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FERTILIZER AND WATER EFFICIENCY IN CITRUS PLANTS USING *FERTILIZER IRRIGATION MOBILE CONTROL*

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Abstract. Citrus plants have a high growth response. Regular fertilization is needed to serve the high growth response. One of the important things in the cultivation of citrus plants is recognizing the need for fertilizers and water in accordance with the stages of growth of citrus plants Indonesian citrus farmers still rely on conventional fertilization and irrigation. They spreading fertilizer around the citrus plant and flush the water around it. This process of fertilization and irrigation needs more fertilizer and high cost because its need many labors to do it. This research proposes a system to control fertilization and irrigation automatically thus the farmers can reduce production costs.

1. Introduction

Citrus is a plant that has a fairly high growth response, so it requires continuous fertilization which is carried out throughout the year at different intervals according to the needs of the citrus plant [1]. Each plant grows plants need different amounts it. The process of watering the citrus plants is more intensive when the plants begin to bear fruit. To cultivate citrus requires hard work and perseverance. One way is by fertilizing which aims to provide nutrients to plants to grow well and be able to produce throughout the year [2]. Fertilization is a routine activity carried out in the cultivation of oranges but it will greatly influence the improvement in quality and quantity of the harvest if it is done without consideration [3]. Sometimes farmers are late in providing fertilizer and water because farmers have difficulty in finding workers to do the work.

Indonesian citrus farmers have been cultivating citrus for a long time but still rely on conventional fertilization. They spreading fertilizer around the citrus plant and flush the water around it. This process of fertilization and irrigation needs more fertilizer and high cost because its need many labor to do it. Watering and fertilizing systems for citrus plants carried out by citrus farmers in Indonesia are still conventional. It was wasteful in using the fertilizers and irrigation which only 60 percent of efficiency. The process of applying fertilizer and watering also requires workers thus the farmer need more money to pay the workers.

This paper proposes a regulatory system called *Fertilizer Irrigation Mobile Control System* for automatically administering fertilizers and irrigation that can be controlled via a mobile device. By using this system, the farmers can regulate the provision of fertilizer and water automatically and on time. It is expected that by using this Fertilizer Irrigation Mobile Control System, citrus fruit farmers

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can savings and improve the efficiency in the use of fertilizers and labor costs, thus production costs become lower and the revenue become higher because citrus plants can produce optimally.

Related Work

Water is the basic component of plant cell tissue. It is water, above all, which controls the growth and development of citrus trees. Most of the water absorbed by the plant comes from the soil. Nutrients present in the soil are dissolved in water, taken up by the tree, and supplied to all parts of plant through translocation. The common methods of applying water to the orchards are basin, border strip, furrow, sprinkler, and drip irrigation [4]. One of work related to fertilization and irrigation for citrus plant i.e., fertilization and irrigation using automatic irrigation system based on monitoring soil moistures [5]. Another work using low cost sensor for automated irrigation. This work is best suit for places where water is scarce and has to be used in limited quantity [6].

3. Method

Fertilizer Irrigation Control System is a modern agricultural irrigation system that has been widely used by farmers in developed and developing countries such as Britain, India, Vietnam and Thailand. Basically, this research proposes a system that provides liquid fertilizer mixed with water. The mixture is distributed to each plant evenly, so it is very effective and efficient in the use of fertilizers. And this system is controlled by mobile system as illustrated in figure 1.

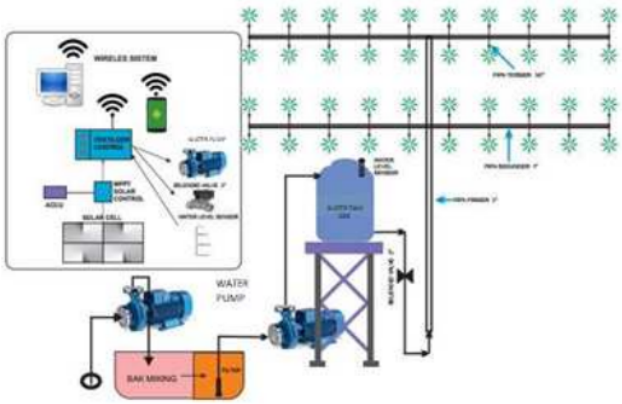

Figure 1. Fertilizer Irrigation Mobile Control System

There are two stages for designing Fertilizer Irrigation Mobile Control, described as follow:

3.1 Design of mobile power and control systems

The Fertilizer Irrigation Mobile Control System is located in a rice field area which far from electricity sources. The electric power system for Fertilizer Irrigation Mobile Control using solar power. Considering the biggest load is a 200 Watt 24V water pump motor. Then the solar panel needed is 400 Watt Peak, assuming it can supply pump motors along with valves and other electronic components. 200Ah 24V battery is used as an accumulator (a reservoir of electrical energy from solar panels). Our solar controller chooses the MPPT 30A method, because it can supply electricity from the solar cell to the battery even in cloudy weather. This system illustrated in figure 2

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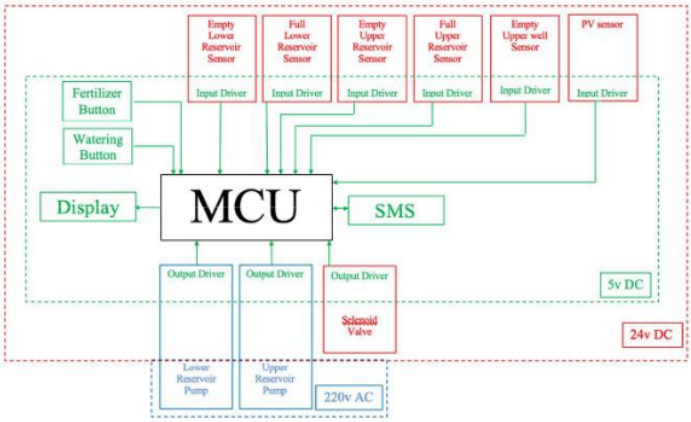

Figure 2. Mobile power and control systems

Our fertilizer and irrigation control system were designed with the addition of a mobile (mobile) system with the aim of being able to be controlled remotely using an Android application and web service. The control system can run automatically through a mobile application (controlled by a mobile phone) and can be controlled manually with the existing button system in the fertilizer control panel. The control system manages the work of the water pump motor to the reservoir (reservoir), controls the contents of the reservoir with water level sensor, controls the flow of water to the plant with a control valve.

3.2 Design of irrigation and fertilization systems

The Fertilizer Irrigation Mobile Control System utilizes organic liquid fertilizer that is efficiently distributed to each citrus plant. The design of the system illustrated in figure 3.

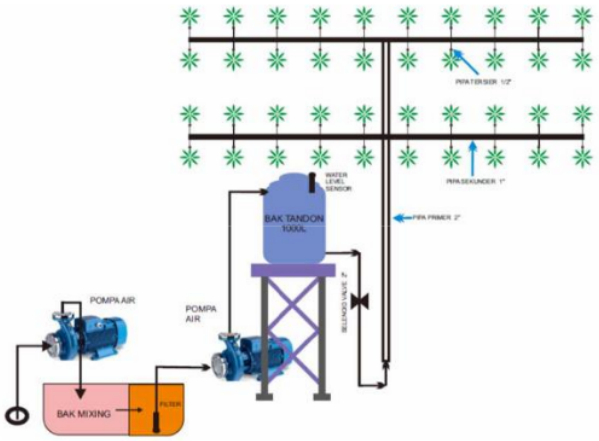

Figure 3. Mobile power and control systems

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Irrigation and fertilizer systems are designed using the earth's gravitational force. So that the mixture of water and fertilizer can flow from the reservoir (reservoir) with a height of 2m from the ground surface to each plant. The flow of water to each plant through the pipes we designed with a close loop so that it has the same pressure at each end. The water and fertilizer mixed distribution pipes are divided into 3 parts. The first part of the primary pipe with a dimension of 2 "which functions as the main channel for mixing water and fertilizer from the reservoir to the secondary pipe. The second part of the secondary pipe with dimension 1 ", is in between the plants which functions to channel the flow of water and fertilizer mixture from the primary pipe to the tertiary pipe. The third part of the tertiary pipe is equipped with a container 20-30 cm from the plant. The container contains a mixture of water and fertilizer volume of 2 liter, its function as a place of water and fertilizer so that it can be absorbed well by plants.

4. Result

This system has been implemented in the citrus orchard belongs to citrus farmer in Umbulsari district of Jember, East Java, Indonesia which can be seen in figure 5. This system can reduce the production cost i.e., fertilizer cost and manpower cost. The comparison between using conventional irrigation and using fertilization and irrigation mobile control system can be seen in table 1.

Table 1. Comparison of System Efficiency

	Manpower needs	Fertilizer Efficiency	Irrigation Water Efficiency	Time of fertilization	Irrigation time
Manual Process	3 People / 1500 m^2	50 Kg / 90 tree	3000 Liter / 90 tree	2 days / 1500 m^2	1 day / 1500 m^2
Automatic system	1 People / 1500 m^2	50 Kg / 50 tree	2000 liter/ 90 tree	30 minutes / 1500 m^2	20 minutes / 1500 m^2

The control of this system developed using android application, thus the operator of this system doesn't have to be on citrus orchard location. The system can be operated from the house or any place far from the citrus orchard. This control system illustrated in figure 4.

Figure 4. Mobile Control Systems

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Figure 4. Implementation systems in citrus orchard

5. Conclusion

From the implementation of system in the citrus orchard, can be known that the fertilizer and irrigation efficiency can be achieved. The manpower efficiency attains to 66 percent, fertilizer efficiency attains to 40 percent and water flush efficiency attain to 30 percent. From this achievement, it can be conclude that the time efficiency was increase very significant using this proposes system.

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