

1. INTRODUCTION

The hydroponic system is a plant cultivation technique in which water replaces the role of the soil which is used as a medium for distributing nutrients and substances needed by plants [1]. Examples of important substances and nutrients are nitrogen (N), phosphorus (P) and potassium (K) which are absorbed by plant roots [2]. The advantage of the hydroponic system is that growers have complete control over the environment, which includes its climate and its nutrient needs [3][4]. The hydroponic planting process can be done in 2 ways, namely outdoor hydroponics, and indoor hydroponics [4].

Sunlight is one of the factors that affect hydroponic growth [5]. Sunlight contains a spectrum of colors that can stimulate the photosynthetic process of hydroponic plants to grow [7]. However, due to some environmental conditions that are not ideal, nutrients for hydroponic plants from lighting may be lacking. To solve this problem, a system can be proposed where the sun's nutrients are replaced through the light-emitting diode (LED) grow lights that can produce a color spectrum like indoor sunlight [8].

Hydroponic planting can be automated with the help of internet of things (IoT) technology [9]. In an IoT-based automation system, monitoring the condition of hydroponic plants is carried out and controlled in the system through several sensors and actuators [10]. Built-in sensors allow monitoring and control of the humidity, temperature, and intensity of the environment light [11]. Data obtained from sensors is used to analyze crop yields for more optimal growth [12].

IoT devices and software applications are included to send and display system information online [13]. The application of IoT-based hydroponic automation in this study ensures that the data obtained is more efficient, the data obtained is said to be efficient because it is not done manually but replaced with the role of IoT [14]. Through automated systems and situation monitoring the data is obtained more because it is real-time [15]. This research aims to design, create, and evaluate a hydroponic automation system by monitoring the quality of plant growth that uses LED grow lights and natural light conditions on hydroponic bok choy. On the proposed hydroponic automation systems, light-feeding is done automatically, this can be carried out with the help of a real-time clock (RTC) module and relays. Furthermore, the monitoring function is carried out through temperature and humidity measurement sensors.

To evaluate the proposed system, a comparison is made with the conventional system. Thus, two systems are measured side by side. Three metrics are used to measure the growth of each hydroponic system, they are leaf count, plant height and fresh weight. To see the significance of the grow light in the plant growth, the t-test is used and the probability density function (PDF) of each growth is shown.

Comment [Y1]: old you please explain the meaning of this efficient data?

Comment [Y2]: Explanation for efficient data was added

Comment [Y3]: We also haven't found out what hydroponic plants are used in this study in the Introduction.

Comment [Y4]: Hydroponic plants used are bok choy was added.

Comment [Y5]: Are the parameters only leaf count and plant height?

Comment [Y6]: The parameters used are leaf count, plant height and fresh weight