PERFORMANCE EVALUATION OF IMPORTED AND LOCALLY MANUFACTURED ALKATHELINE EMITTERS

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A study has been undertaken to compare the performance of locally manufactured alkatheline emitters with the imported alkatheline emitters in order to assess their use in drip irrigation system. All the emitters were tested at pressure of 63, 84, 105, 126 and 147 kPa with four replications of each emitter and the corresponding discharges were measured volumetrically. The discharge of the two local and one imported emitters were 2.7, 6.5 and 3.84 Iph, respectively at standard pressure of 105 kPa fulfilling the required criteria. The coefficient of manufacturing variation, emission uniformity and coefficient of uniformity for local and imported emitters were 2.5, 91.5, 97.6 and 2.1, 93.6 and 93.9%, respectively. The results depict that the locally manufactured emitters Iulfill the standard criteria of fitness and are considered suitable for use in drip irrigation system. The locally manufactured emitters are 90% cheaper than the imported ones.

INTRODUCTION

In Pakistan, water is considered as a limiting factor for crop production. The fast growing population and increasing demand of food and fibre necessitates to adopt high efficiency irrigation system with minimum cost. Trickle irrigation also known as drip irrigation is a technique employed in many countries of the world for optimum and economical use of water for raising fruits, vegetables; crops and forest trees, etc. This technique is versatile in its application and can be applied in areas of uneven topographyand of water scarcity. Because of its attractive features, this technique has become very popular. The basic concept of drip irrigation system is desired due to slow and frequent application of water at particular points. The success of drip irrigation system depends on its uniform, efficient and required application of water at the required time and place. The application of water takes place through the emitters, which is the most sensitive and important part of the system and is responsible for the regulation of the discharge to keep the air and soil moist urc balance wit hin the rootzone at such a level which is recommended for optimum plant growth.

MATERIALS AND METHODS

Development or alkatheline emitters: These emitters were developed by using the ordinary electric wire of 2 mm and 6 mm diameter, named as alkatheline emitters, in the laboratory of the Department of Irrigation and Drainage, University of Agriculture, Faisalabad. The tube was wrapped spirally on a 30 cm long G.I. pipe (1.25 cm outer diameter) and was warmed in boiling water for half an hour.The pipe was then taken out of water and was cooled in the air about 15 minutes and then was cut into pieces having 4 and 8 whorls on each piece. The cost incurred to develop one local emitter was only Rs, 1/- as compared to the imported which was Rs, 10/- per emitter.

Experimental layout: The emitters were installed on lateral 10 m long (13 mm diameter) at a distance of 1.5 m apart. Four emitters of the same type were tested simultaneously for all the range of pressures. Two pressure guages were installed on the upstream and downstream of the emitters. Five levels of pressure i.e, 63, 84, 105, 126 and 147 kPa were applied and the corresponding discharges were measured by volumetric method under steady state conditions. These tested emitters were installed later on a 32 m long lateral at emitter spacing of 4 m to investigate the pressure-discharge relationship along the lateral.

conditions are presented in Table 1 and the criteria adopted for the performance evaluation is described as below (James, 1988).

Coefficient of manufacturing variation (CV): This coefficient describes the quality of the process used to manufacture these emission devices. This coefficient helps to know the level of manufacturing skill and degree of perfectness about design of the device. The manufacturing coefficient of variation is computed as below:

$$C_v = \frac{\sqrt{q_1^2 + q_2^2 + \dots + q_n^2 - n q_{ave}^2}}{q_{ave}\sqrt{n-1}}$$

Table 1. Pressure-discharge relationship of alkatheline emitters

Pressure (kPa)	Emitter discharge (lph) 63		84		105 (Standard)		126		147	
Emitter type	qm*	qp**	qm	qp	qm	qp	qm	qp	qm	qp
Alkatheline *(A48)*	3.22	3.22	3.50	3.52	3.84	3.82	4.16	4.13	4.40	4.43
Alkatheline *(A24)*	2.00	2.05	2.50	2.41	2.70	2.71	3.10	3.04	3.25	3.32
Alkatheline *(A68)*	5.24	5.26	5.90	5.89	6.69	6.44	6.89	6.92	7.34	7.36

* = Measured emitter discharge. ** = Predicted emitter discharge.

RESULTS AND DISCUSSION

The alkatheline emitter is an orifice type emitter. It has no pressure compensating part as in case of some other emitters. However, the size of the tube and number of whorls are responsible for the regulation of discharge through the emitter. The emitters under investigations were imported alkatheline of 4 mm diameter 8 whorls designated as A48 and locally manufactured alkatheline emitters were designated as *A24* and *A68*. The data collected under different hydraulic

where

C_v = Coefficient of manufacturing variation

q_1, q_2, q_n = Discharge of emission devices (lph)

qave = Average discharge of emission devices tested (lph)

n = Number of emission devices tested

As recommended by ASAE (1985), the emitters having C_v value less than 5% are considered good for use.

Emission uniformity (Eu): It depends upon water temperature and the manufacturer's coefficient of variation. The Eu has been developed for evaluating the trickle lateral design and emission device selection. The emission uniformity is defined as below:

$$E_u = 100 \left(1.0 - \frac{1.27}{\sqrt{N_e}} C_v\right) \frac{Q_{min}}{Q_{ave}}$$

where

Eu = Design emission uniformity (%)
Ne = 1 or number of emission devices per emission point
Q_{min} = Minimum emitter discharge (lph)
Q_{ave} = Average emitter discharge (lph)

ASAE (1985) has recommended Eu 90-95% for uniform and 85-90% for steep or undulating soil topography.

Christianson coefficient of uniformity (Cu): The application uniformity describes how only an irrigation system distributes water over a field. For trickle irrigation system, the volume of water discharged in a specified interval of time at several emission devices location was used. The coefficient of uniformity is calculated as below:

$$C_u = 100 - 8.00 \frac{S}{X_{ave}}$$

where

Cu = Christianson uniformity coefficient (%)
S = Standard deviation of observations
X_{ave} = Average value of observations

As recommended by ASAE (1985), emitters having Cu value above 90% arc considered good for use.

A mathematical model which is normally used for pressure-discharge relationship of emitters was developed and is given below (Zur & Tal, 1981):

$$Q = a H^b$$

where

Q = Emitter discharge (lph)
H = Pressure at emission device in kPa
a,b = Constants (Table 2)

Table 2. Evaluutlon criteria for emitters

Emitter type	Cv(%)	Eu (%)	Cu (%)	b	a
Alkathcline imported (A48)	2.1	93.6	93.9	0.80	0.67
Alkatheline local (A24)	2.5	91.5	97.6	0.57	0.19
Alkatheline local (A68)	2.5	91.5	97.6	0.50	0.73