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# EFFECTIVENESS OF DRIP IRRIGATION TECHNIQUES ON THE GROWTH AND PRODUCTION OF PAK CHOY (*Brassica rapa usubsp. Chinensis*) IN GUNUNGSITOLI, INDONESIA

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***Abstract***

*Proper drip irrigation techniques can optimize the use of water in crop cultivation. Pak Choy (Brassica rapa subsp. chinensis) is one of the commodities that can grow and produce more effectively using drip irrigation techniques. This study aims to look at the growth response and production of Pak Choy plants using drip irrigation system techniques. This research was conducted in Gunungsitoli, North Sumatra. The method used is a randomized design of groups (RAK) with 2 treatment factors, namely liquid organic fertilizer with drip irrigation system. The factor of liquid organic fertilizer (P) consists of 3 levels, namely P0 = Control; P1 = 2 ml/l; P2 = 4 ml/l. Drip irrigation factor (I) consists of 3 levels, namely: K0 = Control; I1 = 35 drops/minute; I2 = 45 drops/minute. The results showed drip irrigation techniques had a significant effect on the number of leaves (strands) 25 days after planting and 30 days after planting, and had no significant effect on the height of plants and the wet weight of Pak Choy plants*

***Key words*****:** *effectively, drip irrigation techniques and pak choy plants*

## INTRODUCTION

Plant cultivation techniques using drip irrigation are a solution to be able to optimize the use of water, especially in areas that are difficult to get access to water and during the dry season. Global climate change is also affecting the agricultural sector. In Indonesia, the area of agricultural land reaches 76 million hectares and more than 89 percent is dry land. To find out the condition of the soil that has water stress one of the indicators is to look at the number of dry days during the growing season. According to Agus et al. (2005) plant conditions for seven days or more without obtaining a water supply sourced from the rain so can result in inhibiting the growth process of plants while the roots of plants are still limited to several centimeters on the surface layer [2].

Plants can receive water through water from the ground and subsurface which can be done by soaking water into the soil under the rooting zone either through an open system or using porous pipelines. Water supply with a watering can be done by sprinkler irrigation or drip irrigation. Arsyad (2010), suggested that the use of water on the land can be more efficient by comparing the amount of crop production per unit used during one growing season. This can be done using drip irrigation techniques effectively [3].

This study will look at the effectiveness of the use of drip irrigation on the cultivation of Pak Choy plants both their growth and production. Pak Choy with the name "sawi sendok" (*Brassica rapa subsp. chinensis*) is one of the vegetable plants that are now widely cultivated organically in Indonesia (Perwitasari, 2012 and Fatma, 2009) [4, 14].

### Effectiveness of Drip Irrigation Techniques to Pak Choy Growth and Production

Pakcoy vegetable production can be increased by making various efforts such as in the use of proper irrigation systems and good crop growing media. A proper drip irrigation system will give good results to the growth and production of Pak Choy crops on agricultural land. Advantages in the use of drip irrigation that can save water, energy, management costs, the use of appropriate fertilizers, energy and can also control diseases that exist in plants and can also be

used for uneven land and narrow land (Susila and Poerwanto, 2013) [27].

The drip irrigation system is the most efficient irrigation system for crop growth in agricultural land. The efficiency of water use of drip irrigation systems can reach 80% to 90% due to the direct feeding of water to rooting areas regularly and slowly (Simonne et al., 2010) [21] and has an efficiency value of 80-95 percent compared to sprinkler irrigation and surface irrigation (Valenzuela, 1997; Shock, 2003; Mechram, 2008) [12, 22, 28]. The efficiency of water use in agricultural land can be optimized through the use of appropriate irrigation techniques (Haryati et al. 2011) [9].

Irrigation aims to meet the needs of plant roots to grow and develop, especially in dry conditions in a dry land. Irrigation is defined as a process of tapping or extracting water from the source for agricultural purposes to meet the needs of crop water (PP Irrigation No. 20, 2006) [13]. The supply of water in small volumes and sustainable through drip irrigation aims to maintain soil moisture to avoid losing such as percolation and runoff so that the availability of water for plants is fulfilled. Drip irrigation is a method of providing water with low discharge and high frequency continuously in plants either through the ground level or directly to the root zone using an emitter either single or in the form of a drip line (perforated hose) (Hanafiah, 2005) [6]. The flow of water in drip irrigation utilizes capillary forces and gravity that move vertically and horizontally in the soil profile (Hansen et al. 1992) [6].

**Morphology of Pak Choy**

Pak Choy plant has a taproot system with long round root branches that spread all directions at a depth between 30-50 cm (Setyaningrum and Saparinto, 2011) [20].

This plant has a very short stem and segments, so it is almost invisible. This stem serves as a shaper and leaf support. Pak Choy has smooth leaves, hairless, and does not form a crop formation. The stem of the leave is wide and sturdy, the bones of the leaves and leaves are similar to green Pak Choy, but the leaves are thicker than the green Pak Choy (Haryanto et al., 2007) [7].

The flower structure of Pak Choy plants is arranged in long, multi-branched flower stalks. Each flower bud consists of four petals, four crown leaves, four stamens, and one hollow two pistils. Pollination of the flowers of this plant can take place with the help of insects as well as by humans. Mustard fruit plants include a type of pod-shaped elongated and hollow with small round seeds blackish brown (Sunarjono, 2013) [26].

**Terms of Growing Pak Choy Plants**

Pak Choy is a seasonal plant that can only be harvested once. Pak Choy can be harvested at the age of 40-60 days (planted from seeds) or 25-30 days (planted from seedlings) after planting (Prastio, 2015) [16]. Pak Choy plants can grow on lowland to highlands with an altitude of 5-1,200 m above sea level. But Pak Choy plants will be better if planted on high ground with cool air (Haryanto et al., 2007) [7].

A good climate for Pak Choy growth is an area that has a temperature of 15-30oc, has rainfall of more than 200 mm/month, as well as solar illumination between 10-13 hours (Rukmana, 1994) [18].

The humidity suitable for Pak Choy growth is between 80-90%. Soil suitable for the growth of Pak Choy plants in loose soil that contains a lot of humus, fertile, with a pH between 6-7, as well as good drainage because Pak Choy plants do not like puddles.

## MATERIALS AND METHODS

The research was conducted in Gawu-gawu Bousu Village, North Gunungsitoli District, Gunungsitoli City, altitude level is ±40 meters above sea level. The materials used in this study included several parts, namely Pak Choy plant seeds, liquid organic fertilizer, water. The tools used in this study included several parts, namely hand sprayer, aqua bottle size 1.5 l, infusion rope (diameter: 1 Ø 3.0 mm, 0 Ø 4.1 mm), scales, and other tools that support the implementation of research. The research method was a Randomized Design group (RAK) with two treatment factors, namely: Factor 1: The provision of liquid organic fertilizer (P) consisted of 3 levels of treatment, namely, P0 = 0 ml/liter;

P1 = 2 ml/liter; P2 = 4 ml/liter. Factor II: Administration of drip irrigation (I)/minute consisted of 3 levels of treatment, namely: I0 = 0tetes/minute; I1 = 35 drops/minute; I2 = 45 drops/minute. The implementation of the research was soil processing by making a plot with a size of 1 m x 1 m 27 plots with a height of 30 cm and a distance between the replay of 50 cm and the distance between the plot 30 cm which served as a drainage channel. Soil processing to 2 at once by inserting liquid organic fertilizer (POC) into the aqua that has been given 1 liter of water. Observations were made on the height of the plant (centimeters), the number of leaves (strands), wet weight per sample (grams), and wet weight per plot (grams).

## RESULTS AND DISCUSSIONS

Drip irrigation system analysis had no significant effect on plant height 30 days after planting.

Table 1. Single effect of the drip irrigation system on plant height (cm) at the age of 30 days after planting

| **Treatment - Drip irrigation (ml/l)** | **Plant Height (cm)** |
|---|---|
| I0 | 18.68$^{tn}$ |
| I1 | 16.49$^{tn}$ |
| I2 | 15.77$^{tn}$ |

Source: Own Calculated (2021).

Table 1 shows that the single effect of the highest drip irrigation application was on the I0 treatment of 18.68 cm and the lowest score was in the I2 treatment of 15.77 cm.

According to Hendriyani and Setiari (2009), the application of water with different volumes will not have a real effect on the growth of plant height (cm), because the difference in plant height depending on the type of planted plant [10].

But according to Sugito (2012), the amount of water that was less can also inhibit the high growth of plants because water that served as mineral solvents and nutrients in the soil was not enough to dissolve so that plants lack nutrients [23]. According to Rahmat, (2009) land with high permeability will be able to increase the rate of infiltration that occurred to lower the rate of running water [17].

Permeability is the ability of the soil to be able to hold water, if the ability of the soil in holding water is weak it will be able to affect the water in the irrigation channel, then the soil in the irrigation channel that has a weak permeability will be able to cause water loss in the soil (Sunardi, 2006) [25].

According to Isdarmanto (2009), with increased metabolic productivity, plants will need more nutrients and increase water absorption, this was related to the need for plants in the period of growth and development. Analysis of drip irrigation system has a significant effect on the number of leaves (strands) at the height of plants aged 25 days after planting [11].

Table 2. Effect of single drip irrigation system application on the number of leaves (strands) at age 25 days after planting

| **Treatment - Drip irrigation (ml/l)** | **Plant Height (cm)** |
|---|---|
| I0 | 4.51b |
| I1 | 3.88ab |
| I2 | 3.74a |

Source: Own Calculated (2021).

Table 2 showed that the single effect of the highest drip irrigation application was on the I0 treatment of 4.51 strands and the lowest score was in the I2 treatment of 3.74 strands. I0 treatment was no different from I1 treatment but different from I2 treatment. I1 treatment was no different from I0 treatment but different from I2 treatment. The I2 treatment was significantly different from the I0 and I1 treatments.

This was due to the age of 25 days after planting plants in the vegetative period where the roots have been numerous and the number of leaves has increased. In this vegetative period, Pak Choy plants can absorb nutrients through roots and leaves. Elements C and O are taken from the air in the form of $CO_2$ through leaf stomata in the process of photosynthesis. Water was also absorbed by plants through the leaves but in small amounts. Increasing the number of leaves will increase the rate of photosynthesis and produce carbohydrates in large quantities. Carbohydrate compounds were the basic ingredients for the synthesis of proteins and

other compounds used to compose plant organs as well as plant life activities thus on the synthesis of more leaves (Hamim 2004). states more and more leaves allow more photosynthesis to occur. Increased photosynthesis will result in more and more photosynthesis so that the dry weight of the top of the plant will increase photosynthesis and the resulting energy was used to form and maintain the quality of the leaves [8].

This was following the opinion of Sarido and Junita (2017) [19]. Analysis of drip irrigation systems had no significant effect on wet weight per sample (gram) age of 30 days after planting.

Table 3. Effect of single drip irrigation system application on wet weight per sample (gram) at age 30 days after planting

| **Treatment - Drip irrigation (ml/l)** | **Wet weight per sample (gram)** |
|---|---|
| I0 | 9.44$^{tn}$ |
| I1 | 8.42$^{tn}$ |
| I2 | 7.59$^{tn}$ |

Source: Own Calculated (2021).

Table 3 showed that the single effect of the highest drip irrigation application was found in the I0 treatment of 9.44 grams and the lowest score was in the I2 treatment of 7.59 grams. Analysis of drip irrigation system has no significant effect on wet weight per plot (gram) age of 30 days after planting.

Table 4. Single effect of liquid organic fertilizer (POC) application with drip irrigation system on wet weight per plot (gram) at age 30 days after planting

| **Treatment - Drip irrigation (ml/l)** | **Wet weight per sample (gram)** |
|---|---|
| I0 | 18.52$^{tn}$ |
| I1 | 25.37$^{tn}$ |
| I2 | 15.18$^{tn}$ |

Source: Own Calculated (2021).

Table 4 reflected that the single effect of the drip irrigation system was found in treatment I1 of 25.37 grams and the lowest score was in the treatment of I2 of 15.18 grams.

According to Suhartono (2008) that water is a major component in plant life, about 70% to 90% of the fresh weight of plants containing water [24].

Water can enter the plant through the so-called diffusion process. The diffusion process is influenced by differences in water concentration and environmental factors that also play a role in the process of water balance in the soil, plants, and air. The results of the analysis in this study were different from the opinion of Poli (2009) in his research which suggested that the increasing number of plant leaves will automatically increase the fresh weight of the plant because the leaves were the sink for plants [15]. Also, the leaves on vegetable crops were organs that contain a lot of water, so with the number of leaves that were getting more and more, the water content of plants will be high and cause the fresh weight of plants to be higher as well. This showed that the research conducted has not met the water needs of Pak Choy plants because environmental factors such as high intensity of solar illumination will cause plant growth to be hampered by short stems and small leaves that cause low yields but high nutrient content in crops (Sugito, 2012) [23].

The response of plants to temperatures varied depending on the type of plant and the stage of growth. Pak Choy plant was a cold area plant so it was less suitable in hot areas such as Gunungsitoli. According to Adhiguna (2018) [1] drip irrigation technology can manage the provision of water in crop rooting zones in a sustainable manner to increase land productivity and cultivation activities can take place at all times. But this application should also pay attention to the optimal water needs of plant types.

It was very important to calculate the number of drops of water per minute to get optimal water needs to support the growth and production of Pak Choy plants because this plant was strongly influenced by climate conditions or environmental weather.

The application of a drip irrigation system based on the automatic controlling system can increase the efficiency of water use in plants because it was able to work based on the actual condition of agricultural land through the soil moisture level.

The effectiveness of cultivation using drip irrigation techniques can be achieved if paying attention to environmental factors that support the growth and production of Pak Choy plants.

## CONCLUSIONS

Based on the results of research on the effectiveness of drip irrigation techniques to the growth and production of Pak Choy plants can be achieved if paying attention to environmental supporting factors such as season, the intensity of sunlight, temperature, and so forth. Researchers should also adjust the number of drops of water per minute sufficient for the growth and production of Pak Choy plants

## REFERENCES

[1]Adhiguna, R. T., Amin Rejo, 2018, Drip Irrigation Technology In Optimizing Water Use Efficiency in Agricultural Land. Proceedings of the National Seminar on World Water Day 2018 Palembang, March 20 2018 (Teknologi Irigasi Tetes Dalam Mengoptimalkan Efisiensi Penggunaan Air Di Lahan Pertanian. Prosiding Seminar Nasional Hari Air Dunia 2018 Palembang 20 Maret 2018.

[2]Agus, F., Surmaini, e., Sutrisno, N., 2005, Water Saving Technology and Supplemental Irrigation. Dryland Management Technology in Adimihardja and Mappaona (eds). Towards Productive and Environmentally Friendly Agriculture. Edition II. Center for Land and Agro-climate Research and Development. Agricultural Research and Development Agency. Ministry of Agriculture. Pages: 223-245. (Teknologi Hemat Air dan Irigasi Suplemen. Teknologi Pengelolaan Lahan Kering dalam Adimihardja dan Mappaona (eds). Menuju Pertanian Produktif dan Ramah Lingkungan. Edisi II. Pusat Penelitian dan Pengembangan Tanah dan Agroklimat. Badan Litbang Pertanian. Deptan. Hlm: 223 – 245).

[3]Arsyad, S., 2010, Soil and Water Conservation. IPB Publisher (Konservasi Tanah dan Air. Penerbit IPB (IPB Press). 472 p

[4]Fatma, N. D., 2009, The Effect of Organic Fertilizer on the Growth and Yield of Caisim Mustard (*Brassica Juncea* L.). (Pengaruh Pemberian Pupuk Organik Terhadap Pertumbuhan Dan Hasil Tanmaan Sawi Caisim (*Brassica Juncea* L.). Agronobis, 1 (1): 89-98).

[5]Hanafiah, K. A., 2005, Basics of Soil Science. (*Dasar-Dasar Ilmu Tanah).* Jakarta: Raja Grafindo.

[6]Hansen, V.E., Israellsen, O.W., Stringham, G.E., 1992. Irrigation Basics and Practices. Erlangga Translation. (Dasar-dasar dan Praktek Irigasi. Terjemahan Erlangga). Jakarta.

[7]Haryanto, W., Suhartini, T., Rahayu, E., 2007, Planting Techniques of Mustard and Lettuce Hydroponically. Jakarta: Self-help spreader (Teknik Penanaman Sawi dan Selada Secara Hidroponik. Jakarta : Penebar Swadaya).

[8]Hamim, 2004, Underlying drought stress effects on plant: Inhibition of photosynthesis [ulasan]. Hayati 11(4):164–169.

[9]Haryati, U., Abdurachman, A., Subagyono, K., 2011, Efficient Water Use Sharing Irrigation Techniques for Planting Chili in Dry Land in Typic Kanhapludult Lampung. Proceedings of the National Seminar on Agricultural Land Resources. Bogor, 30 November-1 December 2010. Book III. Water, Climate and Swamp Management. Center for Research and Development of Agricultural Land Resources. Agricultural Research and Development Agency. Ministry of Agriculture. Pages: 23 - 46. (Efisiensi Penggunaan Air Berbagi Teknik Irigasi Untuk Pertanaman Cabai di Lahan Kering Pada Typic Kanhapludult Lampung. Prosiding Seminar Nasional Sumberdaya Lahan Pertanian. Bogor, 30 November-1 Desember 2010. Buku III. Pengelolaan Air, Iklim dan Rawa. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian. Badan Litbang Pertanian. Kementrian Pertanian. Hlm: 23 – 46).

[10]Hendriyani, I. S., Setiari, N., 2009, Chlorophyll Content and Growth of Long Beans (*Vigna sinensis*) at Different Water Supply Levels. (Kandungan Klorofil dan Pertumbuhan Kacang Panjang (*Vigna sinensis*) pada Tingkat Penyediaan Air yang Berbeda. J. Sains & Mat. 17(3): 145-150.

[11]Isdarmanto, 2009, The Effect of Organic Fertilizers and Leaf Fertilizer Concentrations on Growth and Yield of Red Chili (*Capsicum annum* L.) in Potting System Cultivation. [Thesis] Sebelas Maret University. Surakarta. (Pengaruh Macam Pupuk Organik dan Konsentrasi Pupuk Daun Terhadap Pertumbuhan dan Hasil Tanaman Cabai Merah (*Capsicum annum* L.) Dalam Budidaya Sistem Pot. [Skripsi] Universitas Sebelas Maret. Surakarta.

[12]Mechram, S., 2008, Determination of Small Hose Type Head Loss Emitter from Local Materials along the Lateral Pipes in the Drip Irrigation System. Journal of Agricultural Technology, 9 (2): 114-120 (Penentuan Head Loss Emitter Tipe Selang Kecil dari Bahan Lokal Sepanjang Pipa Lateral pada Sistem Irigasi Tetes. Jurnal Teknologi Pertanian, 9 (2) : 114-120).

[13]Peraturan Pemerintah Republik Indonesia, Republic of Indonesia Government Regulation Number 20 of 2006 concerning Irrigation. Ministry of State Secretary of the Republic of Indonesia (Nomor 20 Tahun 2006 Tentang Irigasi. Kementerian Sekretaris Negara Republik Indonesia)

[14]Perwitasari, B., Mustika, T., Catur, W., 2012, The Effect of Planting Media and Nutrition on Growth and Yield of Pakcoy (*Brassica juncea* L.) Plants with Hydroponic Systems (Pengaruh Media Tanam dan Nutrisi Terhadap Pertumbuhan dan Hasil Tanaman Pakcoy (*Brassica juncea* L.) Dengan Sistem Hidroponik). Agrovigor: 5 (1) : 14-25.

[15]Polii, G.M.M., 2009, The response of the production of Kangkung Darat (*Ipomea reptans Poir*.) To the Variation in Time of Giving Chicken Manure (Respon Produksi Tanaman Kangkung Darat (*Ipomea reptans Poir*.) terhadap Variasi Waktu Pemberian Pupuk Kotoran Ayam). Journal Soil Environment Vol.VII No.1. 5 hlm.

[16]Prastio, U., 2015, Hydroponic Vegetable Harvest Every Day. PT AgroMedia Pustaka (Panen Sayuran Hidroponik Setiap Hari. PT AgroMedia Pustaka). Jakarta.
[17]Rahmat, H. 2009. Identifikasi Senyawa Flavonoid Pada Sayuran Indigenous Jawa Barat, Bogor: Program Teknologi Pertanian Institut Pertanian Bogor
[18]Rukmana, R., 1994, Planting Petsai and Sawi. Yogyakarta: Kanisius.(Bertanam Petsai dan Sawi. Yogyakarta: Kanisius).
[19]Sarido, la., Junita, 2017, Growth and Yield Test of Pakcoy (*Brassica Rapa* L.) Plants by Giving Liquid Organic Fertilizer to the Hydroponic System. AGRIFOR Journal Vol.XVI No. 1. (Uji Pertumbuhan Dan Hasil Tanaman Pakcoy (*Brassica Rapa* L.) Dengan Pemberian Pupuk Organik Cair Pada System Hidroponik. Jurnal AGRIFOR Vol. XVI Nomor 1.
[20] Setyaningrum, H. dan C. Saparinto. 2011. Panen Sayur Secara Rutin di Lahan Sempit. Penebar Swadaya. Jakarta
[21]Simonne, Eric & Dukes, Michael & Hochmuth, Robert & Studstill, David & Avezou, Galien & Jarry, Diane. (2006). Scheduling Drip Irrigation for Bell Pepper Grown with Plasticulture. Journal of Plant Nutrition. 29. 1729-1739. 10.1080/01904160600897448.
[22]Shock, C. C., 2003, An Introduction to DripIrrigation. Malheur Experiment Station. Oregon State University, Corvallis Oregon, USA.
[23]Sugito, Y., 201, Plant Ecology; The Influence of Environmental Factors on Plant Growth and Its Several Aspects. Brawijaya University Press. Poor. (Ekologi Tanaman; Pengaruh Faktor Lngkungan terhadap Pertumbuhan Tanaman dan Beberapa Aspeknya. Universitas Brawijaya Press. Malang).
[24]Suhartono, 2008, The Effect of Water Interval on Growth and Yield of Soybean (*Glycine max* (L) merril) in Various Soil Types. (Pengaruh Interval Pemberian Air Terhadap Pertumbuhan dan Hasil Tanaman Kedelai (*Glycine max* (L) merril ) pada Berbagai Jenis Tanah. Jurnal Embryo. Vol. 5(1).
[25]Sunardi, 2006. Unsur Kimia, Yrama Widya, Jakarta
[26]Sunarjono, H., 2013**,** Plant 36 kinds of vegetables. Jakarta: Self-help spreader (Bertanam 36 Jenis Sayur. Jakarta: Penebar Swadaya).
[27]Susila, A. D., Poerwanto, R., 2013, Irrigation and Fertigation. Module IX - Basic Course Teaching Materials for Horticulture. Bogor: Bogor Agricultural University (Irigasi dan Fertigasi. Modul IX – Bahan Ajar Mata Kuliah DasarDasar Hortikultura. Bogor: Institut Pertanian Bogor).
[28]Valenzuela, H., 1997, Crop Production Guidlines Drip Irrigation. HITAHR, University of Hawaii, West Oahu, USA.