POROUS PIPES AS SUBSURFACE MICROIRRIGATION LATERALS

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Keywords: subsurface micro irrigation, porous pipe lateral, irrigation uniformity, discharge exponent, friction factor.

Introduction

Irrigation systems are well known for their low efficiencies. Efforts must be made to conserve water resources in view of a greater competition from domestic, industrial and other sectors of the economy. Since a micro irrigation system can achieve very high application efficiency, it should be further explored even for supplemental irrigation in a humid tropical country like Malaysia. Porous pipe is useful both for surface and subsurface micro irrigation systems. If buried, a lot of irrigation water which otherwise would be lost to evaporation will be saved. Even though more expensive, the advantages as claimed by the manufacturers such as an increased water use efficiency, a continuous wetted strip, and less weed growth due to dry soil surface for subsurface application give a good reason why subsurface porous pipe irrigation is worth considering. However very little information is available about discharge uniformity and operating characteristics of porous pipe irrigation laterals. This work done at UPM focuses on the hydraulics of two types of porous pipes to determine such performance criteria as the pressure-discharge relationship and friction head loss, and the moisture distribution in the soil profile.

Materials and Methods

Two types of porous pipe were tested. One is known as "CT12-poritex exudating hose" manufactured from plastic geotextile and acts as a conduit and emitter. The other is known as "precision porous pipe", soaker hose or leaky hose made from recycled rubber and polyethylene (2/3 recycled rubber and 1/3 polyethylene). The experimental setup consists of a water source, an electric pump, a flow meter, pressure gauges, control valves and volume measuring cylinders. The setup could measure water pressures of up to 250 kPa and flow rates of up to 1000 litres per hour. Several lengths of the imported "poritex" and "precision" porous pipe were subjected to various flow rates and inlet pressures to determine the average discharge along the lateral and the frictional head loss. The "poritex" porous pipe, 0.5 mm thick with 12 mm inside diameter, was cut into sample lengths of 45, 65, 80,100, 130, 150 and 195 m. The "precision" porous pipe has 15 mm inside diameter and 2.7 mm thick. All hydraulic studies were done with the porous lateral pipe on level ground. Manufacturing variability was not tested in this study. A 2m X 2m X 2m soil bin was constructed to study the moisture distribution from a subsurface installation.

Results and Discussion

The flow in the emitter lateral was found to be highly sensitive to pressure. The discharge exponent ranged from 0.93 to 1.04 for the "precision" porous pipe, and from 1.07 to 1.67 for the "poritex" porous pipe. The head loss in relation to inlet head for various "precision" porous pipe are about 16%, 20%, 25%, 30% and 36% for 60, 80, 100, 130 and 147m length, respectively. For "poritex" pipe, head losses ranged from 28% to 60% for lengths from 65 m to 195 m, respectively. Lower head loss occurred as a result of lower inlet heads irrespective of the lateral lengths. Since a porous pipe was very sensitive to pressure variation, it is desirable to have low head losses. This means that the porous pipe is best used with low inlet pressure input. Graphs were developed to ease design work in the determination of the required inlet pressure head for any design discharge and pipe length. The average discharge rate was low (< 3 L/h/m for "precision", and < 5 L/h/m for "poritex" porous pipe) for the pipe lengths tested in this study with operating pressures up to 1 bar. The relevant equations for average discharges from 1 L/h/m to 5 L/h/m can be derived from the graphs for any pipe length up to 200 m. Operating at 1 bar inlet pressure for 80 m length on a level field gave 3 L/h/m average discharge, but if only 2 L/h/m was required, the length can be as long as 160 m. Higher discharge rates required higher inlet pressure or bigger pipe diameter for the same input pressure. The allowable head loss for good irrigation uniformity was small. Hence porous pipe laterals up to 200 m on a level field are possible only with average discharge rates as low as 1 L/h/m at an inlet pressure head of 5 m. Graphs that were developed may be used in the design of "precision" and "poritex" porous pipe micro irrigation laterals. Porous pipes have a rough inner pipe wall. The relationship between head loss and Reynolds number of the flow in the pipe was found using the Darcy-Weisbach head loss formula with F=0.333 to compensate for infinite outlets. Analyses of the frictional head loss shows that the "poritex" porous pipe was not as smooth as an equivalent size polyethylene pipe. The friction factor is about 40 % above that of the smooth pipe curve of von Karman-Prandtl or its linearised version of Blasius equation. This is equivalent to a Hazen-Williams roughness coefficient C=120. Polyethylene lateral pipes usually have friction factor 10 % above the Blasius line or C=130 (Amin, 1994). The inner wall of the "Precision" porous pipes is much rougher as compared to "poritex". Its friction factor is about three times as large as that of a smooth pipe. This is equivalent to Hazen-Williams C = 70. A wetted strip of 1 m moisture spread found in this study is typical for a sandy textured soil profile. Wider moisture spread is expected for heavier soils.

Conclusions

Both types of porous pipe can be used as a subsurface micro irrigation lateral. Graphs and charts developed based on the results of the study will facilitate design of both types of porous pipe for various applications. Since Malaysia has abundant used rubber tyres that can be recycled, larger pipe sizes can be manufactured for a higher discharge rates requirement. The pipe may also be suitable as a subsurface drainage pipe. A wetted strip of 1 m moisture spread found in this study is typical for a sandy textured soil profile.

References

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Supported by IRPA Grant 01-02-04-0136