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# Verticulture of Lettuce (*Lactuca sativa* L.) in the Growick Irrigation System with Various Wick Widths

*Vertikultur Tanaman Selada (Lactuca sativa L.) pada Sistem Irigasi Growick dengan Berbagai Lebar Sumbu*

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## ABSTRAK

Sistem irigasi growick merupakan irigasi bawah tanah yang mampu mencegah kehilangan air bagi tanaman karena langsung membasahi daerah perakaran. Penggunaan lebar sumbu dalam sistem irigasi growick mampu memenuhi kebutuhan air pada media tanam. Penelitian ini bertujuan untuk mengetahui pengaruh lebar sumbu penggunaan sistem irigasi growick pada pertumbuhan dan hasil tanaman selada yang ditanam secara vertikultur. Penelitian ini dilaksanakan pada bulan April hingga Mei 2021. Penelitian dilakukan di kebun percobaan dan penelitian, Fakultas Pertanian, Perikanan, dan Biologi, Universitas Bangka Belitung. Penelitian dilakukan rancangan acak kelompok (RAK) yang terdiri dari 5 taraf perlakuan. Perlakuan terdiri dari kontrol, lebar sumbu 0,5, 1, 1,5 dan 2 cm. Hasil penelitian menunjukkan bahwa lebar sumbu pada sistem irigasi growick dan vertikultur berpengaruh terhadap konsumsi air pertanaman, dan tidak berpengaruh nyata terhadap parameter pertumbuhan dan hasil selada. Perlakuan lebar sumbu 0,5 cm cenderung lebih baik dalam mendukung pertumbuhan dan hasil selada pada sistem penanaman vertikultur.

Kata kunci: sistem irigasi growick, selada, vertikultur, lebar sumbu

## ABSTRACT

The growick irrigation system is an underground irrigation that can prevent plant water loss because it directly wets the root area. The use of the width of the wick in the growick irrigation system is can meet the water needs of the growing media. The aimed of this study were to determine the effect of wick width using the growick irrigation system on the growth and yield of lettuce grown vertically. This research was conducted from April to May 2021. The research location was in the Experimental and Research Station, Faculty of Agriculture, Fisheries, and Biology, University of Bangka Belitung. The study was conducted using a randomized block design experimental method (RBD) which consisted of 5 levels of treatment. The treatment consisted of control, wick width 0.5, 1, 1.5, 2 cm. The result shows that width of the wick of the growick and verticulture irrigation systems affected the crop water consumption but had no significant effect on the growth parameters and yield of lettuce. The treatment of 0,5 cm wick width tends to be better in supporting the growth and yield of lettuce in the vertical cultivation systems.

Keywords: growick irrigation system, lettuce, verticulture, wick width

## INTRODUCTION

The rapid increase in population is one of the challenges that must be faced by developing countries. According to the Central Bureau of Statistics data (2020), in 2019 the total population in Indonesia was 268,074,600 with a population growth rate for the last 10 years of 1.31%. The limited amount of land cannot compensate for the need for large areas of land. Pomalingo et al. (2017) revealed that various efforts were made to solve this problem, one of which was to utilize a vertical system.

Verticulture is a way of farming by placing planting media in containers that are arranged vertically or terraced (Sari et al., 2016). Vertical cultivation of plants provides many advantages. According to Hasyim and Mirajuddin (2013), these advantages include efficiency in land use, easy maintenance, saving on fertilizers and biopesticide, practical and easy control of weed growth, can be moved easily, and vegetables that are harvested are cleaner and healthier. Pamungkas et al. (2013) stated that one of the plants suitable for cultivation in a verticulture system was lettuce. Lettuce (*Lactuca sativa* L.) is a vegetable that is consumed fresh and is popular with the public because it has a fairly high nutritional content, especially minerals (Nugroho et al., 2017). According to the USDA National Nutrient Data Base (2018), 100 g of lettuce contains 15 calories of energy, 2.87 g of carbohydrates, 1.36 g of protein and 0.15 g of fat. Adimihardja et al. (2013) stated that this makes lettuce have high economic value. Hakim et al. (2019) added that this high economic value is evident from export data for 2012, namely the demand for lettuce on the world market was 2.792 tons while imported lettuce from Indonesia was 145 tons.

The high market opportunity for lettuce plants makes lettuce cultivation very potential to be developed. Nurjumadil et al. (2018) stated that in order for the growth of plants including lettuce to take place properly, water regulation must be considered. Amuddin and Sumarsono (2015) report that so far farmers are still watering their plants manually, which wastes a lot of time and uses a lot of energy and wastes water. According to Inonu et al. (2021), this can be overcome by using growick irrigation system.

The capillary wick irrigation system, can really contribute in the emerging problems and issues that are now facing agri-cultural water development such as water scarcity, how to increase the productivity of existing water resources, and how to respond to climate change (Felipe & Bareng, 2022). The growick irrigation system is an underground irrigation that is able to prevent water loss for plants because it directly wets the root area. The working principle of growick is to use a wick or axis system that can drain water from a bucket or water container to the surface of plant roots (Inonu, 2021). The availability of water in the growick system is very dependent on the quality of the wick. The greater number of capillary pipes causes water to be absorbed more optimally (Sakinah, 2017). Inonu et al. (2021) in his research on the effect of the number of wicks on the Pakcoy growick irrigation system showed that one flannel cloth with a width of 1 cm showed better growth and yields compared to controls and other treatments. Ardriani et al. (2019) found that flannel has a high water absorption rate and high water absorption rate, so it is good for use as a wick in a growick irrigation system. This is the basis for conducting this research, namely to determine the effect of the width of the wick and what is the proper width of the wick on the verticulture of lettuce plants using the growick irrigation system. The objectives of this study was to determine the effect of wick width using the growick irrigation system on the growth and yield of lettuce grown vertically.

## MATERIALS AND METHODS

The research activity was carried out from April to May 2021. The research was conducted at the Experimental and Research Station, Faculty of Agriculture, Fisheries and Biology, Bangka Belitung University.

The tools used in this study were tape measure, seedling trays, flannel cloth, mild steel, , 8 L ice cream buckets and lids, pots, scissors, hoes, machetes, rulers, digital scales, paper envelopes, oven, measuring cup, sample ring, groundwater moisture light meter and thermohygrometer. The materials used were New Grand Rapid lettuce seeds, topsoil, chicken manure, NPK fertilizer (16:16:16)

This research was conducted using the experimental method. The design used was a randomized block design (RBD) with a total of 4 blocks. The treatment used was a variety of wick widths consisting of 5 treatment levels, namely:

Control = direct/conventional watering
L0,5 = 0,5 cm wick width
L1,0 = 1 cm wick width
L1,5 = 1,5 cm wick width
L2,0 = 2 cm wick width

Control (direct or conventional irrigation) was used as a comparison in the study. There were 20 experimental units with a number of samples observed in each treatmens as many as 5 plant samples. The number of samples and plant populations was 100 plants.

### Research Procedures

### Plant Material Preparation

The seeds were soaked for one hour before sowing. The seeds were sown using top soil media and manure with a ratio of 1:1. Seeding was done using a seedling tray and cared for until there ware 4-5 leaves or 21 days after sowing (DAS).

### Creation of the Growick Units

The growick unit was a combination of several components such as an 8 L ice cream bucket, pot and wick. There were 80 units of growick units made.

### Making Vertical Growick Installation

Merging of mild steel circuits and growick installations The number of installations made was 1 installation.

### Preparation of Planting Media

The planting medium used was a mixture of top soil and chicken manure with a ratio of 1:1. The media was then put into the pot.

### Planting

The criteria for seeds ready for planting were that they already have 4-5 leaves or were 21 HSS in the planting hole. Each planting hole planted 1 lettuce seed. Planting lettuce seeds was done in the afternoon to avoid wilting of the seeds.

### Addition of Irrigation Water

The first volume of water in the container was filled with 5 L. The addition of irrigation water to the Growick system was carried out when the water has reduced by ¼ of the initial volume. The addition of irrigation water was carried out until it reaches the maximum volume. Irrigation in the control treatment was carried out every day with the volume of water adjusted to the conditions of the media.

### Maintenance

Maintenance of lettuce plants with a vertical growick system includes fertilizing, weeding, replanting and controlling pests and diseases. The fertilizer used was NPK compound fertilizer at a dose of 3 g/plant (Idha & Herlina, 2018). Fertilization was done at the age of 14 days after planting (DAP).

**Harvesting**

Harvesting was done when the lettuce plants were 35 DAP, that was, before entering the flowering phase and carried out simultaneously.

**Variables observed**

The variables observed in this study consisted of the main parameters, namely plant height (cm), number of leaves (sheets), stem diameter (cm), production per plant (g), shoot dry weight (g), root length (cm), root fresh (g), root dry weight (g), water comsumption per plant (L), water use efficiency (WUE), and supporting parameters namely air temperature ($^oC$) & air humidity (%), soil temperature ($^oC$) and soil water content (%).

**Data analysis**

Observational data were analyzed Analysist of Variance using at α = 0.05. The results of the variance that showed a significant effect were further tested using Duncan's Multiple Range Test (DMRT) at α = 0.05. Test results were presented in the form of tables, graphs, and histograms.

## RESULTS

**Result of Variance**

Based on the analysis results (Table 1), various wick widths had a significant effect on the parameters of crop water consumption. The use of various types of wick width had no significant effect on the parameters of plant height, number of leaves, stem diameter, crop production, soil water content, water use efficiency, root length, root fresh weight, root dry weight, shoot dry weight, and total dry weight.

Root dry weight and shoot dry weight tended to be the same for all variations in wick width, which caused the total dry weight to tend to be uniform. On a 1 cm of wick width, the total dry weight was slightly heavier than the other widths (Table 2).

Table 1. Results of variance of various wick width on plant growth & yield variables

| Variables | F | Pr > F | CV% |
|---|---|---|---|
| Plant Height (cm) | 2.57 | $0.0722^{ns}$ | 8.06 |
| Number of Leaves (sheets) | 2.02 | $0.1360^{ns}$ | 8.96 |
| Stem Diameter(cm) | 0.79 | $0.6120^{ns}$ | 14.73 |
| Root Length(cm) | 2.61 | $0.0689^{ns}$ | 16.66 |
| Root Fresh Weight (g) | 1.15 | $0.3960^{ns}$ | 42.42 |
| Root Dry Weight (g) | 0.78 | $0.6144^{ns}$ | 47.63 |
| Shoot dry weight (g) | 0.32 | $0.9284^{ns}$ | 42.99 |
| Total Dry Weight (g) | 0.50 | $0.8167^{ns}$ | 38.54 |
| Crop Production (g) | 0.67 | $0.6915^{ns}$ | 38.53 |
| Water Consumption of Each Plant (L) | 165.69 | $> 0.0001^{**}$ | 6.55 |
| Water Use Efficiency (g/L) | 1.60 | $0.2274^{ns}$ | 38.62 |

Note: Pr > F = Probability of Value, $^{**}$ = Very Significant Effect on ANOVA 95%, $^{ns}$ = no significant effect, CV = Coefficient of Variance

Table 2. The average dry weight of lettuce plants in the treatment of various wick widths using the verticulture cultivation system

| Treatment of Various Wick Widths | Root Dry Weight (g) | Shoot Dry Weight (g) | Total Dry Weight (g) |
|---|---|---|---|
| 0.5 cm | 0.02 | 0.03 | 0.05 |
| 1 cm | 0.03 | 0.03 | 0.06 |
| 1.5 cm | 0.02 | 0.03 | 0.05 |
| 2 cm | 0.02 | 0.03 | 0.05 |
| Control | 0.04 | 0.03 | 0.07 |

**Lettuce Plant Growth**

The addition of lettuce plant height on the use of various wick widths increased every week (Figure 1). Lettuce plant height in the 1st to 2nd week tended to increase relatively the same in each treatment. From the 3rd to the 5th week, the height growth rate of lettuce plants in the 0,5wick width treatment experienced a relatively faster increase compared to the other treatments, but not better than the control treatment.

In the variables of number of leaves and stem diameter, there was a tendency that the wider the wick, the number of leaves and stem diameter increases. When compared with the direct watering treatment (without growick), the addition of these two variables was still slower (Figure 2 & 3). In the variables of root length and root wet weight (Figure 4), a 2 cm wide wick tends to inhibit root growth compared to a narrower wick. Root growth in the control was still better than the growick system.

**Plant Production Results**

Based on Figure 5, the 1.5 cm wick width treatment gave the highest yield of 1.44 g from the 0.5 cm, 1 cm, and 2 cm wick width treatments. The conventional treatment showed the highest results compared to the wick width treatment using the growick system.

**Water Consumption of Each Plant and Water Use Efficiency**

Based on Duncan's Multiple Range Test (DMRT) (Figure 6), the Water requirement of each treatment in the conventional treatment showed the highest results compared to the growick treatment and was significantly different from the other wick width treatments. Among the various wick widths that consume the most water, 0.5 cm wick width was significantly different from 1.5 cm wick width and 2 cm wick width but not significantly different from 1 cm wick. In Figure 7, that the wider the wick, the lower the water use efficiency. The control treatment had the lowest efficiency compared to all the wide-wick treatments with the Growick irrigation system. The 1 cm wick width was the most efficient of water use compared to other wick widths.

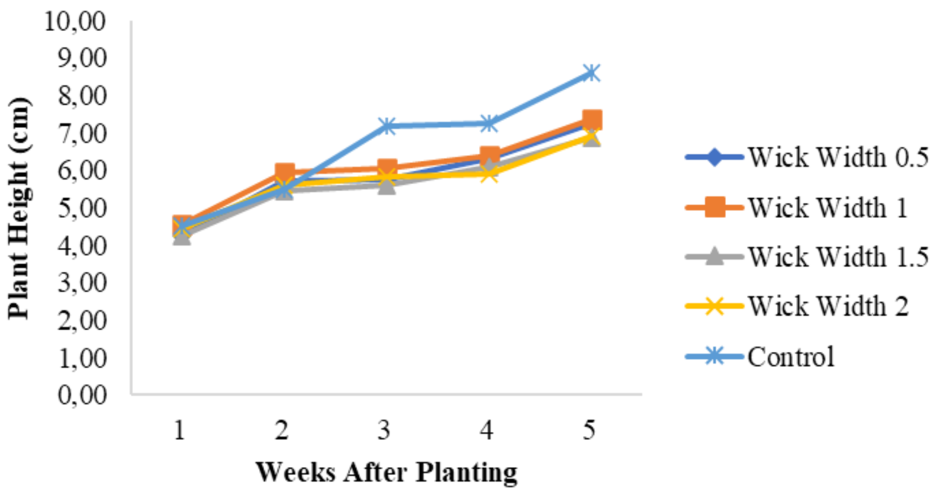


Figure 1. The average height of lettuce plants in the treatment of various wick widths using the verticulture cultivation system

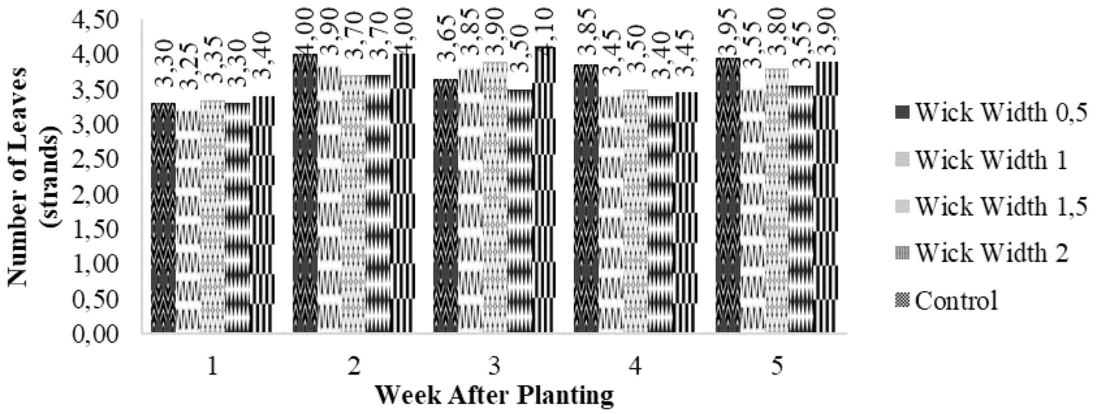


Figure 2. The average number of leaves of lettuce plants in the treatment of various wick widths using the verticulture cultivation system

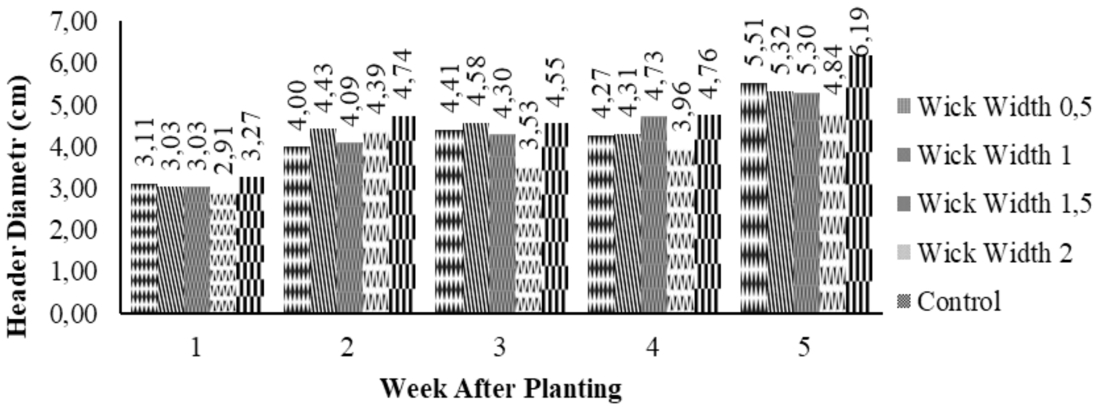


Figure 3. The average header diameter of lettuce plants in the treatment of various wick widths using a verticulture cultivation system

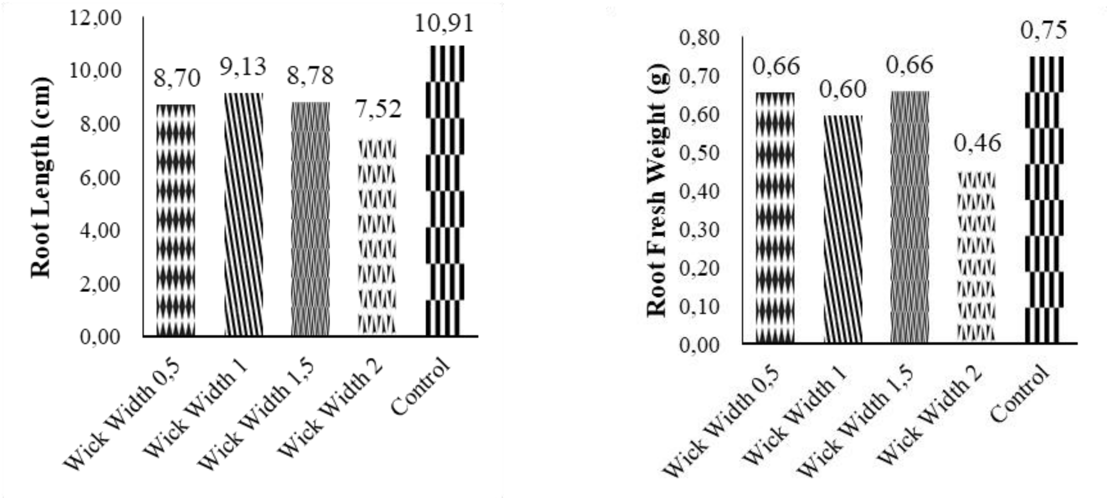


Figure 4. Average length and fresh weight of lettuce roots in various wick width treatments using a verticulture cultivation system

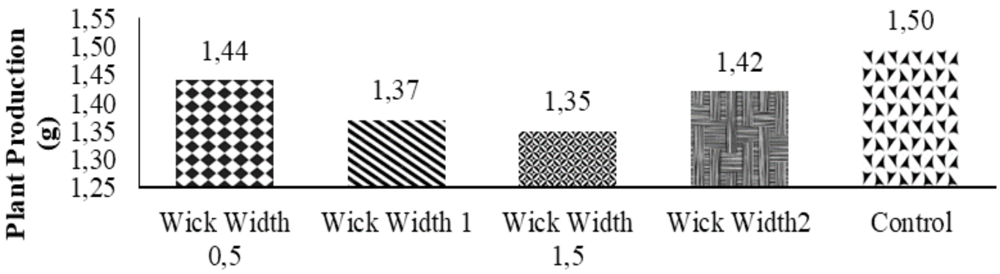


Figure 5. The average production of lettuce plants in the treatment of various wick widths using a verticulture cultivation system

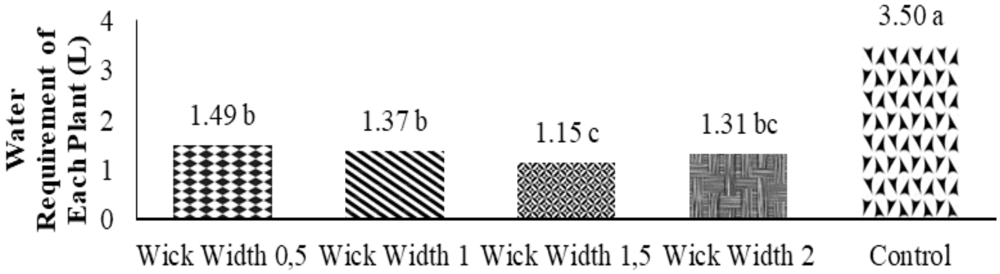


Figure 6. Average Water requirement of each plant in the treatment of various wick widths using a verticulture cultivation system

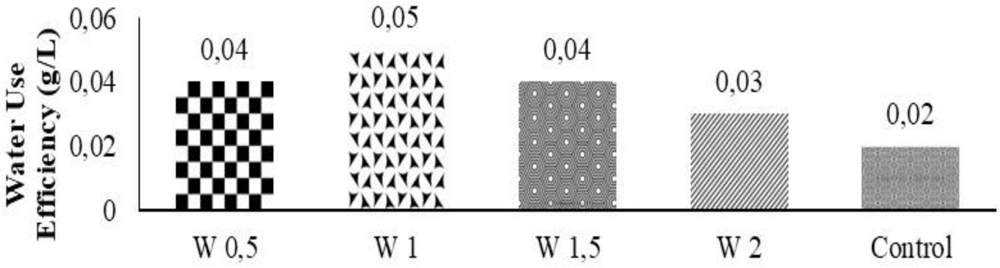


Figure 7. The average water use efficiency of lettuce plants in the treatment of various wick widths using a verticulture cultivation system

## DISCUSSION

Based on research using the width of the wick in the growick irrigation system vertically, it has a very significant effect on crop water consumption. The use of the width of the wick in the verticulture growick irrigation system on the planting medium did not have a significant effect on the growth and yield of lettuce plants, including plant height, number of leaves, stem diameter, root length, root fresh weight, root dry weight, shoot dry weight, total dry weight, and water use efficiency (Table 1).

The width of the wick significantly affects the value of water consumption (Figure 6). Plant water consumption is closely related to soil water content. The wider the wick, the more water is absorbed, this can be shown by the soil water content. The flannel used as a wick is fast absorbing water, besides that flannel is a type of wick that is fibrous. The wider the wick used, the greater the cross-sectional area of the wick, this is closely related to the large amount of water that the wick can absorb. The amount of water supplied depends on the number of capillaries used. The greater number of capillary pipes causes water to be absorbed more optimally (Sakinah, 2017). According to Febrianti (2022), the wider the wick used, the more water volume for irrigation. The wick that is used as an intermediary for water to get to the plant root area utilizes the principle of capillary action. The water supplied to the planting medium causes high soil water content, but in this study the use of different wick widths did not show a significant effect on lettuce growth.

Suboptimal plant growth is caused by several factors, namely external and internal factors. These factors cause several parameters to become unreal in this study. These parameters are plant height, number of leaves, stem diameter, root length, root fresh weight, root dry weight, hshoot dry weight, total dry weight, plant yield and water use efficiency (Table 1). One of the most difficult external factors to control is temperature. The optimal temperature for lettuce plants ranges from 15-29$^{o}$C under moderate light conditions (Novitasari, 2018), while in a shaded house the temperature conditions during the day can reach 40$^{o}$C. The high temperature in the growth environment causes a high rate of evaporation in that environment. According to Maulidiya and Suminarti (2022), high evaporation causes uneven distribution of water. In addition, the short roots of lettuce plants (Image 7) also affect the rate of absorption of water and nutrients, so that plants lack food to grow and develop. To reduce water loss from the transpiration process, stomata will close more quickly, so that the rate of photosynthesis and assimilate produced is low.

Temperature conditions above the optimum at the end of growth will usually result in low production. Figure 5 shows low crop production when compared to production in general. This happens because of an imbalance between the low amount of photosynthesis produced, and reduced carbohydrates due to the respiration process. Increasing temperature will increase the rate of both processes, but temperatures above the optimum cause the respiration process to take place at a greater rate than photosynthesis, so that high temperatures result in reduced production (Rai, 2018). To get good production results must be followed by good growth as well, because between growth and production results are very closely related to one another. In addition to the environment affecting plant growth, factors from within the plant itself (genes) really need to be considered. Not all plants are able to adapt to the climate in the lowlands. In this study, New Grand Rapid lettuce was used which can grow optimally at a temperature range of 15-20$^{o}$C in medium to high plains.

The 1 cm wick width treatment has a low water use efficiency value (Figure 9) because the water consumption used by plants is higher. This is in line with the research of Inonu et al. (2021), the flannel wick tends to experience a decrease in the value of water use efficiency and increases water consumption. The low value of water use efficiency also causes the use of water in the growick system by plants to be less than optimal. The efficiency value is quite low because the water given cannot be used properly by plants. The water given to lettuce plants is not absorbed by the growing media due to high evaporation.

Based on the research that has been done on the width of the wick treatment on lettuce plants with the growick system, the results are not significantly different from the conventional system. The growick system with gradually watering can be absorbed by the plants as needed, while the conventional system with large amounts of watering is absorbed by the plants a little. The working principle of growick is to use a wick or wick system that can drain water from a bucket or water reservoir to the surface area of plant roots (Inonu et al., 2021). Water and nutrients can reach plant roots by utilizing capillary action on the wick. The principle of capillarity is a phenomenon of the ups and downs of a liquid influenced by cohesion and adhesion forces with similar and dissimilar particles (Situmorang et al., 2012).

## CONCLUSION

The conclusions of this study are wick width using grow sick and verticulture irrigation systems only affects plant water consumption but do not affect growth variables and lettuce yields. A wick width of 0.5 cm using a growick irrigation system is a wick width that tends to be better at supporting the growth and yield of lettuce in the verticulture planting system.

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