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Experimental Study on the Liquid Medicine Recovery System of Vineyard Spray

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Abstract: Grape is an important economic crop in Hebei, and its plant protection operation also accounts for an important proportion in production. Grapes need to be sprayed many times to kill pests in the whole growth cycle. Traditional farmers use electric backpack spray to spray pesticides in plant protection operations. This is inefficient, heavy workload, and inefficient use of pesticides. Many redundant agricultural chemicals sprayed into the soil will also lead to environmental pollution. In order to solve the related problems, a kind of liquid medicine recovery spray system was studied on the vineyard planting mode and canopy growth information design. The axial flow fan was used as the atomization device, and the liquid medicine recovery device was added to cooperate with the whole machine, so as to realize the automatic air delivery spray operation. Such spray system can effectively realize automatic spray operation, reduce the labor of farmers, recycle the redundant liquid medicine, and significantly improve the liquid medicine use efficiency of spray operation.

At present, the scope of large-scale planting of grapes is constantly expanding. This crop needs to be sprayed many times during the growth cycle. To improve the efficiency of spraying and promote the goal of mechanized and automated production of vineyards, it is necessary to design a liquid medicine recycling spray. The liquid medicine recovery system of the vineyard spray machine designed in this paper can combine with the actual needs of grape production in Hebei, and the related system design can bring efficiency improvement and cost saving benefits for the vineyard spray operation.

1. Problems in Hebei vineyard plant protection mechanization

Hebei is a large vineyard planting base in China. The internal planting patterns are mixed, and there is no unified standard. According to the investigation on several vineyards in Urumqi, Hebei Province, there are two production modes in the internal vineyards. One is irrigation grape planting. Generally, 1.1-1.3m wide and 0.2-0.3m deep ditches are dug under the vineyard frame to irrigate the grape plants. The distance between the grape stands is about 2.5 meters, plus the width of the ditch, so the tractor cannot pass through it normally, and it is difficult to carry out mechanized plant protection operations. Another type is drip irrigation vineyard, with a row spacing of about 2.1-2.3m.

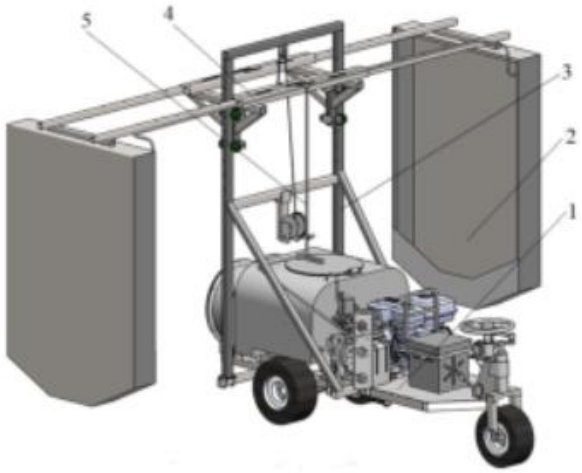
Some of them have wide or narrow row spacing, which makes tractor traction difficult [1].

In addition, the level of plant protection machinery and pesticide application technology in Hebei vineyards is not high, and there is a serious waste of liquid medicine. The traditional electric knapsack spray requires manpower in its operation. The spray is uneven and diffused poorly. It also needs to add water continuously during the spraying operation. The working efficiency is low, the concentration of the sprayed liquid medicine is different, and the liquid medicine is wasteful, which is neither economical nor environmental friendly.

2. Design of liquid medicine recovery spray machine

Based on the planting characteristics of Hebei vineyards, in order to avoid the waste of liquid medicine and environmental pollution problems in traditional spray operations, this paper will design a self-propelled spray with liquid medicine recovery function. This spray is equipped with a liquid medicine recovery system and a self-propelled spray device, which has a good application effect for solving the above problems in spray operation [2].

In this liquid medicine recovery system, the main components are self-propelled spray and liquid medicine recovery device. Among them, the main components of self-propelled spray are organic frame, diesel engine, axial flow fan, power supply, three steel plunger pump, reducer, medicine box, nozzle, etc. The liquid medicine recovery device includes liquid medicine collection device, lifting device, recovery pipeline, expansion device, etc. The user only needs to shake the winch to control the height of the liquid medicine collection mechanism. The telescopic machine can complete the spraying operation on the corresponding vineyard for the distance between the corresponding liquid medicine collection mechanisms, and also realize the liquid medicine recovery [3]. The specific structure of liquid medicine recovery spray rack is shown in Figure 1:



(1) Self-propelled spray (2) Liquid medicine collection device (3) Lifting mechanism (4) Telescopic mechanism (5) Pipeline recovery system

Figure 1: Structure of liquid medicine recovery spray machine

The main work flow of this spray machine is: before the liquid medicine recovery spray machine is pushed into the vineyard, the operator adjusts the lifting mechanism and the telescopic mechanism to ensure that the liquid medicine collection devices on both sides are mounted on the outside of the two rows of grape stands. Then push the spray into the narrow path between the vineyard plants, turn on the self-propelled spray, start the spray system, and the spray droplets sprayed from the system nozzle will be partially precipitated in the grape leaves under the action of the axial flow fan, and some will drift through the grape branches and leaves into the air and soil. The liquid medicine

collection device can intercept and collect the drifting moving air and the falling droplets on the page, and collect them into the liquid collecting tank at the bottom of the system. When the liquid medicine in the liquid collecting tank reaches a certain amount, turn on the recovery membrane pump switch, and the recovered liquid medicine can be processed through the filter and reentered into the medicine box to realize the recycling of the recovered liquid medicine.

2.1. System design of self-propelled spray

2.1.1. General design idea

In order to meet the spray needs of vineyards with different row spacing under different planting modes, spray can carry out plant protection work in vineyards, and self-propelled spray is designed. The main components have been described above, including frame, diesel engine, axial flow fan, power supply, three steel plunger pump, reducer, medicine box, nozzle, etc. In this system, the ignition voltage and current of the diesel engine are provided by the battery. After starting, the engine will charge the battery. The output shaft of the engine is driven by the belt to transmit the power to the plunger pump, fan and reducer of Sansteel respectively. The reducer transmits the power to the rear axle through the auxiliary chain drive. The medicine in the medicine box enters the three cylinder plunger pump through the water outlet and filter for pressurization, and then sends the medicine to the sprayers on both sides through the pipeline at the water outlet of the plunger pump. The sprayer sprays the liquid medicine in the annular wind deflector under the action of the wind force of the fan, so that the liquid medicine can float to the branches and leaves of the plant. The spray machine is set with three gears, namely, gear 1, gear 2 and reverse gear, which is convenient for operation and application and flexible and convenient.

2.1.2. Fan parameter determination and selection

The role of the fan in the whole system device is to make the spray droplets spray onto the branches and leaves of grapes under the action of the air flow, and carry out secondary atomization treatment on the liquid after the liquid pump is pressurized, so that the droplet size is smaller and the spraying is more uniform. Turning the blade makes it easier for droplets to deposit in the traditional canopy, ensuring the deposition rate of droplets on the front and back of the blade, and achieving the ideal effect of spray sterilization and disinsectization. Effective fan selection and use can significantly improve the utilization efficiency of liquid medicine and reduce the environmental pollution caused by liquid medicine drift.

In the current operation of vineyard plant protection machinery, there are three common fans, namely axial flow fan, centrifugal fan and cross flow fan. Axial flow fan has large air volume, high air pressure, convenient installation and low price. It is widely used in orchard spray and air curtain spray bar spray. Centrifugal fan system has good stability, low noise and large air volume, which is more common in multi duct or cannon type orchard spray. The cross flow fan has a relatively uniform air outlet speed and good air flow control effect, which can make the droplets reach the leaves of grape plants effectively. It is commonly used in the circulating spray machine. However, considering the complex mechanism, high cost and small air volume of this fan, its application is not large. Through comprehensive analysis, it is decided to select the axial flow fan as the air supply atomization device of the system to ensure its use effect and economy.

2.1.3. Rack design

In the self-propelled spray system, the rack plays an important role in supporting the overall organizational structure, as shown in Figure 2 below, which is the spray system structure of the self-

propelled spray:

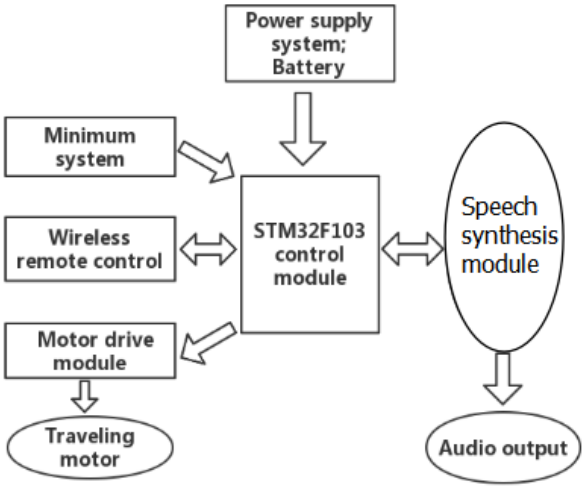


Figure 2: Spray system structure of self-propelled spray

Select 60 × forty × 3mm cold-formed rectangular hollow steel shall be welded, and the main components of the system shall be installed at the corresponding parts of the rack. The medicine box shall be placed at the rear wheel bracket. The height of the frame is set to 0.3m and the length is set to 2.3m in combination with the internal feasible height of the vineyard. This kind of machine body is relatively small and can adapt to the walking conditions of different vineyard plants. The width of the rack shall not only meet the load requirements, but also be as small as possible. In irrigated vineyards, the minimum walking width of the spray is the measured minimum row spacing minus the maximum ditch width. In drip irrigated vineyards with larger widths, the minimum walking width is about 1.8m. After comprehensive analysis, it is determined that the width of the front end of the frame is 0.72m, the width of the rear end of the frame where the medicine box and fan are placed is about 0.52m, and the maximum width after the wheel is installed is about 0.9m.

2.1.4. Movement control design of spray

In the design of the travel route of the spray, the IMU and Kinect fusion algorithm is used to improve the accuracy of the travel route of the spray and ensure that the control of the movement direction and distance of the spray can be accurate. The spray uses laser radar to carry out independent mapping and navigation of the location area, which can ensure the reliable processing speed of the spray system and reduce the load of the equipment on the spray through the connection with the microcomputer. The speed loop and current loop should be added to all relevant motors to ensure that the speed error and spray power can be effectively controlled. The position loop should be added to the corresponding point motor to ensure the accurate and reliable movement direction of the spray. Considering that the four McNamm wheels of the spray chassis need to maintain a certain speed on the ground and also ensure stability in operation, the four chassis motors are controlled by a fuzzy control system, which can output a speed suitable for the two driving wheels under different conditions, so as to avoid the problem that the spray does not travel in a straight line or does not follow the corresponding route.

2.2. Design of liquid medicine recovery system

Liquid medicine recovery is one of the key indicators in the system design. To achieve the

collection of droplets in the air and deposited in the crop target, liquid medicine recovery and reuse. This device is suspended on both sides of the spray machine. In the design, attention should be paid to its size and weight rationality.

First, the liquid medicine recovery device will be installed on both sides of the nozzle, behind the spray, and the weight should be as light as possible.

Secondly, based on cost considerations, it is necessary to effectively collect droplets first, and the height and width of the collection device need to be expanded as much as possible.

Thirdly, since the liquid medicine recovery device is often used, it must have certain corrosion resistance to avoid being corroded by pesticides, so the materials used in the design need to be considered.

Through comprehensive analysis and consideration, it is decided to use stainless steel plate and steel pipe as the main materials of the liquid medicine recovery device. The liquid medicine collection mechanism is set to be 1.2m long and 0.2m wide.

In addition, in the design of the liquid medicine recovery system, the design of the recovery pipeline is an important part. After comparing the jet recovery and pump recovery, we decided to use the latter. Because the former needs to reform the two water outlets of the plunger pump of the spray machine,

It is troublesome. After the pump recovery mode is applied, two diaphragm pumps are installed outside the liquid medicine collection devices on both sides. The self-propelled spray provides power for them and is connected with the control switch to control the switch of the diaphragm pump. During operation, the diaphragm pump can be started after 2-3 lines of walking according to the characteristics of the branches and leaves of grape plants in different growth periods, and it can be closed when it does not absorb water, so that the liquid medicine can be recovered into the medicine box for recycling.

3. Conclusion

The purpose of this paper is to design a self-propelled liquid medicine recovery spray system. The overall structural framework of the liquid medicine recovery spray is described, and the whole working process is described. Starting from the study of the self-propelled spray system and liquid medicine recovery device, the structural design and control mode of the corresponding liquid medicine recovery device are explored, which has important application value for the development of vineyard plant protection work.

Acknowledgement

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