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Application of Hydroponic Plants Watering Automation Based on ATMega328 Microcontroller on Water Spinach (Pomea Aquatic Forsk)

Supardi, I.W
Department of Physics, Faculty of Mathematics and Natural Sciences, Udayana University, Denpasar, Indonesia
Corresponding author email: supardi@unud.ac.id

Ni Nyoman Rupiasih
Department of Physics, Faculty of Mathematics and Natural Sciences, Udayana University, Denpasar, Indonesia

I Ketut Putra
Department of Physics, Faculty of Mathematics and Natural Sciences, Udayana University, Denpasar, Indonesia

***Abstract*---*The development of electronic technology in the era of globalization is very rapid. Utilization of this technology as a means to assist in agriculture, especially hydroponic plantations that are currently developing, to obtain optimal results, it is necessary to monitor the humidity and temperature conditions of the growing media. In previous research, a system was made that was able to maintain the humidity and temperature of the water following what the plant needed. The tool consists of a temperature sensor, humidity sensor, ATMega328 microcontroller, ADC and water pump. Temperature and humidity sensors function to detect temperature and humidity. The ADC functions to change the amount of voltage measured by temperature and soil moisture into a digital quantity which is then forwarded to the ATMega328 microcontroller to be processed into a digital display on the LCD. The ATMega328 microcontroller also regulates the ON and OFF of the water pump engine. The next research is to apply the tools that have been made in real terms. This research willapply the tools that have been made to the water spinach plant (Pomea Aquatic Forsk).*
Keywords*---*ADC, ATMega328, humidity, temperature, water spinach.

Introduction

Agriculture has now shifted from natural farming to a hydroponic model because agricultural land in the form of land is limited. Hydroponics is planting without soil. The media used for hydroponic planting uses water, gravel, coarse sand, rockwool coconut fiber, perlite and wood fiber. Several things influence plant growth in a hydroponic plant system, including: environmental conditions, water, nutrient solutions, light, nurseries, plant media, and measuring tools (Permana et al., 2021).

Water functions as a nutrient solvent as well as an important substance needed by hydroponic plants. You must pay close attention to the condition of the water because excess and dirty water can disrupt the plant growth process (Kimball et al., 1997; Davis et al., 2016). Hydroponic plants require the right amount of water according to the environmental conditions of the day, therefore proper watering control is needed. So this research will be carried out on the application of a hydroponic plant watering automation tool based on the ATMega328 microcontroller to water spinach (pomea aquatic Forsk) plants (Zakariyya et al., 2017; Sharma et al., 2023).

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Materials and Methods

This research will apply tools that have been made to kale plants (pomea aquatic Forsk). In this research, the growth components of kale plants will be observed, namely: plant height, number of leaves, stem diameter, leaf area and physiological parameters observed including chlorophyll content, carotenoid content, and number of stomata (Agustono & Paramita, 2010).

Results and Discussion

To plant vegetables using a hydroponic system you can do it in several steps, namely: The first stage is to sow kale seeds using rock wool. The method is quite easy, starting with wetting the rock wool that will be used for sowing (Kastella, 2019). After that, make a planting hole in the rock wool using a toothpick or something similar (Hock, 2003; Demirbas, 2004). Place the seeds in the planting hole and cover the seedlings until the seeds burst (1-4 days) as shown in Figure 1. After bursting the new seeds expose the seedlings to sunlight. After the seedlings grow true leaves (1-7 days), the seedlings are ready to be transplanted as shown in Figure 2.

Figure 1. Seedling results in 1-4 days

Figure 2. Results of kale plants after 7 days

The second stage is to move the plant to the net pot that will be used. Before moving it to the net pot, first, fill the net pot with a flannel cloth. After the netpot is filled with flannel cloth, the water spinach plants are transferred to the netpot along with the rock wool (Fu et al., 2011; Yang et al., 2012). After the plants are moved to the netpot, the kale is planted and the plants are placed in a hydroponic system. As in Figure 3.

Figure 3. Water spinach plants that have been transferred to a hydroponic system

Plant growth component data is taken by measuring and recording plant height, number of leaves, stem diameter, leaf length and leaf width. The results of the data recording are shown in Table 1.

Table 1
Observation data on the growth of water spinach plants

	Height (cm)	Stem diameter (cm)	Leaf length (cm)	Leaf width (cm)	Number of leaves (pieces)
k1	30	0.3	5	1	8
k2	21	0.3	7.5	1.4	8
k3	19	0.3	3.5	1.2	7
p1	32	1	20	4	32
P2	29	1.1	18	3	30
P3	26	1.2	18	2	24
P4	26	1.2	21	4	24
p5	26	1.1	21	5	24

- Ki = control
- Pi = plants are given treatment

Component data Physiological parameters including chlorophyll content, and carotenoid content were tested in the LAB with FMIPA with UV-Vis and the number of stomata was carried out in the LAB. Biology FMIPA Udayana University with results as shown in Table 2.

Table 2
Physiological Data of Water Spinach Plants

Treatment	chlorophyll content (mg/Kg)	carotenoid content (mg/100 g)	number of stomata stomata/10mm2)
k1	168.02	11651.26	15
k2	139.30	8119.41	11.4
k3	279.60	11758.17	19.4
p1	366.90	10780.87	12.6
P2	423.50	11130.91	17.4
P3	328.82	10052.01	8.8
P4	254.75	8390.49	8.4
p5	343.59	7101.19	11.6

Plant height, number of leaves, stem diameter, leaf length and leaf width from the data in Table 1 can be graphed as in Figure 4.

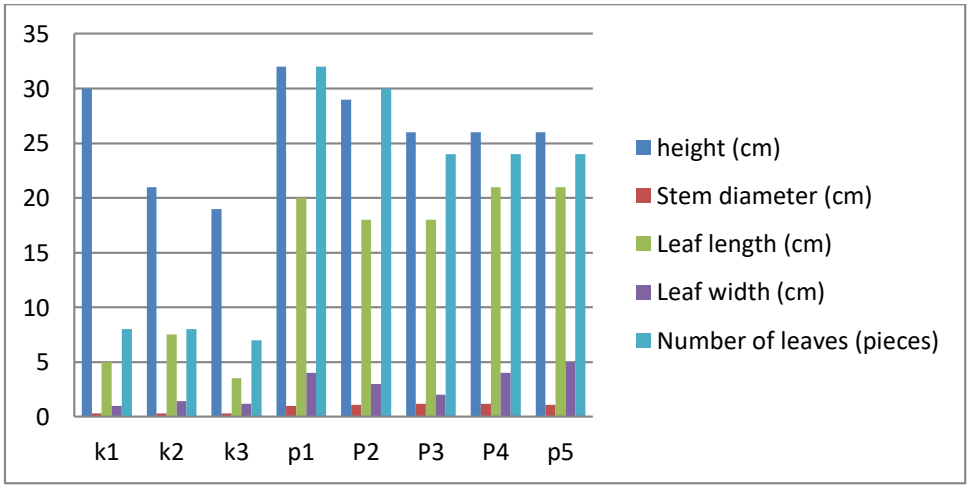

Figure 4. Growth graph of kale plants

Figure 4, it can be seen that the control plants have a smaller stem diameter compared to the treated plants. If you look at the height of the plants, the plants that were given the treatment are taller when compared to the control, if you look at the length and width of the leaves, the plants that were given the treatment are wider and longer when compared to the plants that were not given the treatment and if you look at the number of leaves produced It was also found that a greater number of leaves were treated when compared to those that were not treated (Wang et al., 2008; Bashir et al., 2018). Physiological Data on Water Spinach Plants as in Table 2 can be graphed in Figure 5.

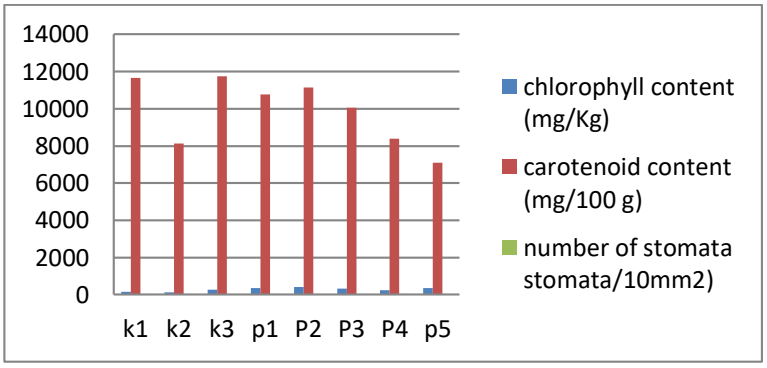

Figure 5. Graphed Physiology of Water Spinach Plants

Figure 5, shows that the chlorophyll content and carotenoid content of control plants are smaller than that of treated plants, while the number of stomata produced by control plants is greater than that of treated plants.

Conclusion

The conclusions from the research that has been carried out are as follows: 1. The ATMega328 microcontroller-based hydroponic plant watering automation tool can be applied to water spinach plants (pomea aquatic Forsk; 2. From plant development, the results showed that control plants had smaller growth compared to treated plants; 3. Plant physiology shows that the chlorophyll content and carotenoid content of control plants are smaller than that of treated plants, while the number of stomata produced by control plants is greater than that of treated plants.

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