Design and Research of Large Ginkgo Biloba Leaf Picker

Dengjie Yang1,* and Lihua Jiang2

1College of Mechanical Engineering, Shandong Huayu University of Technology, Dezhou, Shandong, China
2College of Mechanical Engineering, Shandong Huayu University of Technology, Dezhou, Shandong, China

*Corresponding author email: 1579348629@qq.com

Abstract. In view of the different growth patterns of ginkgo branches and the need to avoid injury to Ginkgo branches when picking ginkgo leaves, this design provides a kind of ginkgo leaf picking machine that can carry out large-scale mechanized picking in the ginkgo leaf planting area and improve ginkgo leaf picking efficiency. The picker puts the picking mechanism in the front of the tractor, which is driven by the tractor. The power needed for the picking mechanism to rotate is provided by the tractor. The picking mechanism contains the storage mechanism of ginkgo leaves in order to achieve harvesting and gathering. Mechanization of ginkgo leaf picking, the picking efficiency of ginkgo biloba leaves was improved to a greater extent.

Keywords: Ginkgo biloba leaf; Picking drum; Picking machine.

1. Introduction

Ginkgo biloba is an ancient plant. Its leaves and fruits have high medicinal value[1-2]. Especially the flavonoids contained in Ginkgo biloba leaves have obvious curative effects on coronary atherosclerosis and cardiovascular and cerebrovascular diseases[3-4]. With people's deep understanding of the medicinal value of Ginkgo biloba leaves, the planting area of Ginkgo biloba trees is expanding year by year, and the picking of Ginkgo biloba leaves has become the key to restrict the development of Ginkgo biloba industry.

As a result of the growth environment of Ginkgo biloba, so far, the extraction of Ginkgo biloba leaves is mainly artificial. Artificial picking is inefficient, and the picking time of Ginkgo biloba leaves is mainly concentrated in July, August and September. Artificial picking can not guarantee timely picking of Ginkgo biloba leaves.

This study combines the previous research on Ginkgo picking machinery, including published papers[5-6] and patents[7-8]. Selected the river beach experimental site on the Henan Bank of Tianshui City, Gansu Province as an example. The results showed that an average plant height of 144.3 cm and a stem diameter of 2.1 cm could be obtained from each mu of leaf-picking nursery, with 6000 seedlings of Ginkgo biloba. Ginkgo biloba trees[9] were planted on a large scale with a row spacing of 250 cm x 60 cm. The number of trees planted per hectare ranged from 7500 to 8400. The length of lateral branches of Ginkgo biloba trees ranged from 50 to 60 cm.

The picking device of ginkgo leaf picking machine is located in the front of the tractor and connected by two supporting rods. The actuator adopts four pairs of picking rollers, which are symmetrically installed on both sides of the leaf storage box of the picking machine. The picking drum is covered with sharp teeth. During installation, the teeth of each pair of picking rollers are alternately distributed. When the picking drum rotates, ginkgo leaves are scratched by sharp teeth and fall into the storage box. The
power required for the rotation of the picking drum is provided by the tractor.

2. Executive Mechanism of Ginkgo Leaf Harvester

According to the growth characteristics of lateral branches of Ginkgo biloba trees, this study adopts drum picking. The actuator is composed of two drums. The surface of the picking drum is evenly distributed with sharp teeth. The bending direction of the sharp teeth on the two drums is opposite, which can increase the biting force on the leaves of Ginkgo biloba. There are two drums between the two drums. At a certain distance, the sharp teeth between the two drums are distributed in phase when matching.

As shown in Figure 1, the gear meshing makes the two drums rotate in opposite directions, while the sharp teeth on the drum are used to separate the ginkgo leaves from the branches during picking. The picking drum and the sharp teeth distributed above are made of rubber material, which have certain wear resistance and elasticity. The purpose is to prevent the side branches of Ginkgo biloba from breaking in the picking process or from being pushed out in time due to too many side branches entering the drum during the picking process, resulting in the bending of the main trunk of Ginkgo biloba and playing a protective role on Ginkgo biloba. Rubber material is lighter in weight, which can reduce the overall weight of the picking part and reduce the power required for rotation.

3. Design of Picking Part of Picking Machine

The designed tractor engine model is YD4RT4. Its rated power is 29KW and rated speed is 3000r/min. In order to simplify the overall structure of the picking mechanism, belt drive and gear drive are used to transfer power from the tractor output power to the picking drum. In order to meet the design requirements, a reducer with a transmission ratio of 2 is installed in the front section of the transmission system. Through the reducer, the engine speed of the tractor is reduced to 1500 r/min, so that it can adapt to the picking speed of the harvester.

As shown in the schematic diagram of the transmission system as shown in Figure 2, the power transmitted by the engine is driven by the belt, and the direction of transmission is changed from a pair of helical gears to a pair of helical gears with an angle of 90º. Then a pair of gears is used to drive one of the picking drums to rotate, while the other is driven by the belt drive. The drum rotates, and then a pair of gears is used to change the rotation direction of the picking drum so that the rotation direction of each pair of gears is opposite.

4. General Structure Modeling of Ginkgo Biloba Leaf Picker

The whole structure of the picking part is shown in Figure 3. It is installed in front of the tractor head and driven by the tractor. The power of the picking drum is also provided by the tractor. The middle of the picking drum on both sides is a leaf storage box, which is used to store the ginkgo leaves.
Figure 3. Picking part of the 3D schematic. The driver's position is equipped with a protective frame to prevent the beating of the driver by the branches of Ginkgo biloba on both sides. At the same time, the arm is provided for the driver to get on and off the car. The upper part of the leaf storage box is depressed downward. The purpose is to expand the driver's vision and facilitate the driver to better observe the road ahead. The overall structure of the ginkgo picker is shown in Figure 4.

Figure 4. Ginkgo leaf picker structure. 5. Finite Element Analysis

5.1. Finite Element Analysis of Supporting Bar

The picking part of Ginkgo biloba picking machine is supported and connected by two supporting rods in front of the tractor, as shown in Figure 5, so whether the supporting rod's force is reasonable or not is related to the stability of the picking parts and affects whether the picking machine can work continuously for a long time. The material of the supporting rod is alloy, and its size is 150 mm * 150 mm * 1800 mm. One end of the supporting rod is welded at the front of the tractor head. The supporting rod is connected with the bolt of the vane storage box.

Figure 5. Support rod installation position. Figure 6. Stress map of support bar.

Figure 6 shows that the greater the isostress of the supporting rod, the greater the isostress at the end, and the maximum isostress at the end is 16.24 Mpa. From the analysis chart and data, it is known that the support rod can support the maximum weight of the picking part, and its design meets the requirements of the picking machine.

Figure 7 is an analysis of the node displacement of the support rod. The broken line diagram of the relationship between the frequency and the node displacement along the X direction can be seen from the extreme point of the broken line. When the frequency is 92Hz, the node displaces more in the X direction. The displacement point is small.
5.2. Finite Element Analysis of Branch Guide Plate
The branch guide plate is located at the front of the ginkgo leaf picking machine. Its main function is to
dredge the disorderly side branches of Ginkgo leaves in front of the picking machine and concentrate
the side branches of Ginkgo leaves in the middle of each pair of guide plates, that is, the meshing points
of each pair of picking drums, so as to facilitate the rapid picking of Ginkgo leaves on the branches of
Ginkgo trees.
When using ANSYS software to analyze the branch guide board, the three sides of the fixed board where
the two branches guide board are located are set as fixed planes, and the opposite faces of the two
branches guide board are set as stress planes. In theory, when the harvester is working, the branches only
produce force on the corresponding faces of the branch guide board, and the force is set up. For 25N,
the principal stress is analyzed.
As shown in Figure 8, the maximum pressure on the contact surface is 4.10 MPa, and the point at which
the maximum pressure is applied is at the contact of the two surfaces. From the analysis chart, it can be
seen that the deformation degree of the branch guide plate is relatively small, and within the allowable
range, it meets the requirements.

5.3. Finite Element Analysis of Bending Plate with Two Sides Protection
The middle position of the upper and lower two groups of picking drums is the place where helical gears
and spur gears are placed, and the force is transferred from tractor to the separation place of the upper
and lower picking drums. At the same time, this position is the place where side branches of Ginkgo
biloba leaves are easily touched. The protective bending plate placed here is used to protect internal
parts from being damaged by side branches of Ginkgo biloba trees.
The protection bending plate is fixed on one side, and the stress surface is to protect the back of the
bending plate. The force acting on the protection bending plate is 30N.
Figure 9. Isometric stress analysis diagram of the protection.

Figure 10. Shear stress analysis chart.

Figure 9 is an iso-stress stress analysis diagram of the protective bending plate. The closer to the fixed surface, the greater the pressure will be. The pressure on the stress surface presents a stepped distribution on the protective bending plate. The maximum iso-stress pressure is 0.17 MPa, and the minimum iso-stress pressure is 1.4 *10^-4 MPa.

Figure 10 is the shear stress analysis diagram of the protective bending plate. The maximum pressure mainly distributes in the upper and lower corners of the fixed surface, while the middle position near the fixed surface receives less pressure. The pressure on the protective bending plate is mainly on the side near the fixed surface, accounting for about one-half of the area of the whole back surface, and the main stress is the main stress. The analysis results of shear stress and isostress show that the protective bending plate meets the design requirements and can protect bevel gear and spur gear from being damaged by the side branches of ginkgo tree when working in Ginkgo planting area.

6. Conclusion

Agricultural mechanization is an effective way to improve the efficiency of agricultural production. At present, many countries have put forward new requirements for traditional farming. In 1988, the U.S. government put forward a new definition of traditional farming [10], advocating conservation farming and increasing rural development.

Our government advocates the development of mechanized agriculture. Mechanized agriculture requires the combination of agriculture and science and technology, the use of technology to promote agricultural production and improve agricultural efficiency. Mechanized agriculture is the use of mechanical intelligence system instead of manual labor. The realization of agricultural machinery intelligence system should first realize the mechanization of agriculture. This design of Ginkgo biloba leaf picking the picking machine is designed to improve the efficiency of ginkgo leaf picking and realize the mechanization of ginkgo leaf picking. It also conforms to the requirements of intelligent agriculture advocated by our government.

Reference

[1] Jin B. Cytological, physiological, and transcriptomic analyses of golden leaf coloration in Ginkgo bilobaL [J]. Horticulture Research, 2018, 5 (1).
[2] Gevrek F. Histopathological, immunohistochemical, and stereological analysis of the effect of Gingko biloba (Egb761) on the hippocampus of rats exposed to long-term cellphone radiation. [J]. Histology & Histopathology, 2017: 11943.
[3] Ren X J, Yang Z B, Ding X, et al. Effects of Ginkgo biloba leaves (Ginkgo biloba) and Ginkgo biloba extract on nutrient and energy utilization of broilers [J]. Poultry Science, 2018.

[4] Fu W, He X, Xu S, et al. Changes in nutrients and decay rate of Ginkgo biloba leaf litter exposed to elevated O3 concentration in urban area. [J]. Peerj, 2018, 6 (3): e4453.

[5] Dengjie Yang, Cunmeng Zhang, Daigen Zhu, et al. Design of spring ginkgo leaf picking machine [J]. Forestry machinery and woodworking equipment, 2017, 45 (7): 30-31.

[6] Dengjie Yang, Cunmeng Zhang, Daigen Zhu, et al. Design of retractable ginkgo leaf picking machine [J]. Forestry machinery and woodworking equipment, 2017, 45 (6): 30-31.

[7] Daigen Zhu, Dengjie Yang, Canyu Yang, etc. A knife-chain ginkgo leaf picker: China, ZL201720504574.1 [p]. 2018.01.05.

[8] Daigen Zhu, Dengjie Yang, Canyu Yang, etc. A retractable ginkgo leaf picker: China, ZL201720502208.2 [p]. 2018.01.16.

[9] Economic Benefit Analysis of Shuai Diehua, Peng Wengui, Zeng Na and Ginkgo Biloba Leaf-picking Nursery [J]. Hubei Forestry Science and Technology, 2017, 46 (3): 56-57.

[10] Harrington L M B. Alternative and Virtual Rurality: Agriculture and The Countryside as Embodied in American Imagination [J]. Geographical Review, 2017.