5. Summary and Conclusion

For optimum design of drip-irrigation system, it is necessary to have actual information about the main components of the system such as the hydraulic charateristics of emitters, laterals and sub-main layouts and its design parameter and the arrangement of emitters to irrigate the desired percentage of the root zone.

Also , optimum design should meet the requirement while remaining within the economic constraints such as initial investment, feasibility, ... etc.

Therefore, the purpose of this work was to obtain actual information necessary for optimum design of drip irrigation through the following studies :

1. Hydraulic characteristics of emiter and emitter avaluation.
2. Effect of emitter discharge rate on soil moisture distrbution.
3. Effect of drip-irrigation lay-out on the capital cost of system.

1. Hydraulic characteristics of emitter and emitter evaluation

Three different types of emitters were hydraulicall tested and evaluated , namely : vortex, long-path (on-line), and long-path (in-line) emitter. The discharge exponent of emitter (x) and the discharge factor of emitter (K) were determined for each type of emitters.

Twenty emitters from each type were tested for one minute. The test was replicated three times for each type of emitter. The testing pressure-heads (H) were 0.5, 0.75, 1.0, 1.25 and 1.5 bar. The corresponding averge flow rate (q) values, were plotted against (H) on log-log paper to determine values of (K) and (x) .

Hydraulic values of (K) and (x) are shown in the following table for the three types of emitters tested, along with remarks on flow.

Emitter types	Hyd. values K	x	Remarks on flow
Vortex	2.65	0.5	Turbulent
Long-path (on-line)	1.32	0.531	Partially turbulent
Long-path (in-line)	1.5	0.519	Partially turbulent

Results on the evaluation of the previous emitter types, show that , the value of "CV" was 0.20 for vortex emitter type, so, it is not recommended for use . Values of "CV" for long-path (on-line) and (in-line) were 0.05 and 0.08 resp. , so they are acceptablle for use.

2. *Effect of discharge rate on soil moisture distribution pattern*

The soil type in this experiment was clay and the nominal discharge rates of emitters were 2, 4 and 8 L/h , while the actual discharge rates were 2.5, 5.1 and 10 L/h respectively, under pressure of one bar. The amounts of water applied were 4, 8 , 12 and 16 L for each emitter resp. Soil samples were taken at different radial distances and depths. The radial distances were 0, 10, 20, 30 and 40 cm and the depths were 0, 10, 20, 30, 40, 50, 60 and 70 cm. Moisture contents were measared before and after water application on dry weight basis.

The results show that, increasing emitter discharge resulted in increasing moisture content of the soil directly close to the emission point, meanwhile , it decreased away from the emitter location. The wetted soil volume increased by increasing the amount of water applied . The horizontal component zone increased with increasing of the water applied, and it increased with the discharge rate of emitters, when the volumes of water applied were 4 and 8 L. It decreased with increase of the discharge rate of emitter, when the volumes of water applied were 12 and 16 L. The results showed also that to get a wetted strip, the maximum emitter spacings on the lateral line can be taken as 33, 31 and 35 cm, when 4 L total volume of water is applied and 43, 38 and 40 cm , when 8 L total volume of water is applied and 47, 43 and 44 cm , when 12 L total volume of water is applied and 49, 47 and 46 cm , when 16L total volume of water is applied, when the discharge rate of emitters were 2 , 4 and 8 L/hr respectively .

3. *Effect of drip irrigation layout on capital cost of system*

This study included the effect of lateral length and the effect of irrigation cycle on capital cost of system for 10 feddan (210 x 200 m) typical citrus-area.

The lengths of laterals were 100 , 50 and 25 m for cases number 1,2 and 3 respectively .

Another three cases (No. 4, 5 and 6) were used to study the effect of irrigation cycle on capital cost of system. In case No. 4, all the field is irrigated during 10 h/d.

Case No. 5 : the field is divided to two parts, each part is irrigated during 5 h/d. Case No. 6 : the field is divided into four parts, each irrigation during 2.5 h/d.

The capital cost of system in each case is estimated according to average market price lists (1992 - 1993).

The results showed that the diameter of lateral increased with lingth, so the cost increased . As the diameters of manifold increased with length of laterals the number and length of manifolds increased with decreasing the length of lateral, while capital cost of submain and fittings decreased with the length of lateral. So , the total capital cost of system decreased with increased length of lateral .

For the effect of irrigation cycle on capital cost of system, the results showed that the sub-total cost of different components of the system (lateral, manifold, submain, and fittings) as well as the grand total of capital cost for system increased with the number of irrigation cycles, i. e. increasing the number of sub plots in the field (6139 L.E. for case No. 4, 6971 L.E. for case No. 5, and 10977 L.E. for case No. 6), which are periodically irrigated during the daily operating time.

From the above mentioned presentation, the following is recommended :

1. The emitter types, their appropriateness and prices were numerous, so, it was necessary to evaluate various emitters in the market.
   In order to define the appropriateness of emitter, it can be tested in the laboratory before using it in the network of irrigation.
   The results in this study show that the long-path emitter types were better than the vortex emitter type. Their " CV" were 0.05 and 0.08 for long path (on-line) and (in-line) resp., compared with 0.20 for vortex emitter.

2. After selecting the most appropriate emitter, it is important to know its opration pressure to give the mean discharge rate by using the catalogue or by testing in the laboratory.
3. To get a continuaus wetted strip in clay soil, it can be recommended that the emitter spacings on the lateral line be 80% of the following spacings : 33 cm when 4L volume of water is applied, 40 cm when 8L volume of water is applied, 44 cm when 12 L volume of water is applied, and 47 cm when 16L volume of water is applied .
4. In order to decrease the capital cost of drip irrigation network , it can be used to a maximum length for lateral of (100 m) and maximum subunit size (10 fedd) which enables irrigation of most or all the field in the same time, with maintaining emission uniformity equal to or more than 90 percent .