ABSTRACT

India's economy is dependent to a large scale on irrigated agriculture. There is an urgent need to improve the application efficiency of the irrigation system in order to bring more area under irrigation. This can be largely achieved by adopting new methods of irrigation, such as sprinkler and micro irrigation. The drip irrigation, a form of micro irrigation, has certain problems such as clogging of emitters, duration of operation etc. This can be minimized by using micro sprinklers in place of drip emitters. In recent time many drip manufacturing industries in India also manufacture micro sprinklers. However, information on hydraulics of micro irrigation system, their changes with water quality, soil and crop requirements as well as on their economical design are not available. The present research is a systematic attempt to design a micro sprinkler irrigation system based on hydraulic, economic and agricultural considerations.

Experiments were conducted to evaluate the effect of stake height and pressure of four types of indigenously manufactured micro sprinklers on discharge, wetting radius, depth of water application and coefficient of uniformity of water application. The data obtained from the experiment was used for optimization of stake height and pressure using Multi Objective Goal Programming of MATLAB-6 software. A criterion for selection of most suitable micro sprinkler was prepared considering soil climate and crop as parameters. Comparing the optimum values of the high pressure-high discharge type MS-1 micro sprinkler was judged to be the most suitable micro sprinkler among the four. Another software written in C++ code was developed to determine the inter emitter spacing of the micro sprinkler on the lateral for achieving the uniformity coefficient of water application greater than 85%. The inter emitter spacing for the selected micro sprinkler MS-1 was found to be 3 m.

The second part of the study deals with factors affecting pressure losses in the pipe network of the irrigation system with the aim of possible reduction of pressure losses. Three major factors that have been taken into consideration were: (i) friction induced pressure losses in the indigenously manufactured different sizes of HDPE and LLDPE pipes and micro tubes which are used as laterals and spaghetti tubes in the irrigation systems, (ii) effect

of quality of water on friction induced pressure drops and (iii) pressure losses at the different sizes of Tee junctions of lateral pipes with micro (spaghetti) tube. The study reveals that in case of small diameter LLDPE laterals pipes of 20, 16, and 12 mm sizes micro tubes of 7, 5 and 4 mm sizes the value of friction coefficient (f ') is on an average 12 to 15% more than the values obtained from Blasius equations. Addition of wetting agents, insecticides and soluble urea in water for foliar application through micro sprinklers increases kinematic viscosity of tap water by 28-48%. If only wetting agent is added at the recommended dose, the friction coefficient of pipe flow decreases, but addition of urea causes increase of friction coefficient. Next to micro sprinkler the pressure drop due to connecting nozzle at the Tee junction of lateral and micro tube consumes maximum pressure in a lateral pipe. By changing the internal diameter of the connecting nozzle from 2 mm to 3.3 mm, the reduction of pressure is 26%, while that in case of 4.4 mm size connecting nozzle is 85%. Reduction in pressure loss decreases with the decrease in the internal diameters of the lateral pipes.

The third aspect consists of economic design of a micro sprinkler irrigation system using (I) the optimum values of hydraulic parameters of the selected micro sprinkler (MS-1), (ii) the results of laboratory experiments for reduction of head loss in the system and (iii) existing local market price. Materials considered for the design were 60, 50, and 40 mm size HDPE pipes for main, 20, 16, and 12 mm size LLDPE pipes for submain, 7 and 5 mm micro tubes and 2, 3.3 and 4.4 mm size connecting nozzles, which constituted 54 combinations altogether. Prior to economic evaluation, optimum size of subunit for each of the combinations consisting of a sub main, a few laterals and the number of emitters (micro sprinklers) per lateral, was determined by a specially developed software in visual C++. Economic analysis revealed that the irrigation system consisting of 70 mm main pipe, 40 mm sub main, 16 mm lateral, 3.3 mm connecting nozzle and 7 mm size micro tube is the most economical system for irrigation with MS-1 micro sprinklers

Key word: *Micro sprinklers, hydraulic parameters, coefficient of uniformity, friction, wetting agents ,Tee junction, connecting nozzle, cost recovery factor, economic design.*