

Electric Control Principle and Experimental Analysis of Rubber Precision Fertilization

Yuan Zhang¹, Yiguo Deng¹, Lijiao Wei^{1,2*}, Yeqin Wang¹, Zhiyang Zhang³, Shengli Liu⁴, Ming Li¹,
Xuehu Dong¹ and Jianhua Cao³

¹Tropical Agricultural Machinery Research Institute, Chinese Academy of Tropical Agricultural Sciences, Zhanjiang, China

²Agricultural Science and Technology Co., Ltd. of YIWU, Zhanjiang, China

³Rubber Research Institute, Chinese Academy of Tropical Agricultural Sciences, Danzhou, China

⁴The Center of CangLong Agricultural Technology Service for Zhanjiang City, Zhanjiang, China
{zhang198414}@126.com, dyg7810@21cn.com, weilijiao2008@163.com, 441213852@qq.com, 418727981@qq.com, 1051568484@qq.com

Keywords: Rubber, precision fertilization, electric control, experimental analysis.

Abstract: In this paper, aiming at the situation that it is difficult to control the amount of natural rubber fertilizer mechanically, this paper introduces in detail a kind of rubber ditch electric control ditching and fertilization combined operation machine, and its control principle, main structure and characteristics are described. The test: the use of electric control precision fertilization control system to take the first booster and then speed mode, the tractor carrier effectively achieve the Promise speed control knob can basically achieve the rubber fertilization precision control, The precision index reaches 94.3%. The fertilization equipment equipped with the control system matches the 80-horsepower tractor. The ditching depth can reach 22cm, the productivity is 1.23hm²/h, the fuel consumption is 3.1kg/hm², the fertilization uniformity is 90.3% and the coverage rate is up to 98.0% , can effectively improve production efficiency and reduce production costs.

1 INTRODUCTION

Precision fertilization is one of the most important parts of precision agriculture. It is the positioning and quantitative fertilization. The so-called "precision", that is, the "essence" and space in quantity and the "quantity" in time, maximum. The precision fertilization technology is not only combined with the traditional fertilization technology, but with the traditional fertilization technology are quite different. The traditional way of fertilization is to use the same amount of fertilizer and fertilization within a large area or in a single plot. In fact, there is a difference in soil nutrient content in different parts of the same land. As a result of the average fertilization, low fertility and insufficient fertilization were achieved in other areas with good fertility, while fertilization was excessive in areas with high fertility but not in other productive traits. As a result, fertilizer wasted, costs were increased and environmental pollution was inevitable (WANG Yeqin, 2016). In view of the soil nutrients, ecological characteristics, current situation

and present production level of rubber plantations in different rubber plantations, the timely adjustment of the amount and mode of application of fertilizers will further enhance the capacity and benefits of natural rubber production. Therefore, precise fertilization is the only way to develop fertilizer technology.

Internationally, the research on precision agriculture-related technologies has made relatively rapid progress. The new technology system developed mainly under the conditions of large-scale operation and mechanized operation in developed countries is applicable to large scale farms and other areas where the technical equipment conditions And supporting the more demanding. At present, the overall technology and system research is still in the theoretical exploration and testing methods and techniques, the application is mostly for a point of function. However, the application of precision technology in rubber fertilization technology has yet to be found.

In China, there are many researches on fertilization technology. Guangxi Crane Extension

Station Ke Fei et al reported that sugar cane cultivating machinery can complete the processes of soil crushing, weeding, fertilizing and earth-shaking at the same time, which play a positive role in improving work efficiency, saving costs and increasing profits. 3ZSP-2-type multi-functional sugarcane fertilizer cultivator developed by Dong Xuehu, Institute of Agricultural Machinery, Chinese Academy of Tropical Agricultural Sciences, can be used not only for breaking the ridge of sugarcane in the host plant, but also for fertilizing and earth-cultivating in accordance with the technical idea of Combining function, structure and performance. Sugarcane seedlings in the new weeding, ditching, fertilization and earth-training, quality and stability, taking into account the fertilization of the first Order monitoring fertilizer explored the like, but the prior art are used in the fertilization of corn, sugarcane, potatoes and other crops in the field has not been published in the paper to the rubber (ZHANG Yuan, 2017; ZHANG Yuan, 2016).

At present, China's natural rubber plantation industry is implementing its "going global" development strategy. The high-precision and high-precision rubber fertilization equipment developed by the plant will have a good space for export-oriented development. It will also be exported to Africa, Asia and other planting countries or regions as a foreign aid technology, It provides technical support for the "going global" of China's natural rubber and has a significant impact on enhancing the international influence of the natural rubber industry.

2 FERTILIZER MACHINE STRUCTURE AND PRINCIPLES

2.1 Machine structure characteristics

Rubber garden electric ditching fertilizers mainly by the rack; open plow body assembly; fertilizer device; fertilizer assembly; limit wheel; dial grass assembly; control system and other structural components, the structure shown in Figure 1.



Figure 1: Rubber precision fertilizer machine structure.

The main equipment has the following structural features:

a. Plow column, loose plow, stiffener, limit plate, soil tooth welding in one, are free to move within the scope of 60° angle to meet the needs of different width of the ditches.

b. The pear acute angle surface is welded with an angle adjusting mechanism, and the angle adjusting mechanism is provided with a plurality of positioning circular holes, which are used together with the supporting rods welded on the pylons to jointly adjust the width of the ditching work.

c. The cutting disc is a double-edge concave structure, and the horizontal gap distance between the tooth and the ground tooth can be adjusted by the function of the positioning hole on the sleeve rod, and the tail of the draft rod contacts with the concave surface of the cutting disc to achieve the function of removing weeds.

d. fertilizer device can be adjusted according to the needs of the movable plate and the fertilizer tube to adjust the amount of fertilizer to achieve the purpose of fertilizer on-demand. Fertilizer hopper specific position can be adjusted to achieve a fixed bolt.

e. The control system can realize the constant speed control on the fertilizing turntable in the cab, and the quality of the scraping unit can be quantified by controlling the turntable speed so as to achieve the purpose of quantitative spreading.

2.2 Control method and working principle

Tractor driving process through the rack driven electric ditching fertilizers work, when the soil into the tooth, cut the first contact with the ground, with the increase of depth into the soil, cut into the tooth with the role of the gap between the weeds, cut off weeds, to avoid its winding pylons on the column and increase the ditching resistance. Under the action of the limit plate, the earthing tooth cooperates with the tractor to sink the power, which plays the role of limiting the plow body into the soil without any restriction. As the tractor advances, the earthwork and the stopper plate play the role of loosening the soil. The principle of its own perspective, making the soil along the two sides to open up to the purpose of ditching. At this point in the driver's cab connected to the toll dial control button, the turntable began to work, with the turntable running, the fertilizer inside the fat barrel drops to the turntable, scraper and turntable on the role of the relative movement of fertilizer The

fertilizer is scraped down to the bottom of the hopper and falls down to the back of the plow along the drain tube. With the relative movement occurring, the soil on both sides is automatically backfilled after the ditching and the applied fertilizer is covered, thereby completing the fertilization process. In the process of fertilization according to the demand for fertilizer by the driver to adjust the speed governor fertilizer plate speed, so as to achieve the purpose of quantitative fertilization.

3 ELECTRIC CONTROL METHOD AND COMPOSITION

Electric control system mainly by the wiring device, booster, governor, motor, fertilizer assembly, etc., a brief structure shown in Figure 2:

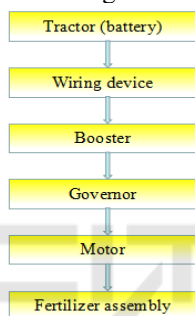


Figure 2: Control system diagram.

The specific control process is described as follows:

When the tractor ignition, the battery power to the instrument line, then the electric control system wiring device and tractor instrument wiring, the driver opens the switch, the wiring device is energized to the booster, the booster will tractor battery voltage from 12V Up to 48V before transmission to the governor, governor Promise speed knob can be controlled at 0 ~ 360r / min motor rotation, the motor relies on universal joints and the transmission assembly to complete the connection to complete the control of the fertilizer turntable , When the amount of fertilizer have fixed requirements, can be installed in the tractor cab by the governor knob speed control, so as to achieve the purpose of fertilization control precision (Shi Yinyan, 2017; Li Hongjun, 2017).

4 TEST

4.1 Test conditions and indicators

Electric control and machine test were carried out in the open space and in the field respectively. The field test was gentle slope, the slope was less than 15 degrees and the area was 1.5hm². The rubber planting distance was 6.5m.Fertilizer moisture content of 3.7%~4.8%, soil moisture content is 12%~16%. Machine matching 80 horsepower tractors, the main test results are as follows:

The ground test mainly tests the numerical value of the amount of fertilizer in the unit strip when the tractor travels at different speeds of different fertilizers under different gear speeds.

The field test mainly tests the productivity of pure working hours, the productivity of working hours, the fuel consumption per unit area, the amount of fertilizer per unit area, the depth of ditches, the stability of ditches, the uniformity of fertilization, the coverage of fertilizers (Zhu Yongren, 2017; Yang Cheng, 2017).

4.2 Experimental procedure

Electric control fertilizer test process shown in Figure 3:



Figure 3: Test process diagram.

Field test process and the effect shown in Figure 4:



Figure 4: effect picture.

4.3 Test results

Electric control test of fertilizer test indicators in Table 1:

Table 1: Electric fertilizer test results.

index	results
D2/9S	113
D2/15S	162
D2/23S	206
D3/9S	97
D3/15S	131
D3/23S	188
Speed ratio accuracy	94.3

Note: D2 / 9S means that the tractor travels at low speed and 2 speeds, and the amount of fertilizer applied per meter is 113g. Speed Accuracy = (actual unit area test value / theoretical calculation per unit area) × 100%.

Field test of the whole index value in Table 2:

Table 2: Machine test index results.

index	results
Pure working hour productivity (hm ² /h)	1.23
Operating hours productivity (hm ² /h)	0.8
Fuel consumption per unit area (kg/hm ²)	3.1
The amount of fertilizer per unit area (kg/hm ²)	1220
Ditch depth(cm)	22
Ditch depth stability(%)	88.9
Fertilizer uniformity(%)	90.3
Fertilizer coverage(%)	98.0
Fertilizer breaking rate(%)	0.1

5 CONCLUSIONS

a. The electric control precision fertilization control system, take the first booster and then speed mode, the effective implementation of the tractor carrier promise speed control knob can basically achieve the precision of rubber fertilization control, accuracy Indicators of 94.3%, while speed accuracy, control reliability and other indicators have yet to be long-term optimization and research.

b. Rubber Park electric trenching fertilizer machine according to the basic realization of the rubber plantation ditch management, fertilizer agronomy simultaneously. Machine matching 80 horsepower tractors, ditching up to 22cm depth, the productivity of 1.23hm²/h, fuel consumption 3.1Kg/hm², fertilization uniformity 90.3%, coverage up to 98.0%, which can effectively improve production efficiency and reduce production costs.

ACKNOWLEDGEMENTS

This work was financially supported by the Central Public-interest Scientific Institution Basal Research Fund for Chinese Academy of Tropical Agricultural Sciences(1630022015018&1630132017003);Public Welfare Research and Capacity Building of Guangdong Province (2017A02028012);2017 provincial agricultural development and rural work special "natural rubber processing of key technologies in Thailand application"(Yue Nongji [2017] No.39);Natural Science Foundation of Hainan Provincial(20155204); Chinese Academy of Tropical Agricultural Sciences(1630132016015);Science and Technology Program special of Zhanjiang City(2015A03023)and Collaborative innovation and platform environment construction special of Guangdong Province (2017A040406003).

I would like to thank the members of the research group for their selfless help, especially the communication author Wei Lijiao, and the guangba farms in Hainan Province for the project test of strong support.

REFERENCES

- WANG Yeqin, DENG Yiguo, ZHANG Yuan, etc. Design of natural rubber precision ditch fertilization machine[J]. Advances in Intelligent Systems Research, 2016. vol.154:719-724.
- ZHANG Yuan, WEI Lijiao, DENG Yiguo, etc. Test and Effect Evaluation of 3XSP-1 Rubber Fertilizer[J]. Modern Agricultural Equipment, 2017. 226 (1) :37-41.
- ZHANG Yuan, DENG Yiguo, WEI Lijiao, etc. Development and Experimental Analysis of Ditching Fertilizer Application in Rubber[J]. Modern Agricultural Equipment, 2016. 224 (5) :50-54.
- Shi Yinyan, Chen Man, Wang Xiaoyue, etc. Analysis and Experiment of Fertilizing Performance for Precision Fertilizer Applicator in Rice and Wheat Fields[J]. Transactions of the Chinese Society for Agricultural Machinery, 2017, (8) : 97-103.
- Li Hongjun, Jia Rongcong. Intelligent fertilization machine design[J]. Electronics World, 2017, (17) : 187.
- Zhu Yongren. Design of Orchard's Machine Structure with Ditching and Deep Fertilizing[J]. Journal of Agricultural Mechanization Research, 2017, (12) : 102-106.
- Yang Cheng, Cang Ying, Zhou Zhiyan, etc. Design and Test of Pneumatic Fertilizer Applicator Variable Ratio Fertilization Control System Based on PID Algorithm[J]. Journal of Shenyang Agricultural University, 2017, (3) : 320-327.