Pak. J. Agri. Sci.
27 (2) 137, 1990

TRICKLE IRRIGATION: ITS ADVANTAGES, PROBLEMS AND SOLUTIONS

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Trickle irrigation has been proved to be the most efficient irrigation system regarding water application efficiency. On average, water saving from 42 to 47% has been observed when compared to furrow irrigation system. Use of saline water upto reasonable limits is also possible. Problem of clogging of emitters/drippers is commonly experienced but it has been shown that this could be avoided by proper filtration of water through sand and screen and with continued acid treatment.

INTRODUCTION

Trickle irrigation on a commercial scale began in USA and Israel in the early 1960s. Positive results became apparent within a short time and thus helped in the rapid spread of trickle irrigation to most type of agricultural produce, to all types of soil and in many countries throughout the world. Israel and USA have invested much in its research and development. Trickle irrigation has been adopted to some field crops and orchards including tomatoes, corn, cotton, sugarcane, grapes, mangoes, etc. The system, however, is not suitable for closely planted crops such as cereals and alfalfa.

MATERIALS AND METHODS

The system, in general, consists in laying a plastic tube of smaller diameter on the surface of the field along the plants and delivering water to the root zone slowly but frequently from holes or special emitters located at appropriate points along the tube. Twin wall rubber hose can be used to maintain the constant and low pressure of flowing water.

RESULTS AND DISCUSSION

A. Advantages

i. Water saving: The principal benefit that cannot be achieved with other techniques is that trickle irrigation supplies plants with precise amounts of water they needed. The wastage is minimum. In Hawaii, the water use efficiency of 80-90% has been reported with trickle irrigation of sugarcane crop. The efficiency of sprinkler irrigation on the other hand was 70–80%. The experiments conducted in Middle East, USSR, Italy and Pakistan show that water saving with trickle system is upto 30% as compared with sprinkler and 45 to 75% as compared with furrow system as shown in Table 1.

Table 1. Water saving with trickle irrigation

Country	Crop	Water saving (%)	Comparative results
Middle East*	Citrus	5 – 10	Sprinkler
	Decidous trees	10 – 20	Sprinkler
	Vine yard	10 – 20	Sprinkler
	Banana	25 – 40	Sprimkler
	Vegetable crops	15 – 30	Sprinkler
	Cotton	0 – 5	Sprinkler
	Corn	10 – 15	Sprinkler
	Fruit trees	20 – 40	Sprinkler
USSR*	Fruit trees	15 – 30	Sprinkler
	Vegetables	45 – 75	Furrow
Italy*	Fruit trees	20 – 40	Sprinkler
Pakistan**	Vegetables	42 – 47	Furrow

* Source: Anonymous, 1984. ICID Bull. 33: 4–9; **Source: Hanif et al. (1976)

Middleton *et al.* (1979) has studied the comparative water saving with trickle and sprinkler irrigation of a young apple orchard given in Table 2. The water application depth with sprinkler was 306 and 220 cm on daily basis and 2-week intervals respectively, whereas a very small amount of water i.e., 34.3 cm depth was needed with trickle system to raise an apple orchard without sacrificing growth or production. The data indicate that about 89% water could be saved by shifting from sprinkler to trickle system. Even larger amount of water saving is possible when compared with furrow system.

Table 2. Centimetres of irrigation plus rains applied by trickle and sprinklers to apple trees, June through September, 1973–76 and evaporation from a class 'A' evaporation pan*

Year	Evaporation (cm)	Sprinkler		Trickle
		2 wk. (cm)	daily (cm)	daily (cm)
1973	92	52	64	2.6
1974	93	53	89	7.1
1975	87	53	78	10.8
1976	80	62	75	13.8
Total	352	220	306	34.3
Percent of total evaporation		62.5	86.9	9.7

ii. Use of saline water: Trickle irrigation works quite well even with water of rather high salt contents. Continued trickling of water pushes the salts outside the periphery of the root zone. Accumulation of salts in the vicinity of the plant roots is almost effectively controlled. The salinity of water within the boundry of the root zone remains quite low and continues to provide favourable growth condition. With traditional methods of irrigation and even with sprinkler irrigation, salts, however, continue to build up within the root zone resulting in an ultimate failure of crop growth.

iii. Pests and diseases: By minimising the wetting of the soil surface and plant foliage, trickle irrigation reduces the development of many insect diseases and fungus problems. In addition, the efficiency of sprays is increased. Trickle irrigation prevents the spreading of diseases and weeds which can be transported along the surface of the soil in other types of irrigation. Trickle irrigation prevents the existence of anaerobic conditions in the soil for an extended time, which could cause conditions suitable for various soil diseases.

iv. Water usage with trickle irrigation: Water usage with trickle irrigation is more efficient compared to any other method of irrigation for the following reasons:

(a) Less loss of water by evaporation

than with sprinkler or flooding.

(b) Winds do not influence water distribution or evaporation.

(c) Low flow rates and point water distribution in trickle irrigation prevent run off even in difficult topographical conditions.

(d) More uniform distribution of water with trickle irrigation than with other methods of irrigation.

(e) The drop in line pressure in trickle irrigation system is much less than in sprinkling.

v. Early maturation: With trickle irrigation, soil temperature is higher than with sprinkling or flooding and therefore with many crops it is possible to achieve early maturation.

vi. Irrigation of potted plants and covered crops: Trickle irrigation is the only method with which it is possible to irrigate efficiently crops under plastic covering and potted plants.

vii. Agronomic benefits: Trickle irrigation does not interfere with cultivation, spraying, picking, and hauling. In fact, trickle irrigation reduces the need for cultivation since there are few weeds, less soil crusting and less compaction problems; the potential for surface run off is reduced to a minimum. This is important as means of erosion control and of preserving the surface drains in the area. The fertilizer injection process is efficient in terms of both labour and the use of fertilizer.

viii. Engineering and economic benefits: For irrigating widely spaced crops (fruit trees), the cost of a correctly designed trickle system is relatively low in comparison to that for other solid set or permanent irrigation systems. Where clogging is not a problem, operation and maintenance cost of the trickle irrigation is usually quite low. Trickle irrigation can be adapted to uneven terrain more readily than surface irrigation. Trickle irrigation requires relatively low pressures and constant discharges, and its application efficiencies are generally high. This further reduces pipe size and use of power.

B. Solution of Problems and Conclusions:

The major problem reported by almost all countries has been clogging of drippers. The cause is attributed to physical, chemical and biological factors. The suspended silt and clay particles, the precipitation of calcium carbonates and production of microbial slime enhances the emitters plugging. Table 3 showing the effects of various physical and chemical treatments on clogging of emitters has been prepared from the data observed by Gilbert et al. (1979, 1981).

Table 3. Description of water treatments

Treatment	Filtration	Chemical	Percentage of emitter clogged
A	Screen (50-mesh)	None	68
B	Screen (50-mesh)	Chlorine & acid intermtt.	68
C	Sand + screen (50-mesh)	None	23
D	Sand + screen (50-mesh)	Chlorine & acid intermtt.	18
E	Sand + screen (50-mesh)	Chlorine & acid continu.	14
F	Sand + screen (50-mesh)	Chlorine & acid continu.	8

The results are summarized as below:

(1) Screen filtration (Treatments A & B) alone was inadequate to prevent the clogging.

(2) A combination of sand and screen filtration (Treatment C) reduced the clogging rate to 23%.

(3) Chemical treatment of water (Treatments D, E & F) reduced clogging even further.

(4) Emitter performance was the best with continuous acid treatment (Treatment F) where clogging rate was reduced to only 8%.

REFERENCES

Anonymous. 1984. ICID Bull. Micro-irrigation: worldwide usage. 33(1): 4-9.

Gilbert, R.G., F.S. Nakayama and D. A. Bucks. 1979. Trickle irrigation: prevention of clogging. Trans. ASAE. 22: 514-519.

Gilbert, R.G., F.S. Nakayama, D.A. Bucks, O.F. French and K.C. Anderson. 1981. Trickle irrigation: emitter clogging and other flow problems. Agri. Water Management, (3): 159-178.

Hanif, M., R.H. Qureshi, and G. R. Sandhu. 1976. Comparative efficiency of trickle and furrow irrigation. The Nucleus. 13 (1&2): 31-36.