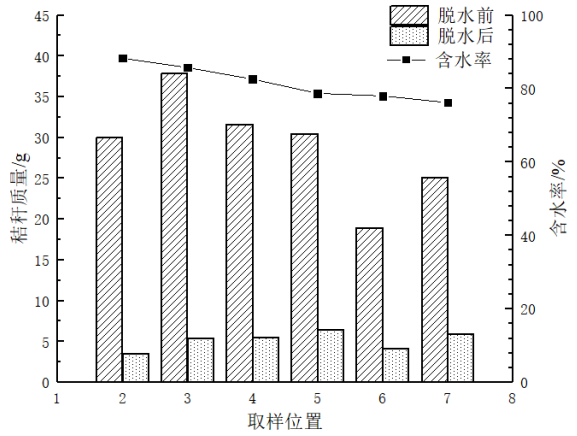


Fig. 5 Water content measurement results of each section

II. Conclusion

(1) This paper introduces the shape and structure of the maize plant. Based on the structure division, the morphological parameters of the maize plant, such as plant height, minimum ear bearing height, ear length, ear big end diameter, stalk length, and stalk diameter, are measured and counted.

(2) The data of plant height and minimum ear setting height of maize were processed, and the regression fitting model was obtained, which showed that there was a linear relationship between them and a positive correlation trend,

(3) Using the analysis method of frequency distribution histogram, the diameter of different internodes of corn stalk was counted and analyzed, and the curve showed the trend of normal distribution.

(4) The moisture content of corn stalk at different positions was measured, and it was obtained that the moisture content of corn stalk decreased gradually from root to ear node.

References

[1]. National Bureau of statistics of the people's Republic of China. China Statistical Yearbook[M]. Beijing:China Statistics Press, 2019.
[2]. Zhang Xiaomeng. Development status and Prospect of corn harvester at home and abroad[J]. Agricultural Machinery Using & Maintenance, 2019(10): 104.
[3]. Geng Aijun, Yang Jianning, Zhang Zhaolei, Zhang Ji, Li Ruxin. Discuss about the Current Situation and Future of Corn Harvest Machinery about Domestic and Abroad [J]. Journal of Agricultural Mechanization Research, 2016, 38(04): 251-257.
[4]. Ji Junjie. Development trend of corn harvester abroad[J]. Agricultural Technology & Equipment, 2006(05): 22-23.
[5]. Cui Tao, fan Chenlong, Zhang Dongxing, Yang Li, Li Yibo, Zhao Huihui. Research Progress of Maize Mechanized Harvesting Technology[J]. Transactions of the Chinese Society for Agricultural Machinery, 2019, 50(12): 1-13.
[6]. China Academy of Agricultural Mechanization. Agricultural Machinery Design Manual (Part 2)[[M]. Beijing: China Agricultural Science and Technology Press, 2007.
[7]. Cheng Daxian.Mechanical Design Manual (Fifth Edition)[M]. Beijing：Chemical Industry Press, 2008, 21: 15-17.
[8]. Geng Duanyang, Zhang Daolin, Wang Xiangyou, et al. New Agricultural Mechanics[M]. Beijing: National Defense Industry Press, 2011.
[9]. Xin Shanglong. Study on mechanism and key technology of vertical roller corn ear picking[D].Gansu Agricultural University,2020.
[10]. Zhang Xinyi. Study on Mechanism and Mechanism Simulation of Rolling,Rubbing and Crushing of Corn Stalks[D]. Harbin Institute of Technology, 2020.
[11]. AI Qingmu. Study on corn straw mechanics and water loss characteristic of different loading [D]. Northeast Agricultural University, 2015.
[12]. Xing Fang. Experimental study on the Physical and Mechanical Characteristics of Corn Straw[D]. Shenyang Agricultural University, 2017.
[13]. Chen Meizhou, Xu Guangfei, song Zhicai, Wei Yuanzhen, Wang Wenjun, Diao Peisong, Teng Shaomin.Experimental study of radial partial compression characteristics of whole silage corn[J/OL].Journal of Jilin University(Engineering and Technology Edition):1-9[2022-03-04].
[14]. Zhang Lixian. Research on the Discrete Element Modeling Method of Corn Stalk's Mechanical Characteristics[D].Northwest University of agriculture and forestry science and technology,2017.

[15]. Wang Yan, Guo Yingjie, Liu Qingfu. Experimental study on shear characteristics of corn straw[J]. Agriculture and Technology, 2011, 31(01): 43-45.
[16]. Cao Yu, Liu Weifeng, Zhang Xinda. Detection of Biluochun Green Tea Quality Grade by Using an Electronic Nose[J]. Journal of Agricultural Mechanization Research, 2012, 34(11): 129-132+137.
[17]. Chen Zhengguang, Wang Defu, Li Liqiao, Shan Ruixia. Experiment on tensile and shearing characteristics of rind of corn stalk[J]. Transactions of the Chinese Society of Agricultural Engineering, 2012, 28(21): 59-65.
[18]. Liu Li. Study of the Physical and Mechanical Properties of Corn Ears on New Snapping Method[D]. Jilin University, 2016.
[19]. China National Standardization Administration Committee. Method for determination of moisture content of wood：GB/T 1931-2009[S]. Beijing：China Standards Press，2009.

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