Poll Res. 39 (February Suppl. Issue) : S149-S153 (2020)

ISSN 0257–8050

DESIGN OF DRIP IRRIGATION SYSTEM IN STRAWBERRY PLANT (*FRAGARIA SP*) : CASE STUDY IN PANDANREJO VILLAGE, BUMIAJI SUB-DISTRICT, BATU CITY

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(Received 6 November, 2019; accepted 15 December, 2019)

ABSTRACT

The engineering and technological innovation of drip irrigation systems is a very important development for farmers. Increasing the quality and quantity to achieve export products in agriculture, especially in horticultural products can be achieved through this innovation. Through this innovation, it is expected to increase regional income, and bring many multiplier effects, for example improving quality, the stability of market prices to the welfare of farmers. Application of drip irrigation systems are in Pandanrejo Village, Bumiaji Sub-Distric, Batu City. Based on this research, that was tested five influence consists of average of the emitter output, head losses, coefficient uniformity, variation in debit emitter, flow variations in the emitter. Drip irrigation system is suitable for plants such as strawberry plants. The results in this research are an average emitter output of L2 is 1.768 L/hr and the lowest value is L3 with average emitter output 1.704 L/hr, average head losses of L3 more higher than L2 and L1, the highest value of coefficient uniformity produced by L2, The value of average coefficient variation L3 0.250 and the lowest average is L2 with the value of average coefficient variation 0.180, P3 has higher more than P2 and P1. Increased pressure make flow variation value increased.

KEY WORD : Drip Irrigation, Engineering and technology, Strawberry plant

INTRODUCTION

Strawberry plant has high economic value, usually grows in the highlands with an altitude around of 1000 - 1500 meters at sea level. Strawberry fruit contain Carbohydrates, Calsium, Phospor, Fe, Vitamin A, Vitamin B1, Vitamin C, and water. Almost 96% of Strawberry fruit can be consumed. The contains of vitamin C in strawberries more than to citrus fruits which is around 25-120 mg/ 100 grams of fruit (Cheng and Breen, 2019). One of the strawberry-producing region is Pandanrejo Village, located in Bumiaji District, Batu City. Pandanrejo village has a superior program, namely the Strawberry fruit picking tour. These plants are not resistant to dryness and dislike too much water. During the rainy season, the productivity of these plants decreases around 50% -70% compared to the harvest time in the dry season. Farmers complained about this condition because the plants could not grow properly. If the dry season arrives, the harvest can be done two to three times a week and the results around 800 kg/ha of fresh fruit. When the rainy season, the average maximum fruit obtained is only about 300 kg/ha. Based on the statement above, the application of a greenhouse and the design of an appropriate irrigation system can be the one of method to resolve it.

The application of greenhouses is useful for protecting plants from excessive sunlight, climate change, maintaining environmental temperature, soil and air around plants can be controlled properly. The main factor of strawberry planting is an irrigation system design. The choice of irrigation

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system and the proper water supply affects the productivity, quality, and quantity of Strawberry. Water-saving technology or drip irrigation can be used to control water in the plant. The average farmers in the Batu City use the traditional irrigation system method called leaking (in java language called ***kocor***), this method requires a lot of labor and water because it is done one by one on plants. Drops of irrigation have been applied to Manalagi Apple plants (Suharto *et al*., 2018), Chili (Ariyanti *et al*., 2013), Melon and the other plants. According to Fitriana *et al*. (2013), a drip irrigation is one of solution to control water system starting from the process of running water until the water can be absorbed by plants. Also, the drip irrigation system can reduce evaporation, where nutrients are directly given to plants through irrigation. Fertilization can be directly applied through an irrigation system. Drip irrigation system is suitable for plants such as strawberry plants.

The engineering and technological innovation of drip irrigation systems is a very important development for farmers. Increasing the quality and quantity to achieve export products in agriculture, especially in horticultural products can be achieved through this innovation. Through this innovation, it is expected to increase regional income, and bring many multiplier effects, for example improving quality, the stability of market prices to the welfare of farmers. Socialization and assistance to farmers is needed in the application of this technological innovation from the beginning to the end of the research. It is intended that between researchers and farmers there is a relationship of continuity (feedback) which will later be able to develop these innovations, especially to all producing areas Strawberry fruits, especially Pandanrejo Village.

MATERIALS AND METHODS

Case Study

The research implemented in the Natural Resources and Environmental Engineering Laboratory, Faculty of Agricultural Technology, Brawijaya University. The research partner is Mr. Nursyaid who is located at Pandanrejo Street, Pandanrejo Village, Bumiaji District, Batu City. Geographically the research area at 7^{o}52'12.0"latitude and 112^{o}32'39.3" east longitude

Data Analysis

The stages of implementation research are Design of Irrigation and Greenhouse Application Systems which are carried out at the Natural Resources and Environmental Engineering Laboratory. After designing the irrigation system and greenhouse application, design calibration is carried out. This function is to test the accuracy of the design results to adapted the field conditions. The factors tested in this design are :

a. Factor I : Operation Pressure consists of three level that is :
   P1= Operation Pressure 5.624,8 kg/m^2 or 0,5 bar
   P2 =Operation Pressure 10.546,5 kg/m^2 or 1,0 bar
   P3 = Operation Pressure 15.468,2 kg/m__^{2} or 1,5 bar

b. Factor II : Length of Pipe consists of three level that is :
   L1 = Length of Pipe 10 meters
   L2 = Length of Pipe 15 meters
   L3 = Length of Pipe 20 meters

RESULTS AND DISCUSSION

The Research Characteristics

Soil conditions are Vertisol type with a ratio of sand particles 20%, Dust 40% and Clay 40%. This type of soil has relatively high organic content. In the topsoil, the organic content is quite high because the ground cover is in the form of weeds and crop residues. Drip irrigation performance testing uses a treatment between Pressure and Pipe Length.

Average Of the Emitter Output

Figure 1 shows the highest average output at a pressure of 15,468.2 kg/m^2 (P3) is 2.343 L/hr. While, the lowest output at pressure 1 (P1) of 5,624.8 kg/m^2 with 1.196 L/hr.

These results indicate that increasing the operation will increase the emitter output. Bernuth and Solomon (1986), states that the emitter output is

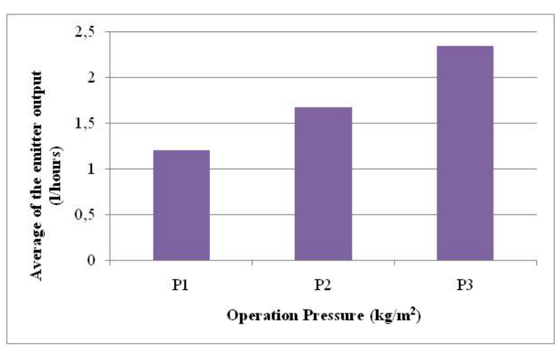

Fig. 1. The results between Operation Pressure and Average of the emitter output

directly proportional to the pressure on the emitter. Pressure on the emitter will increase with increasing operating pressure, Keller and Karmeli (1975) in Buckset *et al*. (1982), so that an increase in operating pressure will increase the pressure on the emitter, and finally increase the emiter output.

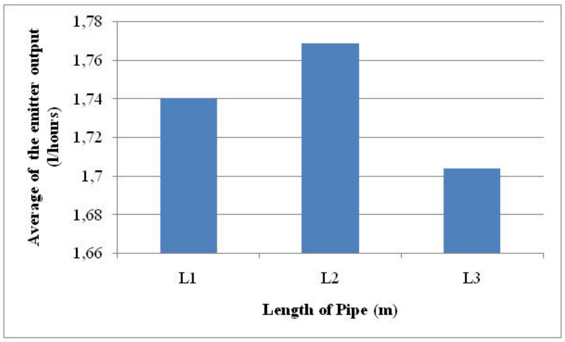

Fig. 2. The results between Length of Pipe and Average of the emitter output

Figure 2 shows the average emitter output, L2 value is 1.768 L/hr and the lowest value is L3 with average emitter output 1.704 L/hr. Different treatment in this research makes the pressure and length of pipes produced a different average emitter output. The smaller operating pressure caused fluctuation of discharge. Increased of operating pressure will caused the emitter outputincreased

Head Losses

Head losses can be occured because of minor losses and major losses. It called major losses because of friction factor and minor losses because deformation of pipe geometry factor.

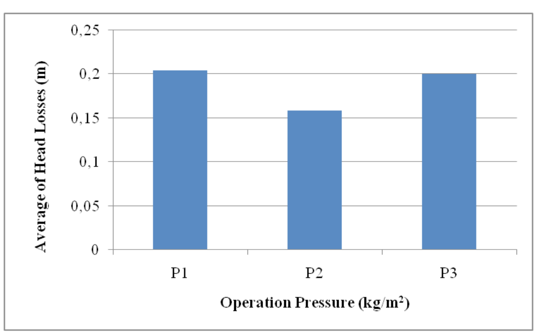

Fig. 3. The results between operation pressure and average of head losses

Based on Figure 3, P1 has higher on average head losses more than P3 and P4. Baars (1976), states that to reach efficiency water of 95% on emiter orifice, pressure variation in lateral pipe do not exceed from 30%. Based on this reseach, head losses P1 has a value of average of head losses 0.204. That value indicates that head losses is still included allowable limit.

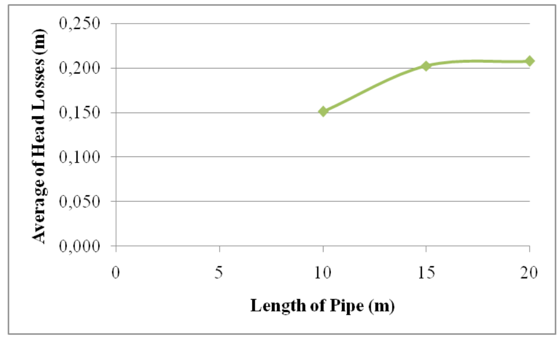

Fig. 4. The results between Average of Head Losses and Length of Pipe

Howel and Hiller (1974) in Bagarello *et al*. (1997), states that head losses are not only caused by pipe head losses, but local losses make some effect in head losses. Figure 4. shows relations between average of head losses and length of pipe. Based on Figure 4, the average head losses of L3 more higher than L2 and L1. The value of L1 0.151 meters and L2 0.203 meters. The longer lateral pipe make the head losses more higher.

Coefficient Uniformity

The coefficient of Uniformity is needed to determine the magnitude of the variation along the lateral pipes.

Based on Figure 5, P3 has higher coefficient uniformity more than P2 and P1.

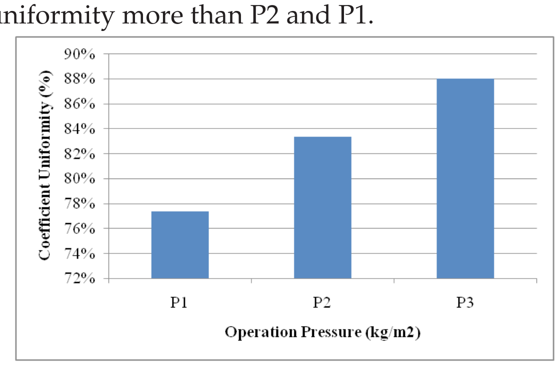

Fig. 5. The results between operation pressure and coefficient Uniformity

The highest value of coefficient uniformity produced by L2 (with length of pipe 15 meters). The similar pressure treatment with different pipe lengths will produce different coefficient. Increased ofoperating pressure will caused the coefficient of uniformity increased. If the lateral pipe far from the water source, the coefficient of diversity is not

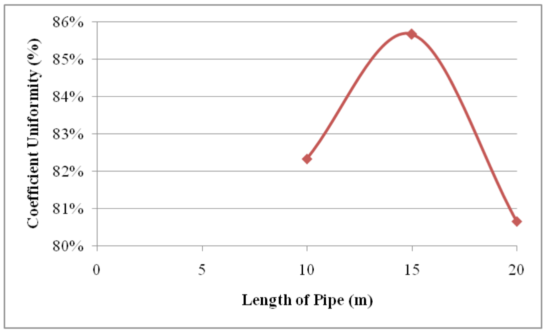

Fig. 6. The results between coefficient uniformity and length of pipe

uniform. According to Hadas (1987), the value of coefficient uniformity influenced by the magnitude average value of emitter output and its deviation value. Increased of deviation value will caused the coefficient uniformity decreased. The smaller of coefficient uniformity, shows the irrigation system is defective (not good) in distribution of water.

Variation in Debit Emitter (Q_{var})

According to Hadas (1987), the value of the variation in debit emitter is strongly influenced by the size of output debit the emitter. Variation in debit emitter values have an inverse relations between coefficient of uniformity. If the value of the coefficient uniformity is high, it indicates small value in the variation debit.

Based on Figure 7 the results P1 more higher than P2 and P3. Increased the operation pressure will caused average of debit variation increased.

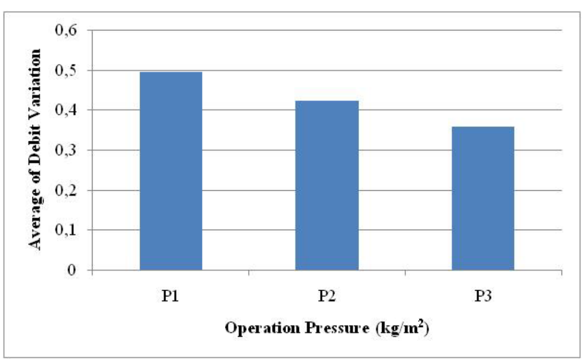

Fig. 7. The results between operation pressure and average of debit variation

L3 has a higher value more than L2. The value of average coefficient variation L3 0.250 and the lowest average is L2 with the value of average coefficient variation 0.180. If the operation pressure increased make the average of coefficient variation decreased. According to Hadas (1987), the values of coefficient

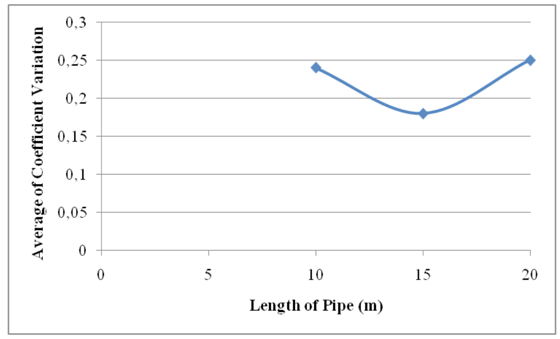

Fig. 8. The results between length of pipe and average of coefficient variation

variation around 0.01 to 0.15. When compared with this study is the value of coefficient variation still in range. The results on the observation show the effect of pressure and operation on the coefficient of variation. It will cause the differences in the flow of water so that it can be effect to debit emitter.

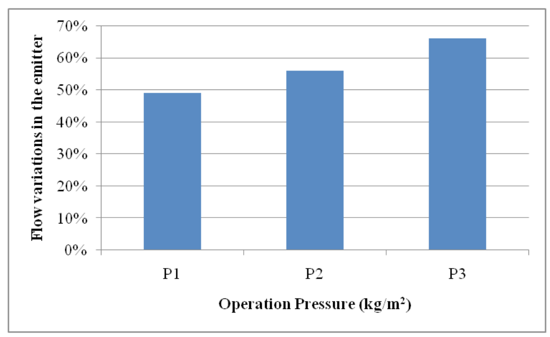

Fig. 9. The results between operation pressure and flow variations in the emitter

Flow Variations in the Emitter

Flow variations generally used to calculate variations flow in emitter. Uniformity can be used to calculate: 1). Hydraulic variations that cause modification in elevation and headloss because friction along the lateral pipe, 2). Variations in emitter give operating pressure caused by

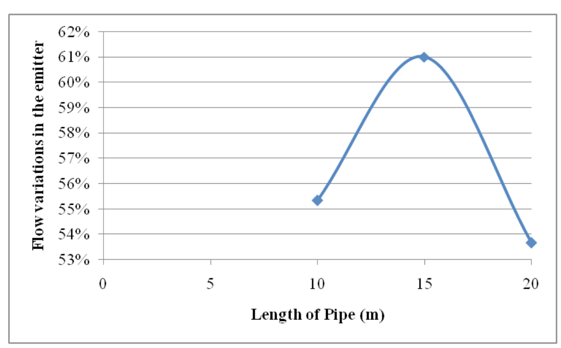

Fig. 10. The results between length of pipe and flow variations in the emitter

variations in manufacture from factories, and blockages. Based on Figure 9, P3 has higher more than P2 and P1. Increased pressure make flow variation value increased.

Keller and Blusner (1990) *in* Dandy (1996) say that the lowest value of flow variations in the emitters are 85% for flat areas. The conclusions based on the research are flow variations less from the Keller and Blusner (1990) standart, but the average value is still in range. According to Ariyanti (1999), in flat areas usually use the emitter with the output water 4 liters per hour and 8 liters per hour. In this study used the emitter with the output water 4 liters per hour.

CONCLUSION

The conclusion from this research are

1. Soil conditions in Bumiaji are Vertisol type with a ratio of sand particles 20%, Dust 40% and Clay 40%.
2. P3 has an average of the emitter output higher more than P2, P3. The average emitter output, L2 value is 1.768 L/hr and the lowest value is L3 with average emitter output 1.704 L/hr.
3. P1 has higher on average head losses more than P3 and P4. The average head losses of L3 more higher than L2 and L1.
4. P3 has higher coefficient uniformity more than P2 and P1. The highest value of coefficient uniformity produced by L2 (with length of pipe 15 meters).
5. The results of average of debit variation P1 more higher than P2 and P3. L3 has a higher value more than L2. The value of average coefficient variation L3 0.250 and the lowest average is L2 with the value of average coefficient variation 0.180.
6. P3 has higher more than P2 and P1. Increased pressure make flow variation value increased.

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