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Sprinkler Static Model Variation of Stock Distance and Height on Irrigation Performance on Limited Area

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Abstract— *Agricultural land has changed its function in urban areas resulting in narrower agricultural land area and many irrigation networks that are not functioning. This has resulted in many isolated lands that cannot even be served by irrigation, so that the alternative source of agricultural water is local shallow ground well water. With the potential of water sources and limited land area, farming is expected to be able to utilize water efficiently. Small sprinkler irrigation systems such as the 24D Netafim on the market, are expected to be an alternative in providing irrigation and for that it is necessary to test the ability of the irrigation system to vary the distance between the sprinkler and the height of the stick to the irrigation radius and its uniformity for a duration of 15 minutes. The test results showed that the irrigation uniformity was above 85% at the distance between sprinklers of 4.5 m, 5 m and 5.5 m and 6 m with a stick height of 0.5 m and 0.75 m. For stick heights of 1.0 m and 1.25 m at the same sprinkler distance, the uniformity coefficient is less than 85%. While the optimal irrigation radius obtained at a sprinkler distance of 4.5 m, 5 m and 5.5 m is an average of 5.6 m.*

Keywords— *Static Sprinkler, stick distance, beam radius.*

I. INTRODUCTION

Indonesia is referred to as an agricultural country, where most of the population lives in the agricultural sector. Along with the increasing population in Indonesia, especially in Malang every year, the needs of the community also develop, one of which is the need for land. The conversion of agricultural land from year to year continues to increase, which causes agricultural land to decrease. Due to the limited area of agricultural land available, the irrigation system used previously, it is estimated that the pattern is no longer adequate for use. In addition, with the increasing population development, demands that the productivity of agricultural land must be carried out to support the availability of local food. The need for irrigation systems that are more suitable for agriculture on a limited land area, and make efficient use of available water sources.

A lot of land is used for development and less land for agriculture especially in urban areas. The development of the pattern of human life from year to year causes changes in land use change. Land use change makes it difficult to find extensive agricultural land and leaves only narrow or little land. Therefore, in increasing the productivity of agricultural products with limited land, it is estimated that the use of micro irrigation systems can be assisted. One type of micro irrigation is mini sprinkler irrigation. The use of a micro irrigation system in its application does not require a large area of land, and can take advantage of minimal water sources, for example on dry land

In agriculture, water is one of the main needs of plants. Each plant has a different growth for example in its height growth. Plant growth is used as an indicator to determine plant characteristics related to plant water requirements.

Swandayani (2020) conducted a study with 3 mini 24D Netafim sprinklers, which stated that the results showed overlapping when the sprinkler irrigation system was tested so that there was an uneven distribution of irrigation.

Maybe it's not quite right, because sprinkler irrigation is sometimes needed to overlap the irrigation between sprinklers with each other to increase uniformity. The purpose of overlapping is to improve the results of the uniformity of the irrigation itself. However, in the MegaNet 24D Netafim sprinkler test, it still needs to be tested because the effect of stick height is closely related to plant height that can be irrigated. As for the sprinkler distance test, it is estimated that it has something to do with the capacity of the irrigation area and the amount of discharge required for the irrigation network.

The existence of a mini sprinkler irrigation system, such as the Netafim 24D mini sprinkler on the market, is expected to assist crop irrigation activities in a limited area. This sprinkler has an irrigation radius of about 5m-6m, so it has the potential and is suitable for farming on a limited land area. Therefore, this study aims to determine the value of the irrigation uniformity coefficient of the Mini 24D Netafim sprinkler at variations in the distance and height of the sprinkler sticks with a duration of 15 minutes, as well as to determine the optimum irrigation radius that may be applied to crops.

With limited farms, it is estimated that by testing the distance variation and height variation of certain Netafim 24D sprinkler sticks, good sprinkler irrigation capabilities will be obtained. With the capability of the irrigation system, the area of irrigated land that can be irrigated and the number of sprinklers needed will be known.

A. Radiant Irrigation

According to Nopianti (2015) that the effect of duration with a three-nozzle mini sprinkler irrigation system on the depth of infiltration into the soil reaches 17 cm in a duration of 1 hour with an average discharge of 0.563 lt/s and produces an average wetness diameter 5.35 meters.

State et al. (2015) has conducted research on mini-sprinkler irrigation on dry land in North Pringgabaya, East Lombok Regency and the results of his research concluded that the uniformity (CU) of three-nozzle mini-sprinkler irrigation was above 70%, classified as good with an irrigation depth of about 0.3 cm – 7 cm. The average mini sprinkler discharge 0.023 m3/sec with irrigation radius (rs) = 2.6 m. According to State et al. (2021) stated that the test results. The effect of variations in the slope of the transmission pipe 10°, 20°, 30° and 40° on the uniformity and radius of irrigation perforated pipe beams shows the results of uniformity values of at least 85% and the largest being 91%, with the largest perforated irrigation jet capability of 2.66 m and 2.40 m.

Soil research in 2009 stated that sprinkler irrigation can save up to 50% of water compared to flushing. sprinkler irrigation. Improve the efficiency of water use in onion plants compared to surface irrigation methods.

According to Ridwan et al. (2014) who has designed a micro irrigation network designed to say that, with 12 mini sprinklers model HADAR 7110 Inverted Rotor, wetting diameter is 10.2 m, with a spacing between lateral and sprinklers 5 m x 5 m. The irrigation water requirement per application of water supply is 26.25 mm. The maximum irrigation time is 5.13 hours, with a maximum irrigation interval of 5 days. The required total pressure height (TDH) is 28.66 m. Considering the fulfillment of a greater TDH requirement, the type of pump that has a BHP of 0.25 KW is chosen, the pump discharge is 1.25 liters/second, with a total head of 60 m. /sec due to the limited ability of the tool to reach only 5 m -6 m. Under these conditions, of course, the area of irrigation wetting obtained will also be smaller than the test mentioned above.

In today's technological developments, the provision of water to plants is growing, starting from free flooding to using power plants. One way to use power generation is irrigation using a transmitter. Sprinkler irrigation is a way of giving water to plants which is carried out from above the plant in the form of broadcasting where the transmission uses a driving force in the form of a water pump. The principle used by this system is to put pressure on the water in the pipe and radiate it into the air so that it resembles rain and then falls on the ground (Sudjarwadi, 1987).

In the design of the bulk irrigation system, the CU value that is considered good is greater than 85%. Micro irrigation designs (such as drip and sprinkler) with a high uniformity value can support efforts to save water (water conservation) in an effort to preserve the environment (Barragan et al., 2010).

Tusi & Lanya (2016), have designed a portable sprinkler that has been developed with specifications: sprinkler head nozzle type impact plastic sprinkler with a nozzle size of 4 mm, the total height of the stick riser is 1.3 meters with a diameter of ¾", lateral elastic pipe with a diameter of 2" and a length of 50 meters, sub-main pipe (manifold) and main pipe of 2". The pump used has a total head of 55 meters with a driving force of 5.5 HP, and a 2" suction hose. This portable sprinkler that has been developed can operate at operating pressures of 1 to 4 bar for sprinkler spacing and laterals of 10 m x 10 m. The test was carried out on an area of 0.10 ha -0.3 ha which showed that the sprinkler discharge at a pressure of 1 bar was 0.12 l/s. The irrigation uniformity value produced at a pressure of 1 bar is 80%. To obtain an irrigation uniformity value of more than 85%, it is recommended to use a minimum operating pressure of 2 bar.

TABLE 1. Plant Height Variation

Plant Type	Plant Height (cm)
Chili	50 – 70
Tomato	30 – 50
Porang	100 – 250
Pakcoy	15 – 30
Cucumber	50 – 250
Potato	50
Long Bean	250
Soybean	64 – 68
Cabbage	40 – 60

B. Sprinkler Irrigation Uniform

The uniformity coefficient of irrigation water distribution is expressed by a parameter called the uniformity coefficient (CU). The uniformity coefficient (CU) is influenced by the relationship between pressure, nozzle size, sprinkler spacing and wind conditions. The uniformity coefficient can be calculated with the equation below (Christiansen, 1942 in Negara et al., 2015):

$$CU = 100\% \,.\, (1 - Dy) \quad (1)$$

$$D = \sqrt{\sum (Y_i - \bar{y}) 2n - 1} \quad (2)$$

CU = uniformity coefficient (%)
D = standard deviation
ȳ = average price of observation
yi = value of each observation
n = number of observation points

C. Irrigation Radius

Sprinkler irrigation radius is the area of wetness that can be reached by sprinkler irrigation and is circular. This data is needed to determine the area of irrigation that can be served by the sprinkler system. The equation used to determine the area of irrigation wetting is as follows.

$$A = 3.14 \; x \; r^2 \quad (3)$$

With:
A = Area (m^2)
r = Radius (m)

For debit calculations, the following equation can be used:

$$Q = v/t \quad (4)$$

With :
Q = flow (m^3/detik)
v = flow container reservoir volume discharge (m3)
t = holding time (seconds).

In this study, the equation used to determine the amount of water flow velocity in the pipe is the continuity equation as follows:

$$V = Q \quad (5)$$

with:
V = flow velocity (m/s).
Q = Water Discharge (m^3/s)
A = Pipe section area (m^2)

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II. METHODS

This research was conducted on ex-rice fields in the Mataram City area which are still empty, while the land around the test site has become new housing. On this land there are also shallow groundwater wells which are used as a source of water from the land. Broadly speaking, the steps for implementing the research are as follows:

1. Preparation stage;
2. The planning stage of the physical model of sprinkler irrigation;
3. Initial testing stage;
4. Research implementation stage;
5. Data collection stage;

The equipment used in this research is as follows:

1. Pipe saws, cameras and meters, buckets with volume
2. 4.6 liters and stationery.
3. A 10 ml measuring cup was used to measure the volume of irrigation water in the uniformity test.
4. Netafim 24D Meganet Sprinkler as shown in Figure 2.
5. A water container with a diameter of 6.2 cm.
6. Stop watch to record the time.
7. Pump water and cok roll.

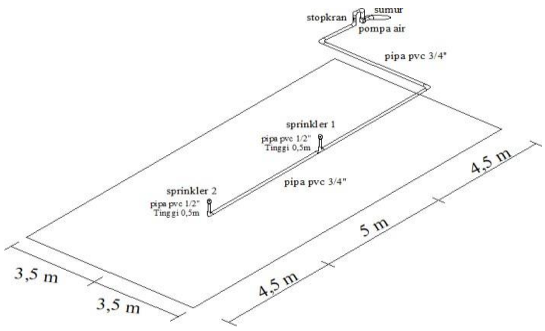

Fig. 1. Sprinkler irrigation network scheme MegaNet 24D Netafim

The materials used in the study consisted of:

1. Clean water from shallow wells
2. 3/4 inch and 1/2 inch PVC pipe
3. Mini sprinklers 2 pieces
4. Stopkran 3/4 inch
5. Pipe connection (elbow, tee)
6. Seal tape and pipe glue.

Fig. 2. Sprinkler MegaNet 24D Netafim

The research was carried out as follows:

1. Land preparation.
2. Preparation of irrigation network spacing and height of sprinkler sticks.
3. Preparation of pump discharge.
4. Preparation of variations in the distance and height of the sprinkler sticks.
5. Testing and measuring the distribution volume of the irrigation water spark plugs that are accommodated in a plastic bowl with a measuring cup. This measurement is the result of the irrigation test carried out 3 times and the result is taken one as the average value and the data is recorded from the average result.
6. The data collected in each test includes the volume distribution of plastic cups for calculating irrigation uniformity (CU), perforation irrigation jet length (L) and height data.

III. RESULT AND DISCUSSION

A. Pump Discharge Analysis

Sprinkler test with an average Qp pump discharge of 0.45 l/s, the results of the flow discharge test for each sprinkler pipe are as follows. In the sprinkler 1 network, the flow rate is 0.24 l/s to 0.25 l/s, while in the sprinkler 2 pipeline the flow is 0.17 to 0.20 l/s. The discharge is the test discharge for all variations of the distance and height of the sprinkler sticks tested.

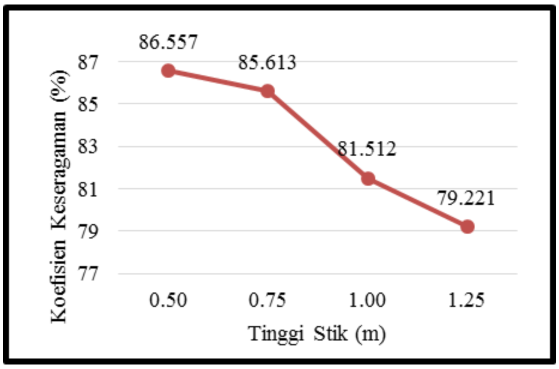

Fig. 3. Uniformity Coefficient Relationship to Stick Height at 4.5 m . Sprinkler Distance

The relationship between sprinkler stick height and irrigation uniformity for each distance variation can be seen in Figures 3 to 6. Based on the results of the graphic analysis in Figure 3, it is known that the magnitude of Sprinkler irrigation uniformity coefficient value at the distance between sticks 4.5 m and stick height 0.5 m was obtained at 86.557%. At a stick height of 0.5 m to 1 m, the CU value is still above 80%. While the stick height is 1.25 m at the distance between the same sprinklers, the CU value is already below 80%.

The stick height is 1.25 m, the CU is below 80%, which is 79.221%. The uniformity produced in the sprinkler test is still better than the test results in Negara et al. (2015), which can only be above 70% and maybe the value is still around 70% to 80%. And based on the results of this test, it is known that the distance between the sticks also greatly determines the uniformity of the irrigation produced. For a test with a distance of 5 m between sprinklers, it can be seen in the following figure.

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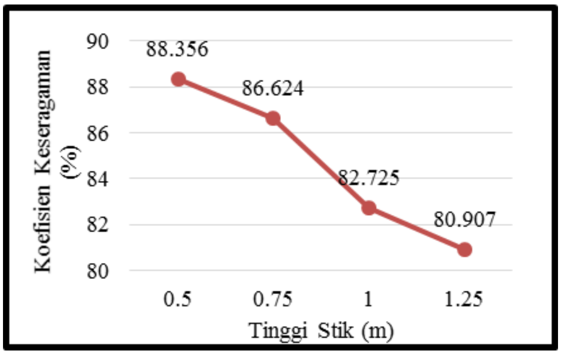

Fig. 4. Uniformity Coefficient Relationship to Stick Height and Sprinkler Distance 5 m

The graph of the relationship between the uniformity coefficient and stick height at a distance between sprinklers of 5 m Figure 4, shows that the highest uniformity coefficient value produced is 88.356% at a stick height of 0.5 m. Meanwhile, the smallest uniformity coefficient value is 80.907% at 1.25 m stick height. So the higher the stick used, the smaller the uniformity coefficient value.

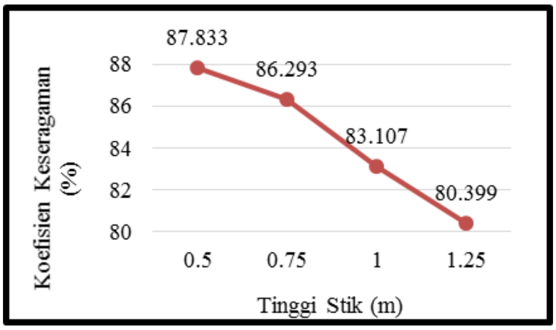

Fig. 5. The Correlation of Sprinkler Irrigation Uniformity Coefficient to Variation of Stick Height and 5.5 m . Distance

The highest irrigation uniformity was 87.833% at a stick height of 0.5 m. While the smallest CU value was obtained at 1.25m stick height of 80.399%. So the results of the CU value of the sprinkler test are still above 80% and at this distance variation, the uniformity of the irrigation produced will decrease if the stick height is higher.

The results of the sprinkler test at a distance of 6 m can be seen in Figure 6.

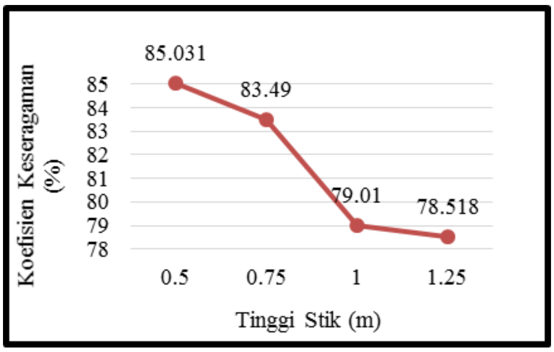

Fig. 6. Correlation of Uniformity Coefficient to Variation of Stick Height and Sprinkler Distance 6 m

Based on the results of the analysis in Figure 6 above, it is known that the largest uniformity coefficient (CU) obtained is 85.031% and the lowest CU value is 78.518%. Based on these results, that at the height of the sprinkler sticks of 1 m and 1.25 m the CU value is below 80%, it is estimated that this distance is an unnecessary limit for irrigation applications because the distribution of irrigation water will be uneven and needs to be avoided.(Alik, Jusoh, and Sutikno 2015)

B. Sprinkler Radius Irrigation

The results of the analysis of the radius of the irrigation beam were carried out by operating two sprinklers simultaneously and measuring the radius of the farthest beam from each sprinkler 3 times each. The distribution pattern or radius of the MegaNet 24D Netafim sprinkler irrigation used can be seen in Figure 7 below:

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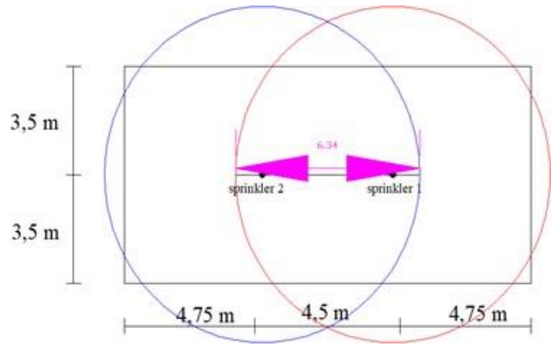

Fig. 7. Radius of Sprinkler Irrigation Radius at a distance of 4.5 m and a stick height of 0.5 m

The graph of the results of the analysis of the relationship between the variation of the height of the sticks and the distance of the irrigation jet can be seen in Figure 8 below:

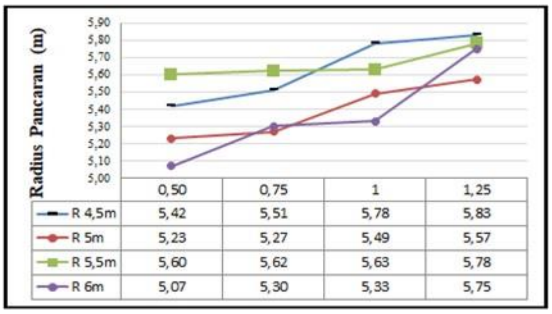

Fig. 8. The Relationship of Stick Height Variation and Sprinkler Distance to Irrigation Radius

In Figure 8 it can be seen that the emitted radius produced at various variations in the distance between sprinklers and stick heights indicates that, at the discharge used, the higher the stick used, the farther the radius of radiation will be and vice versa. In addition to this, what needs to be considered is that not all sprinkler irrigation radii produced have high uniformity, so that the benchmark is the high uniformity value to support applications to certain plants. However, when compared with the test results of spray irrigation with perforated pipes, the uniformity of the MegaNet 24D Netafim sprinkler irrigation is still lower than the perforated irrigation which is above 85% to 91%. Negara et al. (2021). However, when viewed from the results of the beam, the perforated irrigation beam is only able to reach 2.66 m, while the mini sprinkler is able to reach 5.6 m with wider irrigation capabilities.

IV. CONCLUSION

Irrigation uniformity values above 85% are obtained at the distance between sprinklers 4.5 m to 6 m at stick height 0.5 m and 0.75 m. Meanwhile, the distance between the sprinklers is 4.5 m to 6 m. with a height above 0.75 the irrigation uniformity coefficient obtained is less than 85%. For the distance and height of the sprinkler that produces uniformity below 85%, it is necessary to carry out further tests with a larger pump discharge in order to know the optimal ability of the tool.

REFERENCES

[1] Ardhigunawan & Negara, I D. G. J. (2010). Analisis Kinerja Sprinkler Mini terhadap Jarak Pancaran dan Estimasi Kedalaman Capaian Irigasi. Spektrum Sipil Jurnal Keilmuan dan Aplikasi Teknik Sipil, 1 (3), 163-238.

[2] Barragan, J., Cots, L., Monserrat, J., Lopez, R., & Wu, I. P. (2010). Water distribution uniformity and scheduling in micro-irrigation systems for water saving and environmental protection. Biosystems engineering, 107(3), 202-211.

[3] Iskandar, A.Y. (2014). Kajian Kriteria Mutu Air Irigasi. Jurnal Irigasi, 9 (1), 1-15.

[4] Israelsen & Stringham, G. E. (1992). Dasar-Dasar dan Praktek Irigasi. Jakarta: Erlangga.

[5] Negara, I D G. J., Saadi, Y., & Putra, I B.

[6] G. (2015). Karakteristik Kinerja Irigasi Sprinkler Mini Pada Lahan Kering Pringgabaya Utara Kabupaten Lombok Timur. Spektrum Sipil Jurnal Keilmuan dan Aplikasi Teknik Sipil, 2(2), 28–37. Negara, I. D. G. J., Putra, I B. G.,

[7] Supriyadi, A., & Dewi, M .A. (2020). Analisis Kinerja Sprinkler Meganet 24 D Netafim Terhadap Variasi Debit Dan Jarak Penempatan. Seminar Nasional Saintek LPPM Universitas Mataram, Mataram

[8] Negara, I D. G. J., Saidah, H., Yasa, I W., & Halim, A. P. (2021). Keseragaman dan Pancaran Irigasi Pipa Perforasi pada Berbagai Kemiringan Pipa Transmisi. PADURAKSA, 10 (1).

[9] Nopianti (2015). Analisa Pengaruh Pemberian Air Irigasi Sprinkler Mini dan Penggenangan Terhadap Kedalaman Resapan Dan Luas Basahan Pada Lahan Kering Pringgabaya. Skripsi. Mataram: Universitas Mataram,

[10] Ridwan, D., Prasetyo, A. B., & Joubert, D. M, (2014). Desain Jaringan Irigasi Mikro Jenis Mini Sprinkler. Journal Irigasi, 9 (2), 96-107.

[11] Sheikhesmaeili, O., Montero, J., & Laserna, S. (2016). Analysis of water application semi-portable big size sprinkler irrigation with systems in semi-arid areas. Agricultural Water Management, 163, 275-284.

[12] Triatmodjo, B. (2012). Hidraulika I. Yogyakarta: Beta Offset.

[13] Triatmodjo, B. (2013), Hidraulika II, Edisi II. Yogyakarta: Beta Offset.

[14] Tusi, A., & Lanya, B. (2016). Of Portable Sprinkler for Pakchoy Plant. Jurnal Irigasi, 11 (1), 43-54.

[15] Utami, S. N. M. D. (2020). AnalisisVariasi Debit Pompa Terhadap Kinerja Sistem Irigasi Sprinkler Mini Meganet 24D Netafim Untuk Mendukung Usaha Pertanian Di Daerah Perkotaan. Skripsi. Mataram: Universitas Mataram.