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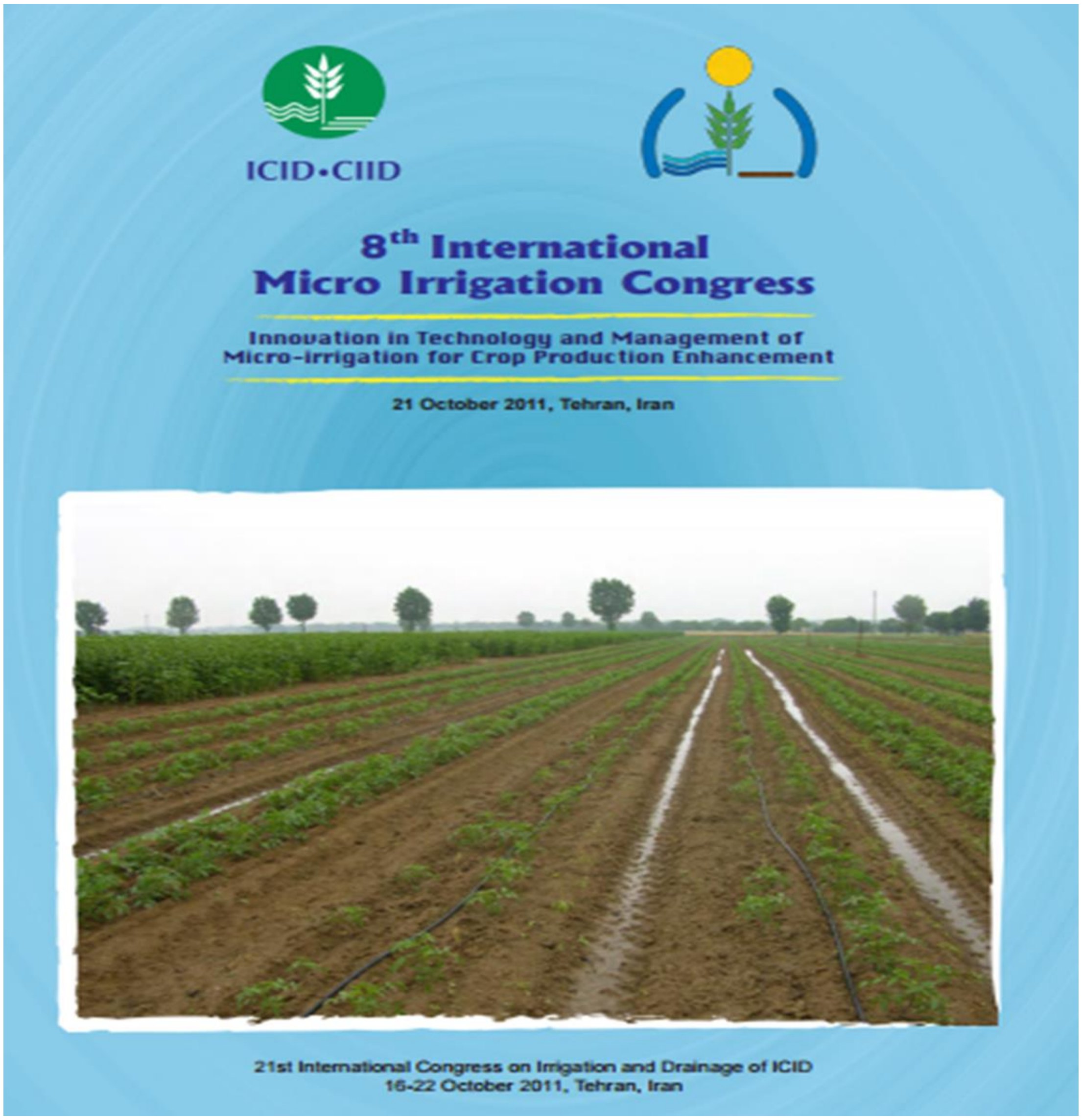

PRESSURE RESISTANT EMITTER DESIGN FOR THE TRICKLE IRRIGATION SYSTEM

DESIGN EMETTEUR RESISTANT A LA PRESSION DU SYSTEME D'IRRIGATIONGOUTTE A GOUTTE

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ABSTRACT

The research objectives were to develop block emitter having S, Y, and Phi types suitable for high pressure condition in drip irrigations system and to test and compare the discharge for each type of emitter in the laboratory. Stages in this research were as follows: 1) designing block type of emitter; 2) developing of block structure media; 3) developing structure block; 4) installing and testing the emitter in the laboratory; and 5) Analyzing data. Results of laboratory test showed that the average discharge for each emitter Phi, S, and Y were 0.2; 0.08; and 0.1 ml/sec, respectively. The highest discharge was found on the Phi structure, while the discharge for S and Y structures were similar. The variability of discharge due to structure design in each emitter had different effect in reducing of pressure. Technical evaluations showed that type of Y structure was simpler to develop than the two other structures. Phi style was the most difficult one to be developed. The main reason was related to the complexity in making structure pattern in the block of emitter. Recommendation for applying emitter was strongly influenced by crop and soil type. Crop which needs high water and planted in the high porosity soil may use emitter with small discharge for long time application. On the other hand, the soil with heavy soil texture may use the high discharge emitter for short time application.

RÉSUMÉ ET CONCLUSIONS

Irrigation goutte à goutte, également connu sous le nom d'irrigation goutte à goutte ou micro-irrigation, l'irrigation est une méthode qui permet d'économiser l'eau et des engrais en laissant l'eau goutte à goutte lentement pour les racines des plantes, soit sur la surface du sol ou directement sur la zone des racines, à travers un réseau de vannes, tuyaux, tubes, et les émetteurs.

Avec l'avènement des plastiques modernes pendant et après la Seconde Guerre mondiale, des améliorations majeures dans l'irrigation goutte à goutte n’est devenu possible. Micro tube plastique et divers types d'émetteurs ont commencé à être utilisé dans les serres de l'Europe, les États-Unis et en Asie.

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Jusqu'à présent, les émetteurs utilisés sont importés de sorte que le prix est encore cher. C'est pourquoi nous avons besoin de nouvelles innovations à base d'ingrédients locaux. Emetteur de matériaux locaux a été élaboré à partir d'un matériau argileux poreux. Toutefois, la faiblesse ne peut pas supporter la pression. Ainsi, cette recherche est nécessaire pour obtenir l'émetteur fabriqués à partir de locaux, facile de rendre les agriculteurs et ale avantage résistant à la pression.

Ces émetteurs ont été les personnes ressources pression Conçu pour les émetteurs substitut pores. Les émetteurs des pore savaient été produites en utilisant des sols d'argile et de leurs caractéristiques de débit ont été testés sur les personnes-ressources irrigation gravitaire. L'utilisation de ces émetteurs sur les flux de pression a eu des résultats dans la répartition des émetteurs, par conséquent, les émetteurs ont été sous pression les personnes-ressources Conçu comme une substitution.

Ce sont les personnes-ressources sous pression produite par les émetteurs utilisant des méthodes simples dans les matières qui leur sont techniquement et facilement disponibles. Moulage de matière été faite à partir de caoutchouc de silicone. Ce matériau a des caractéristiques élastiques de sorte qu'il correspond à aucun déforme proposée. Structure de fabrication a été réalisée en utilisant le matériau de base de gypse.

L'évaluation technique de la fabrication émetteur a montré quel' émetteur de type Y a été plus facile à produire que les types S et Phi. Cela est dû à l'existence du facteur de transport résistant. La fabrication les plus difficiles de type émetteur a été le type de blessure. Résultats des tests de laboratoire ont montré que l'émetteur de type Phi avait le plus de valeur que le transport et les types S Y.L'émetteur de type S a la valeur la plus faible de transport due à l'écoulement en raison de résistants sous forme de lettre S qui produisent des effets positifs pour le transport résistante et diminuerait le moyen de transport.

Recommandation pour l'usage émetteur est fortement affecté par les cultures à planter et les types de sol. Les cultures maraîchère sont besoin de moins d'eau, mais l'eau doit être appliquée en temps fréquentes que les cultures fruitières. Par conséquent, S et Y ont été types émetteur est recommandé d'utiliser pour les cultures légumières, alors que l'émetteur de type Phi a été recommandé pour les cultures fruitières.

1. INTRODUCTION

Irrigation is one of measures which is important for supply of food need. Without irrigation, it is almost impossible to provide enough food for about 6,000 millions people living on earth and 40% of food production was gained through intensification effort by using irrigation (FAO, 2000).

Water management for irrigation purpose is very important when the rainfall amount is insufficient for crops or for maintaining normal growth and development of crops. The dry season or dryness condition can results from natural process such as El Nino. The best operation may consist of water storage during rainfall period and irrigation technology provision at dry season (Wiratmo, 1998).

Irrigation water application technology for crops can be applied for planting within poly bag, pot, drum, or restricted environment, especially for high economic value crops at acid areas or high salinity conditions.

Irrigation water application can be conducted through several methods such as surface irrigation, channel irrigation, sprinkle irrigation, and trickle or drip irrigation (Susanto, 1997). The most efficient method amongst the four above methods is by using drip irrigation. According to Indri et al. (2011), trickle irrigation is water application method that is mostly suitable for dry land that has limited water resources. Efficiency magnitudes for drip irrigation can be as high as 88.01% to 91.44% ; therefore, it can save water more than 80%. The currently disadvantage of some emitters are the pressure loss due to low performance of membrane within emitters. Therefore, a study related to membrane design and production of pressure resistant emitter is needed.

The main problem currently faced by application of trickle irrigation technology is its relatively expensive infrastructure and limited availability of *dripper* or *emitter*. Most emitters currently available are imported product. Therefore, it is important to design and to produce the emitters that are resistant to high pressure application. These emitters require proper materials using specific design so that they can be applied for extensive area by using high pressure pump.

The objectives of this research are as follows:

- To produce block emitters having S, Y, and Phi types for application of high pressure trickle irrigation (non-gravitational).
- To compare the efficiency, flow coefficient, and ergonomics of the three emitter types above.

It is expected that this study can produce the local technology product related to trickle irrigation system and to fulfill the food need as well as to support the "blue revolution", i.e. higher harvest yield for each water drops. Moreover, it is hoped that local industry for emitter products would be developed in the long run which results in a new job opportunity.

2. METHODOLOGY

2.1. Location and Time

This study was conducted at Soil Physics Laboratory, Faculty of Agriculture, Sriwijaya University. It was carried out based on the contract with Research Council of Sriwijaya University for 5 months period consisting of laboratory works for 3 months as well as data analysis and report writing for 2 months.

2.2. Materials and Equipments

Materials used in this study were consisted of *flexi sheet*, *flexi glass*, clear resin, *rubber silicone*, PVC pipe, metal adhesive, PVC adhesive, burn/hot silicone adhesive, stripper, pump, fiber hose, sanding paper, plastic box, candle molding, gypsum molding, clamp, connector pipe, and big container. The equipments used in this study were computer, weight balance, volumetric glass, and stopwatch (*timer*).

2.3. Method

Stages in this study were as follows: 1) design, 2) master fabrication, 3) emitter block molding, 4) emitters installation and trickling test, and 5) data analysis.

Design. Design was conducted by using software of Corel Draw 9. Emitter dimensions was designed which is based on the currently available emitter and it was presented in two dimension feature.

Master fabrication. The produced master or trickle master was block emitter having three types as stated above. These blocks were made by using candle molds which is then stripped according to their design types. Molding was also produced in this stage to develop mold block by using rubber silicone which was coated by mixture of cement and gypsum.

Making block emitter. Molding was produced in this stage to mould master blocks by using rubber silicone which was coated by mixture of cement and gypsum. An emitter block was made by using resins material.

Trickle Installation. After the resin block was formed, emitter installation was set up by installing flexible sheets that were perforated at certain parts and then followed by gluing process.

Emitter Test: The following stage was testing by using pump with specific pressures. The observed data or parameters were as follows:

- Dimensions of blocks and emitters (direct measurement); dimensions and diameter of pores and weight.
- Discharge / trickle intensity (discharge measurement)

Data Analysis: Data was analyzed by using completely randomized design. Discharge and average coefficient of the produced emitter was compared to currently available emitters (import products).

3. RESULTS AND DISCUSSIONS

3.1. Production of Pressure Resistant Emitter

These pressurized emitters were designed to substitute the pore emitters. The pore emitters had been produced by using clay soil and their flow characteristics were tested on gravitational irrigation. The use of these emitters on pressurized flow had results in breakdown of emitters; therefore, the pressurized emitters were designed as a substitution.

These pressurized emitters were produced by using simple method in which their materials are technically and easily available. Molding material was made from rubber silicone. This material has elastic characteristics so that it will match any proposed form. Structure fabrication was done by using base material of gypsum. The formed structures were consisted of Y, S, and Phi types such as shown in Figure 2. After the structures formation, they were put into mold box and rubber silicone was poured into that mold (Figure 3). Structure molding would be formed during 24 hours curing process. The next step is that the structure is ready to be formed into emitter by addition of *flexi glass* and put into 0.5 inch diameter pipe. Prior to emitter installation, it should be connected to connector pipe and conveyance pipe.

The Y type structure was easier to be produced than S and Phi types due to the stripping process. The difficulty was found during initial stage, but all structure types would receive the same treatment after the moldings had been formed.

After the proposed structures had been formed, then they should be coated by flexi sheet. This flexi sheet had elastic characteristics and resistant to pressure. The elasticity of this material is capable to convey water and to regulate the input pressure. The next step was insertion of emitter into connector pipe such as shown in Figures 6 and 7.

Figure 2. Phi, S, and Y structure types

Figure 3. Molding fabrication

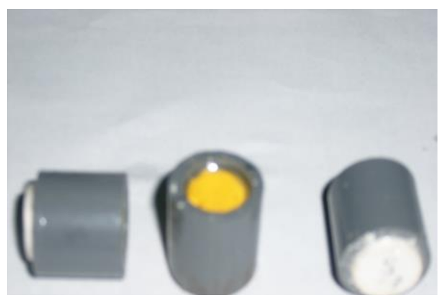

Figure 4. Molding fabrication

Figure 5. Inserting structure

Figure 6. Emitter installation into connector

Figure 7. Emitter is ready to be connected using pipe

3.2. Laboratory Tests

The laboratory test was conducted to determine conveyance capability of each type of structures. It was carried out by installing the emitter in pressurized conveyance pipe. The conveyance capability for each emitter was determined from its discharge (Table 3).

Table 3. Results of emitters test at 0.7 bar pressure.

Codes	Time (minutes)	Volume	Discharge
	1.25	9.8	7.84

Phi 1			
Phi 2	1	17	17
Phi 3	1	14	14
S1	2	9.6	4.8
S2	2	5	2.5
S3	1	5	2.5
Y1	2	10	5
Y2	2	18.3	9.15
Y3	2	5	2.5

Notes :

The constraints found during the test were as follows:

- emitter fabrication: during the gluing of “flexi sheet” with emitter structures (1/2 inch PVC pipe).
- emitter testing: gluing with PVC adhesive having low attachment capability results in some emitters were not resistant at 0.7 bar pressure (2 of 9 emitter structures was detached).
- Testing at 1.4 bar results in all emitter structures detachment from their emitter cover (1/2” PVC pipe)

Solution:

Use the stronger adhesive than PVC pipe adhesive.

It could be concluded from Table 3 that average conveyance capabilities from Phi, S, and Y types were 0.2, 0.08, and 0.1 ml/s, respectively (Table 4).

Table 4. Conveyance capabilities from three emitter types

Structure types	Discharge (ml/min)	Discharge (ml/sec)
Phi	12.9	0.2
S	3.3	0.08
Y	5.5	0.10

Note : Emitters was testes on 0.7 bar pressure.

The conveyance capability of Phi type structure was the highest, whereas the lowest one was S type. The low conveyance capability of S structure type was due to flowing resistant because of S letter form that produce, positive effect toward conveyance resistant.

Recommendation for emitter use is highly affected by the crops to be planted and soil types. Vegetable crops need less water, but the water should be applied in frequent times than the fruit crops. Therefore, S and Y types emitter were recommended to be used for vegetable crops, whereas Phi type emitter was recommended for fruit crops.

4. CONCLUSIONS AND RECOMMENDATIONS

Technical evaluation from emitter fabrication showed that Y type emitter was easier to be produced than S and Phi types. This was due to the existence of conveyance resistant factor. The most difficult fabrication of emitter type was the Phi type.

Results of laboratory test showed that Phi type emitter had the highest conveyance value than the S and Y types. The S type emitter had the lowest conveyance value due to flowing resistant because of S letter form that produce positive effect toward conveyance resistant and would decrease the conveyance.

Recommendation for emitter use is highly affected by the crops to be planted and soil types. Vegetable crops need less water, but the water should be applied in frequent times than the fruit crops. Therefore, S and Y types emitter were recommended to be used for vegetable crops, whereas Phi type emitter was recommended for fruit crops.

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