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Research status and development prospect of grape harvesting machinery in China

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Abstract

Grape is a kind of deciduous vine fruit tree, which has a strong ability to adapt to the environment, and has a wide planting area and large yield in China. According to statistics, China's grape planting area has grown steadily from 2013 to 2021, from the original 721,000 hectares to 738,000 hectares, its output has ranked first in the world, and the grape industry has become the main industry in many areas of China. However, the mechanization level of grape harvest in China is very low, and there is a big gap compared with some developed countries abroad. Therefore, this paper studies and discusses some of the existing grape harvesting machinery in China, and provides some reference for the development of grape harvesting machinery in China. Grape is a very popular fruit in China. It is not only rich in various vitamins, such as vitamin B, vitamin C, vitamin P, etc., but also contains a lot of minerals necessary for human body, such as calcium, phosphorus, potassium, etc. Eating grapes can not only promote our intestinal digestion and absorption, but also relieve fatigue, nourish blood and nourish qi for the human body, but also increase our antioxidant ability and delay aging. Grape variety are many, some grapes and taste acid, and some grapes and taste sweet, provides different options for different taste, including sour grapes, although the taste is sweet, but the sour grapes can promote the metabolism of human body in the summer, regulate the endocrine and temperature of the body, still can be good, to improve the person's appetite.

Keywords

Grape,grape planting, grape Harvesting, mechanization,automation.

1. The development status of grape industry in China

1.1. Grape planting area and yield in China

The history of grape planting in China has been more than 2000 years. According to legend, the grapes of Our country were brought to the Central Plains from the Western Regions when Zhang Qian was on a diplomatic mission to the Western Regions. After many years of planting and spreading, the total area of grape planting in China has reached 438,000 hectares, and China has become the world's largest producer of table grapes. Its total output has reached 16% of the global yield as early as 2013, which is very impressive. Especially in Xinjiang region of China, due to the regional climate characteristics, the temperature difference between morning and

evening is large, xinjiang grape has the advantage of high fructose content, is a famous raisin production in China, and its grapes also have a great popularity.

1.2. The advantages of China's geographical environment for grape production

The most important factor of making grapes growing well is the right temperature. Grapes grow well in subtropical and temperate zones, where the average annual temperature should be above 15 degrees Celsius. If the temperature is too low in the region, the wine needs to be manually insulated to survive the winter, raising labor costs. The climate of China is distributed in the eastern region, which is mostly temperate climate and subtropical temperate climate, so the climate environment of China has certain advantages. Moreover, the climate of the central region of China is temperate continental climate, whose temperature conditions are similar to the temperate monsoon climate, and it also has certain advantages for grape planting. According to statistics, China's subtropical monsoon climate region and temperate monsoon climate region of the total area can reach more than 3/4 of China's total area. In addition, China's hydraulic resources for grape planting also has certain advantages, China's Yangtze River and Yellow River are rich in hydraulic resources, with the implementation of China's south-to-north water diversion project, the water shortage situation in north China has been greatly improved, providing an effective solution for the lack of water for grape planting in north China. Grapes are grown in all provinces and cities in China, from heilongjiang in the north to Hainan in the south, and even in China's high altitude areas such as the Qinghai-Tibet Plateau. But the main production areas are the North China Plain, some warm areas in the northeast, the northwest, and the northern and southern regions around the Yangtze River. China's grape growing provinces are mainly Xinjiang Uygur Autonomous Region, Shandong province, Hebei Province, Liaoning province, etc. Due to the climate characteristics of Xinjiang region, the output of grapes planted in Xinjiang accounts for about 20% of China's total output. However, due to the regional distance limitation, the grapes produced in Xinjiang are mainly dry products of grapes.

1.3. The development of China's wine industry drives the development of grape planting industry

China's wine industry is mainly located in the grape planting area and large output of the region, because it is raw material origin, promote these regions have strong competitiveness, especially shandong, Jilin, Hebei and Xinjiang and other places of the total wine industry accounted for 80% to 90% of China's wine industry. China's wine industry has entered the stage of rapid development since the 21st century. Up to now, China's wine output can rank 7th in the world, and our wine sales can be as high as 5th in the world, and China's wine industry has entered the adjustment stage. It is well known that the progress of wine industry can not only promote the growth of grape planting area and output, but also increase the added value of grapes, which has a great role in promoting the development of grape industry. According to statistics, with the continuous improvement of China's economic level, people's requirements for life are not only limited to the problem of having enough to eat, people have higher requirements for the quality of life; In addition, since China's reform and opening up, foreign cultures have been pouring into China, which has greatly increased the demand of Chinese people for wine. Therefore, China's grape industry has also been greatly promoted.

2. Examples of existing grape planting machinery in China

2.1. Grape picking 4-DOF mechanical arm

A grape-picking 4-DOF robot arm, jointly developed by Jiangsu University and the Key Laboratory of Modern Agricultural Equipment and Technology of the Ministry of Education, can realize automatic grape picking with the planting mode of hedge frame. The robot arm can

realize 4 degrees of freedom movement. The manipulator also uses D-H parameter method to establish its connecting rod coordinate system, through the use of some software to establish mathematical model of the manipulator and simulation experiments, with certain picking accuracy and reliability. There are some problems in China's picking robots, such as complex structure, cumbersome control system and difficult to ensure reliability. There are a large number of complex structures and control components in the robot, so its manufacturing cost is greatly increased, the operation efficiency is difficult to improve, contrary to the agricultural time, increase the cost of picking.

The mechanical arm to solve the above problems, to our country existing picking robot structure and control system has been optimized design, and also through three Microsoft a 3 d modeling, the model of the mechanical arm, the software of kinematics and dynamics simulation experiment based on the experimental results of the research and development of mechanical arm was improved, for the performance optimization of mechanical arm provides a certain basis. In the process of the development of mechanical arm, the researchers first grape cultivation technology of our country a lot of research, found that the height of the general planting grapes is low, the fruit also in distance from the ground 1-8 m or so commonly, and row spacing at about 4 to 6 m, with smaller spacing between each grape, so some foreign large and medium-sized machinery use hard garden, Therefore, the picking arm should reasonably plan its structure and calculate its working range. The automation of the manipulator needs to achieve the requirements through programming and calculation. The manipulator is simple and easy to control, so the difficulty of programming and calculation process is low. The main joints of the manipulator are the waist joint, shoulder joint, elbow joint and wrist joint. The manipulator mainly realizes the operation through the coordination between the four joints. Its main working principle is: the mechanical arm waist joints need to pass a base plate and the mechanical arm are connected to the power unit of the car, needs and implement action of mechanical arm and wrist device connected at the end, and when picking command car received mechanical arm transfer from the power plant will move according to prescribed route to the destination. After arriving at the destination, the robotic arm will transfer the end-effector to the specified position through the rotation of the waist joint, shoulder joint and elbow joint according to the planned path. Finally, the robotic arm will adjust the position and state of the end of the actuator through the rotation of the wrist joint, so as to achieve the purpose of picking. After picking, the robot arm can return to its original position, ready for the next picking task.

2.2. Research on binocular positioning and grasping precision of grape picking machine arm

The research on binocular positioning and grasping accuracy of grape picking mechanical arm by Baicheng Normal University can effectively improve the positioning and grasping accuracy of grape picking mechanical arm in China. Binocular vision positioning technology is widely applied in the field of environmental perception robots, but for the grape picking needs high precision positioning, the development of the existing binocular positioning technology can't meet the requirements of grape picking robots, so the picking manipulator research in view of the binocular positioning technology, the optimization design, the original logical relationship and the principle of extraction, Some important operations such as the calibration of the camera, the matching degree of the stereo and the depth that the manipulator can reach are also calculated. The researchers also studied and discussed the problems existing in the application of binocular positioning technology in the existing grape picking robotic arm in China, and analyzed the existing problems and the main factors leading to these problems.

Using binocular vision positioning technology, the robot can not only collect image information, but also collect specific coordinate positions and grape characteristics. Finally, all the collected

information is comprehensively analyzed to obtain the final position of the robot arm. Based on binocular vision positioning technology in China in recent years research development and application in robot level although there are large, but the accuracy of the binocular visual positioning technology need further improvement, so the manipulator based on the research of the binocular recognition technology innovation improvement, increase the grape picking manipulator's movement precision. The picking mechanical arm is also optimized to grasp the accuracy of the design, first through the grape shape and growth characteristics to do understanding, and then the picking machinery to improve the implementation of the device, the structure of the grape through the first phase of the way to absorb the grape structure is divided into stalk area, fruit area and vine area 3 categories. Then, the stalk area was determined as the shear and clamping area, and the fruit area and the vine area were the areas that the mechanical arm should avoid, especially the fruit area, which must ensure the non-contact rate of the mechanical arm, and the rattan area can have certain interference tolerance. Through the reasonable design of the structure and the reasonable choice of the hardware of the device, the picking arm can not only have high positioning accuracy, reduce the damage rate of the fruit, but also reduce the energy consumption and plan the optimal route. Finally, the manipulator can reduce the dependence on the algorithm and improve the operation efficiency and grasping accuracy.

2.3. Research on rattan obstacle avoidance ability and rattan entanglement prevention of grape picking machine arm

Baicheng Normal University further studied the obstacle-avoiding function of grape picking mechanical arm. The team through to the existing grape picking manipulator has the ability to work are analyzed, and according to the existing research results at home and abroad, the existing of the vines and fruit method used by the characteristics of the mark in terms of design and technology development, and also on the work process should be performed, such as data processing and calculation were compared and the use of work, Finally choose the optimal scheme. For the mechanical arm to avoid the obstacle of vine and prevent the mechanical arm from entangling vines are analyzed in detail, and then it is innovated and improved to get a more reliable mechanical device. Although the device has made some research and improvement on the obstacle avoidance and entanglement problems existing in common grape picking mechanical arm, the device cannot completely solve the complex problems existing in reality. Through the research, the team determined the future development goal is to strengthen the influence of light intensity on the presence accuracy and success rate of the presence of mechanical arm, and continue to improve the existing calculation method and structure of the presence of mechanical arm, to further improve the quality of grape picking in the real environment.

3. China's grape picking machinery development prospects

China's grape industry development prospects are very broad, the demand for grape picking machinery is also very urgent, so the development of grape picking mechanization in China needs to increase efforts. Therefore, the development of grape picking mechanical arm and picking robot will also accelerate the pace, to achieve grape picking efficiency, high quality, high intelligence, mechanical function diversification. To achieve the perfect adaptation to China's grape planting, management, picking agronomic requirements, effectively improve China's grape production efficiency and promote the development of China's grape industry.

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