

CHAPTER 11: Microsprinklers

INTRODUCTION

Microsprinklers are low capacity water emitters, sprinkler in type, but smaller in size than the conventional sprinklers and with flow rates up to 250 litres/h. They are placed on a relatively close rectangular or triangular spacing for the maximum overlap to irrigate potatoes, carrots, leafy vegetables, groundnuts and other densely planted field crops. This method is reliable, highly efficient, and easy to apply, operate and handle.

The system is a seasonal, low pressure, micro-irrigation solid installation which can be easily placed in the field and quickly removed (collected) at the end of the season.

SYSTEM LAYOUT AND COMPONENTS

The layout of the system consists of a head control equipped only with the regulating valves (shut-off, non-return, air) and a filter of about 40–60 mesh (200–300 microns). No injectors are needed as fertigation through this system is not a common practice among farmers.

The arrangement of the main and submain lines, hydrants and manifolds is the same as in other micro-irrigation piping networks.

The size of the manifold feeder lines should be 50–63 mm and in no case exceed 75 mm. Pipelines of 50–63 mm are recommended for flows of approximately 12–18 m³/h when the water is distributed en route continuously.

The pipes used for the system's distribution network are mainly in rigid PVC (buried) or black HDPE (normally laid on the surface). Other kind of pipes are used also, such as layflat hoses and quick coupling galvanized light steel pipes.

The laterals are soft PE pipes, 20, 25 or 32 mm in diameter, according to the length, PN 4.0 bars, laid permanently on the surface. The microsprinklers are placed along the laterals at a spacing of 5–7 m, fixed 70–80 cm above the surface on iron rods inserted into the ground. They are connected to the laterals through a small flexible PVC tube 7–9 mm in diameter and 1 m long.

MICROSPRINKLER EMITTERS

These emitters are low capacity rotary sprinklers designed for low discharges uniformly distributed over the irrigated area in a rainfall pattern (Figure 11.1). Made of durable plastic, they have various operating mechanisms, and are usually compact without external moving parts. They have one low trajectory (jet angle above nozzle), quick rotating, 1.5–2.0 mm nozzle. The main performance characteristics are:

- operating pressure: 2.0 bars;
- flow rate (discharge): 130–250 litres/h (recommended 160–180 litres/h);
- wetting diameter (coverage): 12 m average;
- precipitation rate: 4–7 mm/h (recommended);
- filtration requirements: 40–60 mesh (300–250 microns) approximately.

A complete set consists of: a) the sprinkler emitter compact head; b) a 6 mm iron rod 1 m long; and c) a 7–9 mm flexible PVC tube with a barbed plunger for connection with the PE lateral line.

FIGURE 11.1 - Microsprinkler emitters in potatoes.



IRRIGATION SCHEDULING PROGRAMME

This system enables a high degree of control of both when to apply and how much irrigation water to apply. The restrictions imposed by the system are limited. Thus, there are more timing options in the irrigation scheduling programme. The vegetables are mostly shallow rooted crops, so the selected option is generally that of fixed depletion irrigation.

A gross application depth of 20–30 mm is common for potatoes and vegetables. The gross water requirements of a vegetable or a potato plantation vary from 300 to 400 mm in terms of depth. Thus, the total number of irrigations required is about 12–15, at intervals based on the cumulative evaporation.

DESIGN CRITERIA AND CONSIDERATIONS

In addition to the standard design criteria, such as area, crop, water supply, soil and climate, it is important to examine the system's special features and characteristics as these parameters influence the final decision.

Microsprinklers deliver the water in low application rates and in fine drops. Such drops easily drift in the air, even under low to moderate wind conditions. In order to ensure a high uniformity of application, the sprinkler spacing should be decreased and not exceed 50 percent of the diameter coverage, i.e. the sprinkler spacing along the laterals and between the laterals should range from 5 to 7 m. Hence, common spacings are 5 x 5 m, 5 x 6 m, 5 x 7 m and 6 x 7 m. Furthermore, to mitigate the adverse effects of the wind, a relatively large number of sprinklers per unit area should be operated simultaneously. The operation shifts should be arranged so that the area irrigated at the same time is as compact as possible.

The system laterals are made of LDPE. Experience has shown that the optimum size of these pipes for this system is 32 mm as such pipes are easy to handle on site, to place, to remove, etc. Larger diameters are not recommended.

The maximum permissible length of various size laterals on level ground depending on the number of the sprinklers, the spacing and the flow rate is as follows (Table 11.1):

TABLE 11.1 - Maximum permissible length of laterals

Lateral size and spacing		160 litres/h		180 litres/h	
		No. of sprinklers	Lateral length m	No. of sprinklers	Lateral length m
20 mm	5 m	8	40	7	35
20 mm	6 m	7	42	6	36
20 mm	7 m	7	49	6	42
20 mm	8 m	7	56	6	48
25 mm	5 m	12	60	11	55
25 mm	6 m	11	66	10	60
25 mm	7 m	10	70	10	70
25 mm	8 m	10	80	9	72
32 mm	5 m	21	105	18	90
32 mm	6 m	20	120	17	102
32 mm	7 m	18	126	16	102
32 mm	8 m	18	144	15	120

All pipes LDPE 4.0 bars to DIN 8072 (inside diameter 16.0, 20.2 and 27.2 mm respectively).

COST

The cost for a complete installation of this system is approximately US\$3 300/ha. The head control unit accounts for 8–10 percent of the total cost of the system; the plastic pipes (tubes), exactly 50 percent; and the low capacity sprinklers, nearly 35 percent.

ADVANTAGES

- Low labour O&M requirements.
- Flexibility and adaptability: the technology is simple and easy to adopt and manage. The safe transition from traditional surface methods to advanced micro-irrigation can be successfully accomplished through the installation of this kind of system.
- High irrigation application efficiency.

DISADVANTAGES

- High initial purchase cost.

EXAMPLE DESIGN – Microsprinklers with potatoes

Area and crop

The plot dimensions are 120 × 85 m (1.0 ha) planted with spring potatoes (Figure 11.2).

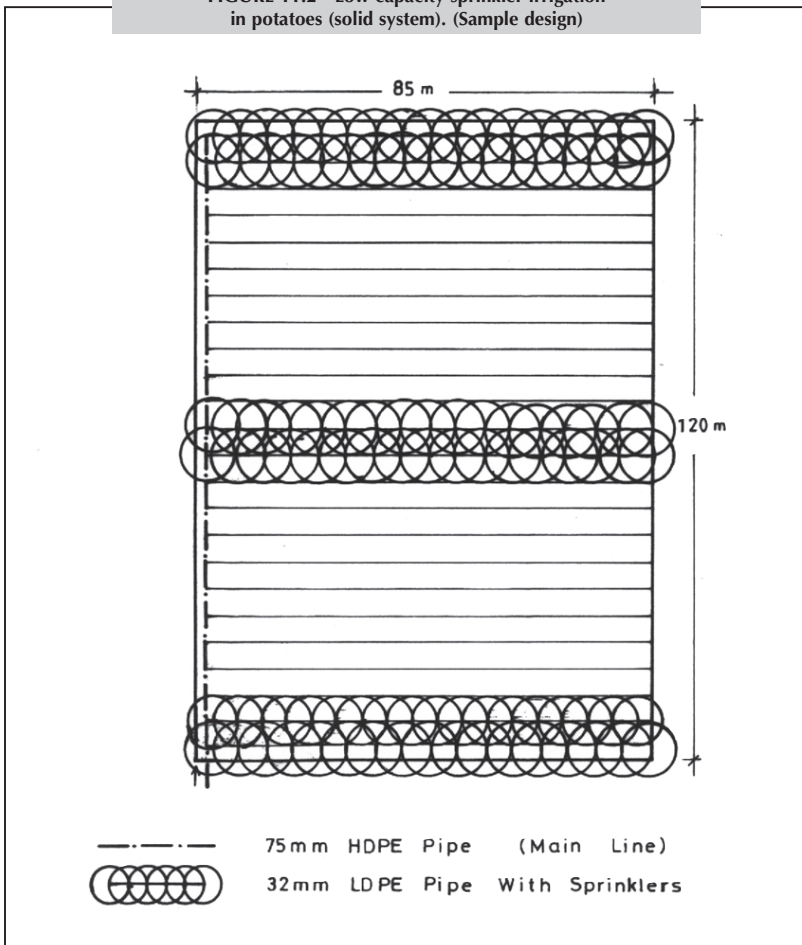
Soil, water and climate

Fine texture soil of good structure with a permeability of approximately 11 mm/h, and a high water holding capacity (200 mm/m). The water is supplied from a properly treated reservoir; it is clean, but slightly saline. The spring potato season is from January to May. In April the average pan readings are 3.3 mm/d; multiplied by the pan correction factor (0.66), this gives $E_{To} = 2.18$ mm/d.

Crop water requirements and irrigation schedule

Peak demand is in April and the k_c value is 0.9. Then, $ET_c = 2.18 \times 0.9 = 1.96$ mm/d (net water requirements at peak). The system's application efficiency is 75 percent. In addition, an extra amount of about 15 percent should be applied for leaching salts. The peak gross irrigation requirements are:

FIGURE 11.2 - Low capacity sprinkler irrigation in potatoes (solid system). (Sample design)



$$1.96 \text{ mm/d} \times 100 \div 75 = 2.61 \text{ mm/d} \times 100 \div 85 = 3.1 \text{ mm/d} \times 10 \times 1.0 \text{ ha} = 31 \text{ m}^3/\text{day}$$

The soil available moisture is 200 mm/m depth, the effective root depth is 0.35 m, and the maximum recommended moisture depletion is 40 percent. The maximum irrigation interval in April is:

$$200 \times 0.35 \times 0.4 \div 1.96 = 14 \text{ days}$$

The irrigation scheduling programme is arranged at a fixed depletion of about 20 mm (cumulative evaporation). Thus, the interval in April is: $20 \div 1.96 = 10$ days. The gross irrigation application is 31.4 mm, which gives a gross amount of 314 m³/ha per irrigation.

System layout

The system is a solid installation with all the sprinkler laterals permanently laid on the field. The head control unit is equipped with regulating valves and a screen filter of 60 mesh. There is only the main line, 75 mm HDPE, 6.0 bars, laid along the side of the field serving also as a manifold, feeding the laterals. The sprinkler laterals are 32 mm LDPE, 4.0 bars, connected with the mains through 2 1/2 inches hydrants.

Sprinklers

160 litres/h at 2.0 bars, full circle, wetting diameter (coverage) 11 m. Spacing: 5 m along the lateral x 5 m between the laterals. Precipitation rate: 6.4 mm/h. Number of sprinklers per lateral: 17.

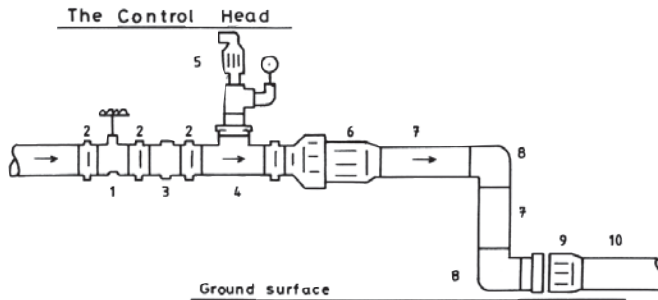
Lateral line discharge

2 720 litres/h. Total number of laterals: 24. Number of laterals operating simultaneously (per shift): 6. System discharge: 16.3 m³/h. Number of shifts per irrigation: 4. Duration of application per shift: 4.9 h (4 h 50 min). Time required for one irrigation: 19.5 h (all shifts) (Tables 11.2 and 11.3 and Figure 11.3).

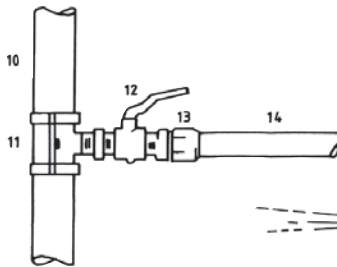
TABLE 11.2 - System's operating pressure

	bars
Pressure required at the sprinkler head	2.00
Friction losses in the lateral	0.20
Friction losses in the main line	0.35
Friction losses in the head control	0.50
Minor local losses	0.20
Total dynamic head	3.05

FIGURE 11.3 - Low capacity (micro) sprinkler system.



The Hydrant



1. 2 1/2" Gate valve
2. " Nipple
3. " Check valve
4. Tee threaded
5. 1" Air valve
6. Disk filter
7. 2 1/2" Threaded Pipe
8. " Bend

The L.C micro sprinkler

9. 2 1/2" x 75mm PP Adaptor
10. 75mm HDPE Pipe
11. 75mm x 1" PP Clamp saddle
12. 1" Ball valve
13. 1" x 32mm PP Adaptor
14. 32mm LDPE Pipe

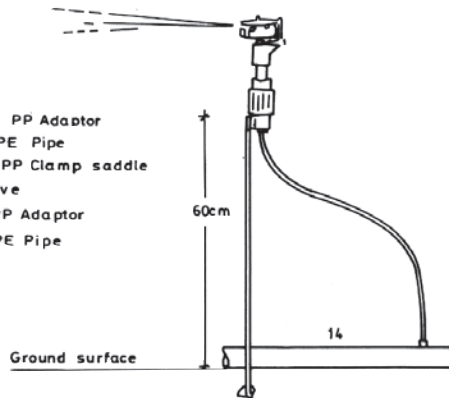


TABLE 11.3 - List of equipment needed for the installation

Item	Description	Quantity	Unit price US\$	Total price US\$
	System distribution network			
1.	75 mm black HDPE, 6.0 bars	120 m	2.60	312.00
2.	32 mm black LDPE, 4.0 bars	2040 m	0.65	1326.00
3.	75 mm x 2 ½ in PP adaptor	1 pc	9.00	9.00
4.	32 mm x 1 in PP adaptor	24 pcs	1.25	30.00
5.	75 mm PP end plug	1 pc	9.00	9.00
6.	32 mm PP end plug	24 pcs	1.25	30.00
7.	75 mm x 1 in PP clamp saddle	24 pcs	1.80	43.20
8.	1 in brass shut-off valve	24 pcs	3.50	84.00
9.	1 in nipple	24 pcs	0.40	9.60
10.	Low capacity sprinklers, full circle, 160 litres/h at 2.0 bars, 11 m wetted diameter, complete with supporting stake and connector tube	408 pcs	2.80	1142.40
	Sub-total			2995.20
	Head control			
11.	2 ½ in brass check valve	1 pc	15.00	15.00
12.	2 ½ in brass shut-off valve	2 pcs	13.00	26.00
13.	2 ½ in tee (galvanized iron or PVC)	3 pcs	3.50	10.50
14.	2 ½ in nipple	4 pcs	1.00	4.00
15.	1 in air valve (single automatic)	1 pc	12.00	12.00
16.	2 ½ in filter screen type 60 mesh	1 pc	180.00	180.00
	Sub-total			247.00
	TOTAL COST			3242.20