SPRINKLER IRRIGATION

Introduction

In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. With careful selection of nozzle sizes, operating pressure and sprinkler spacing the amount of irrigation water required to refill the crop root zone can be applied nearly uniform at the rate to suit the infiltration rate of soil.

Advantages of sprinkler irrigation

- Elimination of the channels for conveyance, therefore no conveyance loss
- Suitable to all types of soil except heavy clay
- Suitable for irrigating crops where the plant population per unit area is very high. It is most suitable for oil seeds and other cereal and vegetable crops
- Water saving
- Closer control of water application convenient for giving light and frequent irrigation and higher water application efficiency
- Increase in yield
- Mobility of system
- May also be used for undulating area
- Saves land as no bunds etc. are required
- Influences greater conducive micro-climate
- Areas located at a higher elevation than the source can be irrigated
- Possibility of using soluble fertilizers and chemicals
- Less problem of clogging of sprinkler nozzles due to sediment laden water

Crop response to sprinkler

The trials conducted in different parts of the country revealed water saving due to sprinkler system varies from 16 to 70 % over the traditional method with yield increase from 3 to 57 % in different crops and agro climatic conditions. (Table .1)

Response of different crops to sprinkler irrigation

Crops	Water Saving, %	Yield increase, %
Bajra	56	19
Barley	56	16
Bhindi	28	23
Cabbage	40	3
Cauliflower	35	12
Chillies	33	24
Cotton	36	50
Cowpea	19	3
Fenugreek	29	35
Garlic	28	6
Gram	69	57
Groundnut	20	40
Jowar	55	34
Lucerne	16	27
Maize	41	36
Onion	33	23
Potato	46	4
Sunflower	33	20
Wheat	35	24

Source : INCID (1998) adapted from Table 6.5

General classification of different types of sprinkler systems

Sprinkler systems are classified into the following two major types on the basis of the arrangement for spraying irrigation water.

1. Rotating head or revolving sprinkler system.
2. Perforated pipe system.

1) Rotating head:

Small size nozzles are placed on riser pipes fixed at uniform intervals along the length of the lateral pipe and the lateral pipes are usually laid on the ground surface. They may also be mounted on posts above the crop height and rotated through 90^0, to irrigate a rectangular strip. In rotating type sprinklers, the most common device to rotate the sprinkler heads is with a small hammer activated by the thrust of water striking against a vane connected to it.

Fig .1 Example of a few rotating type sprinkler irrigation systems

2) Perforated pipe system:

This method consists of drilled holes or nozzles along their length through which water is sprayed under pressure. This system is usually designed for relatively low pressure (1 kg/cm^2). The application rate ranges from 1.25 to 5 cm per hour for various pressure and spacing.

Based on the portability, sprinkler systems are classified into the following types:

(i) **Portable system :** A portable system has portable main lines, laterals and pumping plant

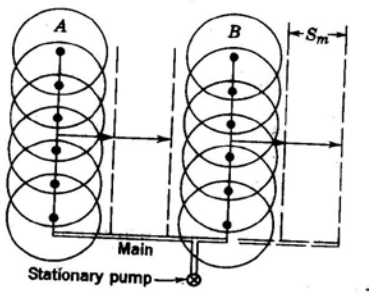

Fig .2 Fully portable sprinkler irrigation system

(ii) **Semi portable system:** A semi portable system is similar to a portable system except that the location of water source and pumping plant is fixed.

(iii) **Semi permanent system:** A semi permanent system has portable lateral lines, permanent main lines and sub mains and a stationery water source and pumping plant.

(iv) **Solid set system:** A solid set system has enough laterals to eliminate their movement. The laterals are positions in the field early in the crop season and remain for the season.

(v) **Permanent system:** A fully permanent system consists of permanently laid mains, sub mains and laterals and a stationery water source and pumping plant.

Components of sprinkler irrigation system

The components of portable sprinkler system are shown through fig .3. A sprinkler system usually consists of the following components

(i) A pump unit

(ii) Tubings- main/submains and laterals

(iii) Couplers

(iv) Sprinker head

(v) Other accessories such as valves, bends, plugs and risers.

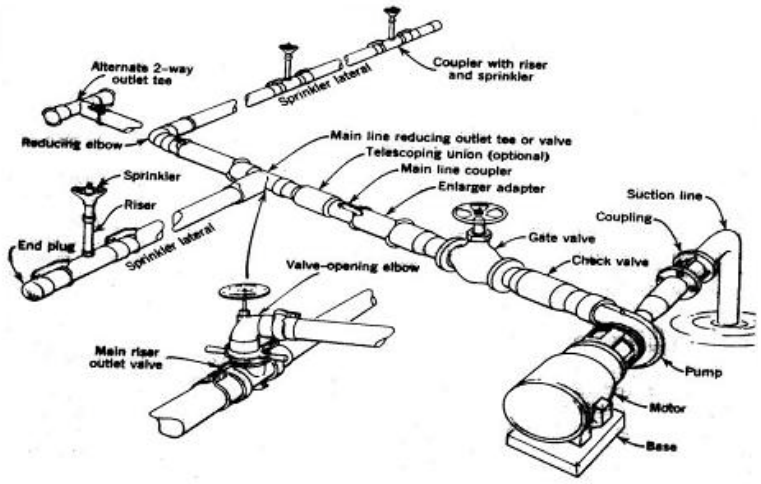

Fig .3 Component of a portable sprinkler irrigation system

(i) **Pumping Unit**: Sprinkler irrigation systems distribute water by spraying it over the fields. The water is pumped under pressure to the fields. The pressure forces the water through sprinklers or through perforations or nozzles in pipelines and then forms a spray. A high speed centrifugal or turbine pump can be used for operating sprinkler irrigation for individual fields. Centrifugal pump is used when the distance from the pump inlet to the water surface is less than eight meters. For pumping water from deep wells or more than eight meters, a turbine pump is suggested. The driving unit may be either an electric motor or an internal combustion engine.

(ii) **Tubings**: Mains/submains and laterals: The tubings consist of mainline, submanins and laterals. Main line conveys water from the source and distributes it to the submains. The submains convey water to the laterals which in turn supply water to the sprinklers. Aluminum or PVC pipes are generally used for portable systems, while steel pipes are usually used for center-pivot laterals. Asbestos, cement, PVC and wrapped steel are usually used for buried laterals and main lines.

(iii) **Couplers**: Couplers are used for connecting two pipes and uncoupling quickly and easily. Essentially a coupler should provide

(a) a reuse and flexible connection
(b) not leak at the joint
(c) be simple and easy to couple and uncouple
(d) be light, non-corrosive, durable.

(iv) **Sprinkler Head**: Sprinkler head distribute water uniformly over the field without runoff or excessive loss due to deep percolation. Different types of sprinklers are available. They are either rotating or fixed type. The rotating type can be adapted for a wide range of application rates and spacing. They are effective with pressure of about 10 to 70 m head at the sprinkler. Pressures ranging from 16 to 40 m head are considered the most practical for most farmers.

Fig.4 Sprinkler head

Fixed head sprinklers are commonly used to irrigate small lawns and gardens. Perforated lateral lines are sometimes used as sprinklers. They require less pressure than rotating sprinklers. They release more water per unit area than rotating sprinklers. Hence fixed head sprinklers are adaptable for soils with high intake rate.

(v) **Fittings and accessories**: The following are some of the important fittings and accessories used in sprinkler system.

(a) Water meters: It is used to measure the volume of water delivered. This is necessary to operate the system to give the required quantity of water.

(b) Flange, couplings and nipple used for proper connection to the pump, suction and delivery.

(c) Pressure gauge: It is necessary to know whether the sprinkler system is working with desired pressure to ensure application uniformity.

(d) Bend, tees, reducers, elbows, hydrants, butterfly valve and plugs.

(e) Fertilizer applicator: Soluble chemical fertilizers can be injected into the sprinkler system and applied to the crop. The equipment for fertiliser application is relatively cheap and simple and can be fabricated locally. The fertilizer applicator consists of a sealed fertilizer tank with necessary tubings and connections. A venturi injector can be arranged in the main line, which creates the differential pressure suction and allows the fertilizer solution to flow in the main water line.

QRC HDPE sprinkler with metal latches

QRC HDPE sprinkler with plastic latches

QRC HDPE sprinkler base

QRC HDPE pump connector

QRC HDPE bend

QRC HDPE tee

QRC HDPE end plug

Fig 2.5 Different sprinkler pipes and fittings

General rules for sprinkler system design

- Main should be laid up and down hill
- Lateral should be laid across the slope or nearly on the contour
- For multiple lateral operation, lateral pipe sizes should not be more than two diameter
- Water supply source should be nearest to the center of the area
- Layout should facilitate and minimize lateral movement during the season
- Booster pump should be considered where small portion of field would require high pressure at the pump
- Layout should be modified to apply different rates and amounts of water where soils are greatly different in the design area.

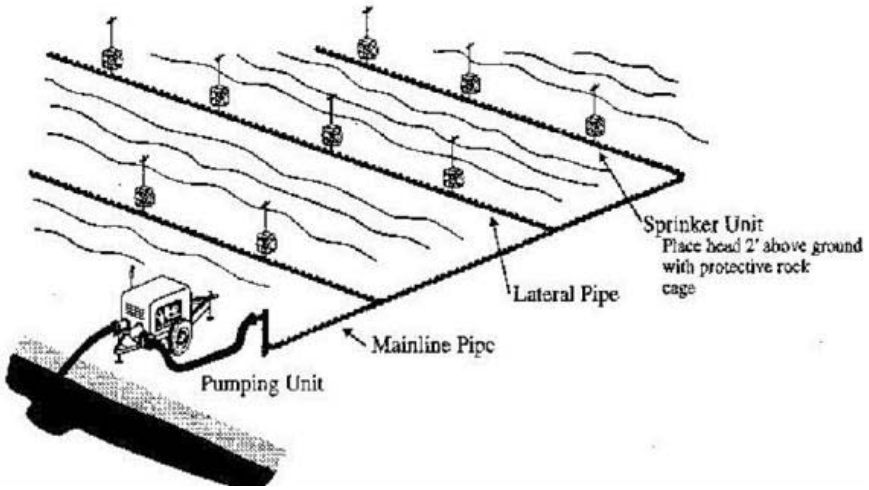

Fig.6 Layout of sprinkler irrigation system

Selecting the most appropriate sprinkler systems

While selecting a sprinkler system, the most important physical parameters to be considered are:

1. The crop or crops to be cultivated.
2. The shape and size (acres) of the field.
3. The topography of the field.
4. The amount of time and labor required to operate the system.

Selecting sprinkler system capacity

A sprinkler system must be designed to apply water uniformly without runoff or erosion. The application rate of the sprinkler system must be matched to the infiltration rate of the most restrictive soil in the field. If the application rate exceeds the soil intake rate, the water will runoff the field or relocate within the field resulting in over and under watered areas.

The sprinkler system capacity is the flow rate needed to adequately irrigate an area and is expressed in liters per minute per acre. The system capacity depends upon on the: Peak crop water requirements during the growing season; effective crop rooting depth; texture and infiltration rate of the soil; the available water holding capacity of the soil; pumping capacity of the well or wells (if wells are the water source).

Constraints in application of sprinkler irrigation

(i) Uneven water distribution due to high winds
(ii) Evaporation loss when operating under high temperatures
(iii) Highly impermeable soils are not suitable
(iv) Initial cost is high
(v) Proper design
(vi) Lack of Package of practices
(vii) Lack of awareness
(viii) Lack of social concern to save natural resources
(ix) High water pressure required in sprinkler (>2.5kg/cm^2)
(x) Difficulty in irrigation during wind in sprinkler

Operation and Maintenance of Sprinkler Systems

Proper design of a sprinkler system does not in itself ensure success. It should be ensured that the prime mover and the pump are in alignment, particularly in the case of tractor-driven pumps. For these the drive shaft as well as the pump shaft should lie at nearly the same height to prevent too great an angle on the universal shaft.

While laying the main and lateral pipes, always begin laying at the pump. This necessarily gives the correct connection of all quick coupling pipes. While joining couplings, it is ensured that both the couplings and the rubber seal rings are clean.

In starting the sprinkler system, the motor or engine is started with the valves closed. The pump must attain the pressure stated on type-plate or otherwise there is a fault in the suction line. After the pump reaches the regulation pressure, the delivery valve is opened slowly. Similarly, the delivery valve is closed after stopping the power unit.

The pipes and sprinkler-lines are shifted as required after stopping. Dismantling of the installation takes place in the reverse order to the assembly described above.

Maintenance

General principles regarding the maintenance of the pipes and fittings and sprinkler heads are given below:

1. Pipes and fittings

The pipes and fittings require virtually no maintenance but attention must be given to the following procedures:

(a) Occasionally clean any dirt or sand out of the groove in the coupler in which the rubber sealing ring fits. Any accumulation of dirt or sand will affect the performance of the rubber sealing ring.

(b) Keep all nuts and bolts tight.

(c) Do not lay pipes on new damp concrete or on piles of fertilizer. Do not lay fertilizer sacks on the pipe.

2. Sprinkler heads

The sprinkler heads should be given the following attention:

(a) When moving the sprinkler lines, make sure that the sprinklers are not damaged or pushed into the soil.

(b) Do not apply oil, grease or any lubricant to the sprinklers. They are water lubricated and using oil, grease or any other lubricant may stop them from working.

(c) Sprinklers usually have a sealed bearing and at the bottom of the bearing there are washers. Usually it is the washers that wear and not the more expensive metal parts.

Check the washers for wear once a season or every six months which is especially important where water is sandy. Replace the washers if worn.

(d) After several season's operation the swing arm spring may need tightening. This is done by pulling out the spring end at the top and rebending it. This will increase the spring tension.

In general, check all equipment at the end of the season and make any repairs and adjustments and order the spare parts immediately so that the equipment is in perfect condition to start in the next season.

Storage

The following points are to be observed while storing the sprinkler equipment during the off season:

(a) Remove the sprinklers and store in a cool, dry place.

(b) Remove the rubber sealing rings from the couplers and fittings and store them in a cool, dark place.

(c) The pipes can be stored outdoors in which case they should be placed in racks with one end higher than the other. Do not store pipes along with fertilizer.

(d) Disconnect the suction and delivery pipe-work from the pump and pour in a small quantity of medium grade oil. Rotate the pump for a few minutes. Blank the suction and delivery branches. This will prevent the pump from rusting. Grease the shaft.

(e) Protect the electric motor from the ingress of dust, dampness and rodents.

Trouble Shooting

The following are the general guidelines to identify and remove the common troubles in the sprinkler systems:

1. Pump does not prime or develop pressure

(a) Check that the suction lift is within the limits. If not, get the pump closer to the water.

(b) Check the suction pipeline and all connections for air leaks. All connections and flanges should be air tight.

(c) Check that the strainer on the foot valve is not blocked.

(d) Check that the flap in the foot valve is free to open fully.

(e) Check the pump gland (s) for air leaks. If air leaks are suspected tighten the gland (s) gently. If necessary repack the gland (s) using a thick grease to seal the gland satisfactorily.

(f) Check that the gate valve on the delivery pipe is fully closed during priming and opens fully when the pump is running.

2. Sprinklers do not turn

(a) Check pressure.

(b) Check that the nozzle is not blocked. Preferably unscrew the nozzle or use a small soft piece of wood to clear the blockage. Do not use a piece of wire or metal as this may damage the nozzle.

(c) Check the condition of washers at the bottom of the bearing and replace them if worn or damaged.

(d) Check that the swing arm moves freely and that the spoon which. moves into the water stream is not bent by comparing it with a sprinkler which is operating correctly.

(e) Adjust the swing arm spring tension~ Usually it should not be necessary to pull up the spring by more than about 6 mm.

3. Leakage from coupler or fittings

The sealing rings in the couplers and fittings are usually designed to drain the water from the pipes when the pressure is turned off. This ensures that the pipes are automatically emptied and ready to be moved. With full pressure in the system the couplers and fittings will be effectively leak-free. If, however, there is a leakage, check the following:

(a) There is no accumulation of dirt or sand in the groove in the coupler in which the sealing ring fits. Clean out any dirt or sand and refit the sealing ring.

(b) The end of the pipe going inside the coupler is smooth, clean and not distorted.

(c) In the case of fittings such as bends, tees and reducers ensure that the fitting has been properly connected into the coupler.

Unit Cost of Sprinkler Systems

Different components required for a sprinkler irrigation system to irrigate 1 ha to 4 ha area and their cost has been estimated and given in Table .3

Table .3 Unit Cost of Sprinkler Systems

Sprinkler System Components	**1.0 ha (50mm dia)**		**2.0 ha (63mmdia)**		**3.0 ha(75mm dia)**		**4.0 ha (75 mm dia)**	
	Quantity (No.)	**Amount (Rs.)**	**Quantity (No.)**	**Amount (Rs.)**	**Quantity (No.)**	**Amount (Rs.)**	**Quantity (No.)**	**Amount (Rs.)**
HDPE Pipes with quick action coupler (2.5 kg/cm^2) of 6m long	25	7770.00	30	10448.70	37	13378.09	45	16270.65
Sprinkler coupler with foot baton assembly	5	921.60	7	1411.20	11	2382.30	14	3032.00
Sprinkler nozzles (1.7 to 2.8 kg/cm^2)	5	1188.00	7	1662.20	11	2613.60	14	3326.40
Riser pipe 20mm diameter x 75cm long	5	264.00	7	369.60	11	580.80	14	739.20
Connecting nipple	1	115.20	1	129.00	1	167.00	1	167.00
Bend with coupler 90^0	1	108.00	1	126.00	1	168.00	1	168.00
Tee with coupler	1	138.00	1	152.40	1	180.00	1	180.00
End plug	2	96.00	2	108.00	2	132.00	2	132.00
Basic system cost per hectare (Rs.)		10600.80		14407.10		19601.79		24015.25