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Research Notes

Performance evaluation of porous pipe irrigation in heavy soils

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An efficient irrigation system should provide maximum productivity per unit area with unit quantity of water. Subsurface irrigation is an efficient method of irrigation, in which water, nutrients and soil additives can be applied to the root zone that encourages deeper and more extensive root development resulting healthier and more productive plants (Murugaboopathy *et al.* 1991). Since water is applied below the soil surface, development of hardpan, sealing of soil strata, compaction of soil etc. can be avoided. The moist environment below the soil surface is conducive for the activities of earthworms and microbial life (Sohrabi and Gazori, 1997).

Porous pipe subsurface irrigation can be defined as "application of water below the soil surface at the root zone of the plants through tiny openings provided on the wall of the pipe at a rate that allows the soil to absorb the water at its natural rate" (Yoder *et al.* 1995). Porous pipe is made from recycled rubber and polyethylene. It allows both air and water to pass through pores provided in the wall at low pressure. Porous pipe is designed to operate at low poressure, which allows for smaller and less expensive pumping systems & smaller energy demands (Mohammad, 1998). Moreover maintenance of porous pipe is minim Even though porous pipe subsurface irrigatic has so many advantages, very little informatio available on the discharge availabiity and operatin characteristics of the porous pipes in differe soils. In this study, an attempt is made t study the hydraulic performance of porous pip in heavy soil.

The experiment was conducted at th College of Agricultural Engineering, Tamil Nad Agricultural University, Coimbatore during 200(2001. The soil at the experimental site w sandy clay loam for the top 20 cm dept and sandy clay for deeper layers.

The discharge line of the experiment setup consists of a 3.75 cm diameter PV pipe and 1.6 cm diameter porous pipe (outsid diameter = 2.2 cm; inside diameter = 1.6 cm A screen filter was provided in the delive line for filtration. Ball valve and pressure gau connected to the main line was used to s the operating pressure by controlling the flo The porous pipe laterals of 10m lengths we connected to the main line by using start a washer connectors. In each line separate ta were provided to allow the water to flow on

Table 1. Discharge rates of porous pipe

Pressure (kg/cm²)	With sand envelope (lit/hr/m)			Without sand envelope (lit/hr/m)		
	5	15	27.5	5	15	27.5
0.4	2.82	5.93	3.43	2.14	5.43	3.12
0.6	4.22	8.40	6.62	2.77	7.54	5.49
0.8	6.15	11.01	7.17	4.35	9.25	6.64
1	5.18	10.10	6.23	3.45	8.93	6.02

Table 2. Distribution efficiency of porous pipe

Depth of installation of porous pipe (cm)	Just after irrigation		24 h after irrigation	
	With sand envelope (%)	Withous sand envelope (%)	With sand envelope (%)	Without sand envelope (%)
5	52.76	48.21	58.42	57.23
15	76.80	74.32	80.06	78.68
27.5	66.01	67.51	70.48	70.52

through the desired porous pipe. The porous pipes were installed at three different depths of 5, 15 and 27.5 cm with and without sand envelopes of 5 cm thick.

Discharge Characteristics

Normally, precision porous pipes are expected to introduce moisture to the surrounding soil in commensurate with its intake rate. This necessitates the operating pressure to be low. Keeping this in mind, the operating pressures were fixed as 0.4, 0.6, 0.8 and 1 kg/cm². During the discharge measurement, pressure was kept constant by adjusting the ball valve. Discharge rate of various porous pipes (with and without sand envelope) installed at different depths (5, 15 and 27.5 cm) were measured at selected pressures and is given in table 1. In all the cases, discharge rate was found to increase with increase of pressure upto 0.8 kg/cm² and there after decreased with increase of pressure. When press increased, pressure head acting at a particular point increased resulting in more discharge. But with increase of pressure, frictional losses at this minute pores also increased. This might have caused a reduction in the discharge; *i.e* upto 0.8 kg/cm² gain due to increase of pressure was more than the loss due to increase of frictional loss and beyond 0.8 kg/cm², considerable frictional losses may occur leading to reduction in discharge. Hence 0.8 kg/cm² can be considered as the optimum operating pressure for the porous pipe having an inside diameter of 1.6 cm. Hence by operating the porous pipe subsurface irrigation system at 0.8 kg/cm², the time and cost of operation can be get reduced.

Further, table 1 revealed that the discharge rate of porous pipe installed at 15 cm depth below the soil was comparatively more. At this depth, the pressure exerted by the soil on the pipe may be optimum to make the water ooze out of the pores. At 5 cm depth, the pressure exerted by the soil may be lower than required where as at 27.5 cm depth, the pressure applied was more than required. Hence in both the cases discharge rate was found to be comparatively less.

From the table 1, it can also be seen that, the discharge rate of all the porous pipes provided with sand envelope of 5 cm thick was comparatively more. The soil in the experimental site was clayey type and on wetting, the clay particles expanded and blocked the tiny pores of the porous pipe and prevented the water from oozing out of the pores. A small covering of sand envelope (5 cm all-round) allowed smooth flow of water through the tiny pores. The large porosity and non-sticking property of the sand helped to improve the hydraulic performance of the porous pipe. Hence in sandy clay loam soil, it is better to instal the porous pipe at 15 cm depth below the soil with sand envelope.

Distribution efficiency

The distribution efficiency was calcualted by using the formula

$$E_d = \left(1 - \frac{y}{d}\right) \times 100$$

Where

E_d = Water distribution efficiency (%)

d = Average depth of water stored during irrigation

= {((MC$_2$-MC$_1$) x depth x bulk density)}/ 100 Where

MC_2 = moisture content observed after irrigation

MC_1 = moisture content observed before irrigation

y = Average numerical deviation from d

Soil moisture measurements were taken before irrigation, just after irrigation and 24 h after irrigation. The observations were taken at 10, 25 and 45 cm from the centre of the porous pipe. In all the cases soil moisture measurements were made at different depths *viz*. 5, 25, 45 and 60 cm below the ground along the lateral lengths at 2, 6 and 8m.

The distribution efficiency obtained for the porous pipes installed at different depths with and without sand envelope is given in table 2. Among different set up, moisture was distributed more uniformly in the case of porous pipe installed at 15 cm depth with sand envelope. This may be due to the fact that the pressure applied by the soil will be optimum to make the water flow out uniformly through the tiny pores. It can be seen that the porous pipe is having only low to medium distribution efficiency. This may be due to the fact that direct control of the porosity of the material during the manufacture is not always possible. Some of the pores were found to be bigger in size and water was oozing out like small streams whereas some of the pores were very small in size through which water was ooying out very slowly drop-by-drop. Moreover these pores were not provided uniformly throughout the length of the pipe.

The study revealed that in sandy clay loam, the porous pipe should be installed at 15 cm depth below the soil with sand envelope. In order to ensure higher discharge rate and uniform distribution of water in the soil, the operating pressure for the porous pipe should be kept between 0.6 and 0.9 kg/cm^2. The porous pipes gave only low to medium distribution efficiency in heavy soils. Both clayey soil and salty water had a tendency to clog the tiny pores of the porous pipes. Hence porous pipe subsurface irrigation can be recommended in the areas having light textured soils and good quality water.

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