ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 10| October 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

SPRINKLER IRRIGATION SYSTEM MAINTENANCE FOR IMPROVED UNIFORMITY AND APPLICATION EFFICIENCY IN BARREN LAND

T. Thenmozhi[1], J.Joselin Zibia[2], C. Ajay[3], A.Akila[4], S. Ashwin Kumar[5], E. Krishnaraj[6], N.Janani[7], G.Monika[8]

[1,2,7,8] *Assistant Professor, Department of Agricultural Engineering, RVS Technical Campus, Coimbatore, Tamil Nadu, India -641 402*

[3,4,5,6] *Student, Department of Agricultural Engineering, RVS Technical Campus, Coimbatore, Tamil Nadu, India -641 402*

Correspondence: *Dr. D. Rajkumar, Professor, Department of Agricultural Engineering, RVS Technical Campus, Coimbatore, Tamil Nadu, India -641 402*

Article DOI: https://doi.org/10.36713/epra18685
DOI No: 10.36713/epra18685

ABSTRACT

An irrigation sprinkler is used to water agricultural crops, lawns, landscapes, golf courses, and other areas, also aiding in cooling and dust control. Sprinkler irrigation mimics rainfall and is promoted over surface methods, especially in regions like Coimbatore, where annual rainfall ranges from 550 to 900 mm. This paper examines the efficiency of sprinkler irrigation at RVS Technical Campus, aiming to optimize water use and reduce human intervention. The study focuses on an impact sprinkler system, monitoring soil moisture to determine water needs and using a rotating system to ensure accurate water scheduling and minimize runoff.

KEYWORDS: *Sprinkler irrigation, Soil Moisture, Water efficiency, Installation, Design.*

INTRODUCTION

An irrigation sprinkler, also called a water sprinkler, is a device used to water agricultural crops, lawns, landscapes, and other areas. It also helps with cooling and controlling airborne dust. Sprinkler irrigation distributes water in a controlled manner, similar to rainfall, through a network of pumps, valves, pipes, and sprinklers. It is suitable for residential, industrial, and agricultural use, especially on uneven land or sandy soil where water is scarce. Perpendicular pipes with rotating nozzles are attached to the main pipeline at regular intervals for efficient distribution (Padhye.A.H,1990).

COMPONENTS

Major Components of Sprinkler Irrigation System

1. Pumping station or Header Assembly
2. By-pass valve
3. Fertilizer Tank
4. Filtration system
5. Pressure Gauges
6. Control valves
7. HDPE/PVC Pipes
8. QRC Pump connector
9. Sprinkler Nozzles
10. Service Saddle

BASIC DESIGN PRINCIPLES

✓ Sprinkler Heads

Impact and gear-drive sprinklers, commonly used in lawns, gardens, and pastures, produce moving water streams and can be set for full or part-circle patterns. They cover large areas (around 12 m spacing) and are ideal for larger spaces. These systems can be configured as solid set, where sprinklers remain fixed and draw water from surface or buried lines, or set-move, where lateral lines are moved every 12 to 24 hours. Solid set systems are costlier to install but require less labor and can be automated, while set-move systems are cheaper but need more manual operation (Patel.I.S. et al, 1993).

✓ Centre Pivot

The self-propelled sprinkler system, which rotates around a pivot point, requires minimal labor compared to other systems. It consists of pipes connected to movable towers, with water application controlled by the rotation speed. Center pivots can be adjusted for various crop heights and work well on lighter soils. A computerized control system allows operators to program multiple irrigation features. Additionally, a corner attachment system, or "end-gun," can be installed to irrigate corner areas that traditional center pivots may miss.

✓ Linear Move

The linear move (also called lateral move) irrigation system is built the same way as a center pivot; that is moving towers and pipes interconnecting the towers. The main difference is that all the towers move at the same speed and in the same direction. Water is pumped into one of the ends or into the center. Due to the high capital investment, linear moves are used on high- value crops such as potatoes, vegetables and turf (McCauley. G. N, 1990)

METHODOLOGY

SITE PLANNING & PREPARATION

a. Works shall be carried out under the supervision of the Site Engineer, Safety Officer, and QA/QC Engineer.
b. Work to be carried out in line with approved Site layout drawing relevant to the area and the required trial pit related to the excavation must be inspected, verified by the consultant prior to trench excavation.
c. Traffic will be managed by the Site Engineer/ Site Supervisor and the Safety Officer for any re-routing as well as the monitoring of equipment movements on site, transporting foundations, and lifting area.
d. Working area will be protected with plastic jersey barriers, safety signage, and safety tapes. Existing Structures, Utilities, Sidewalks, Pavements should also be protected.
e. Any MEP or any other underground utilities required clearance shall be obtained prior to
f. starting the activity.
g. Ensure that enough tools, materials, and manpower are available before commencing the work.
h. All relevant documentation (approved shop drawings, checklists, method statement irrigation system, material sample for pipes, fittings, and solvent cement/adhesives, etc.,) and materials applicable for the section of work will be checked by the Site Engineer/Supervisor prior to commencement of work.
i. The Site Engineer/Supervisor will give necessary instructions to the tradesman and provide the necessary approved shop drawings.
j. Materials shall be delivered in their original, tightly sealed containers or unopened packages, all clearly labelled with manufacturers name, brand name, number, and batch member of the material where appropriate.
k. The material shall be delivered to the site in ample time to avoid delay in the job progress and at such times as to permit proper coordination of various parts (Westcott.M.P and Vines. K.W,1986),

CHECKS FOR INSTALLATION

- Find out if the design or sketch of the designated plot is ready.
- Also, see if the physical conditions of a site meet the dimensions mentioned in the plan.
- Check if all tools, material and fittings required for the installation are available.
- Find out if the trenching is ready as per design and pipe specifications(Suryawanshi.S.N. and Pampattiwar.P.S,1985)

TOOLS AND EQUIPMENT REQUIRED FOR INSTALLATION

The following tools and equipment are required for the installation of a microirrigation system.

- Pipe wrench (18″, 24″or 36″)
- Spanner set (preferably adjusting sly wrench)
- Drill machine with drill bits of different sizes
- Drill guide
- Screwdriver and pliers
- Hacksaw blade with frame and one spare blade
- Measuring tape and scale
- Straight or ejecto punch
- Hand punch
- S-hose pump
- Plier punch
- Take-off tool
- Solvent cement
- Teflon tape
- Jute
- GI threaded joint's synthetic compound
- Pencil or marker
- Pressure gauge with adopter and nozzle

INSTALLATION OF SPRINKLER IRRIGATION SYSTEM

The components of the sprinkler irrigation system are tested before being installed. The entire system is tested once the installation is complete. The installation work must be carried out as per the installation guidelines. Guidelines to maintain the system and few precautions starting from the installation will ensure trouble-free operation. (Muazu dantala.et al,2012).

Installation of head control unit

The installation of head control unit requires a cemented platform. The size of the platform depends on the various components to be installed, such as pump, bypass mechanism, non- return valve, hydro cyclone filter, fertigation unit, media filter, screen or disc filter and air release valve. A layer of paint on these fittings is used to avoid rusting. Pressure gauges are installed wherever needed to check pressure readings.

Installation of pipes

PVC pipes must be installed according to the specified size and class. Exercise caution on hot days, as temperature drops can loosen the pipes. Before joining, remove burrs and clean the surfaces with sandpaper and a cloth. Apply solvent cement evenly around the spigot end and push it into the socket to the marked depth. Store solvent cement in a cool, dry place away from fire and children. Use Teflon tape to prevent leakage at threaded ends, avoiding over-tightening with a pipe wrench. Immediately support or fill trenches after joining pipes and fittings, and backfill only after testing, ensuring materials are free of stones to prevent damage.

Installation of valves

Air valves on the mainline must always be installed at the highest point of the pipeline or at a point of change in the slope. Control valves must be installed minimum one feet above the ground level and need to be straight, both vertically and horizontally. Use Teflon tape to wrap the threaded parts of adopters for fitting it into the valves in order to avoid leakage. Avoid over tightening by pipe wrench.

Installation of main, sub-mains and laterals

Main line - Rigid Poly Vinyl Chloride (PVC) and High-Density Polyethylene (HDPE) pipes are used as main lines in irrigation systems to minimize corrosion and clogging, with recommended diameters of 63 mm and above, rated for 4–10 kg/cm². The main line serves as the primary artery of a sprinkler irrigation system, conveying water to the sub-mains at the required pressure. Typically buried about 30 cm below the soil surface, it supplies water efficiently to the sub-mains.

Sub-mains - Light PVC, HDPE, or Linear Low-Density Polyethylene (LLDPE) pipes are used as sub-mains, typically with an outer diameter of 32–75 mm and a pressure rating of 2.5-4.0 kg/cm². The sizes of main and sub-mains are based on crop water requirements and field size, with both featuring flush valves for sediment removal and flow control (ball) valves at the start of each sub-main. Flush valves should be installed horizontally with an elbow to prevent spillage, while sub-mains connect to the main line using fittings like tees and elbows, secured with solvent cement.

Laterals - Laterals are tubes located between the shut-off valve and sprinkler heads. The laterals are, usually, made of LDPE, Linear Low-Density Polyethylene (LLDPE) or HDPE pipes of 10 to 20 mm in diameter and with a wall thickness of 1–3 mm with a pressure rating of 2.5 kg/ cm2. Lateral pipes are, usually, flexible, non-corrodible, resistive to radiation and to the effects of temperature fluctuation. They are easy to install. Laterals are, usually, black in colour. The laterals supply water to a field through sprinklers. To install laterals, the following need to be done.

(i) To connect the laterals (poly-tubes) to the submains, holes are drilled on the PVC sub-main pipes using a drilling machine. The holes are drilled at a distance equal to the row spacing of the crop. The size of the holes depends on the size of the laterals and the grommet take off (GTO).

(ii) Grommets are fixed in the holes and take-offs are fixed on the grommets. The laterals are then connected to the take-offs.

Sprinkler riser and head

Sprinkler risers connect the sprinkler heads to the lateral pipes or tubes. Sprinkler heads distribute water uniformly over the field without run-off or excessive. The characteristics that need to be considered for sprinkler selection are jet trajectory, operating pressure and sprinkler body design. The sprinkler operating conditions to be considered in sprinkler selection are soil infiltration characteristics, desired irrigation depth, desired or appropriate irrigation cycle, crop characteristics, wind conditions and plant spacing.

The uniformity of water distribution from sprinklers depends on the pressure of water, wind velocity, rotation of sprinklers, spacing and nozzle diameter. The spacing of sprinklers in a lateral, and lateral spacing are adjusted considering all these parameters.

RESULT AND DISCUSSION

EFFICIENCY OF SPRINKLER IRRIGATION

Efficient irrigation systems are cost-effective, yet many are inefficient, leading to water wastage, increased energy use, and reduced profits. A well-designed sprinkler system applies water uniformly without exceeding soil infiltration capacity, considering factors such as pressure, nozzle size, weather conditions, and crop water use. Leakage losses should be minimized for optimal efficiency; in this evaluation, a Distribution Uniformity (CU) of 86% and a Deep Percolation Rate (DPR) of 87% were deemed satisfactory. Performance assessment involves measuring water depth in cans placed between sprinklers to ensure uniform distribution. Results show that reduced uniformity leads to decreased water productivity, particularly at higher adequacy levels, highlighting that the uniformity coefficient alone is insufficient for evaluation. Thus, irrigation strategies must consider both irrigation adequacy and uniformity to prevent discrepancies in crop growth and yield across the field, making lower adequacy levels more justified in systems with lower uniformity.

FORMULA FOR IRRIGATION EFFICIENCY

The scheme irrigation efficiency (e in %) is that part of the water pumped or diverted through the scheme inlet which is used effectively by the plants. The scheme irrigation efficiency can be sub-divided into:the conveyance efficiency (ec) which represents the efficiency of water transport in canals, and the field application efficiency (ea) which represents the efficiency of water application in the field.

The conveyance efficiency (ec) mainly depends on the length of the canals, the soil type or permeability of the canal banks and the condition of the canals. the scheme irrigation efficiency (e) can be calculated, using the following formula: with

$$e = \frac{ec \times ea}{100}$$

e = scheme irrigation efficiency (%)
ec = conveyance efficiency (%)
ea = field application efficiency (%)

A scheme irrigation efficiency of 50-60% is good; 40% is reasonable, while a scheme Irrigation efficiency of 20-30% is poor.

It should be kept in mind that the values mentioned above are only indicative values. Unit cost of sprinkler irrigation setup shown in table 1.

CONCLUSION

Expert knowledge is crucial for effective irrigation management, including the maintenance of motors, water supply pipes, and mechanical components to avoid damage and costly repairs. Sprinklers work best in sandy soils with high infiltration rates and should have an application rate lower than the soil's basic infiltration rate to prevent surface ponding and runoff. They are unsuitable for soils prone to crusting or salinization and can easily clog due to sediment. Sprinkler irrigation mimics rainfall, distributing water efficiently over various crops and soil

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 10| October 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

types. However, these systems can incur high capital costs and may require careful management to prevent clogs.
Advancements in mathematical and numerical modeling have led to better design and management tools for sprinkler systems, with several applications awaiting adoption by farmers. Effective irrigation relies on governing equipment using accessible meteorological, water resource, and crop data online. The development of collective irrigation schedulers will enhance simulation models and decision-making routines, increasing the importance of applied mathematics in irrigation management.

Figure 1: Components of sprinkler irrigation system

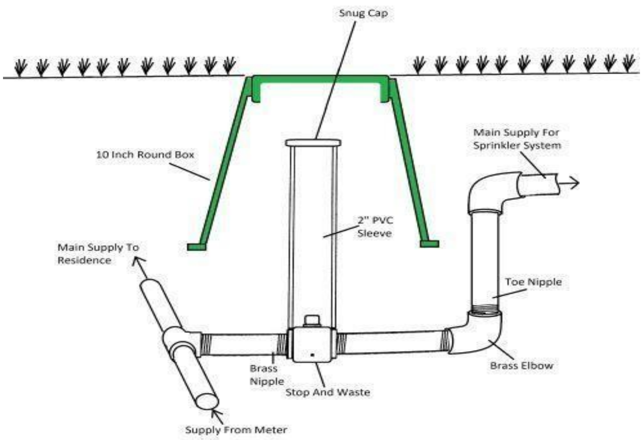

Figure 2: Final setup of sprinkler irrigation

Table 1: Unit cost of sprinkler irrigation setup

Key: HDPE=High Density Poly Ethylene, PVC= Poly Vinyl Chloride

S. No.	Components	Nos.	Price (INR)
1	Sprinkler heads (brass)	6	3600
2	Sprinkler riser	6	600
3	HDPE sprinkler elbow	1	100
4	HDPE Male and Female Reducer - Increaser	6	800
5	HDPE Sprinkler Tee	1	200
6	PVC Sprinkler pipe adapter with lock system	6	4100
7	HDPE sprinkler pipes	15	10,500
8	HDPE black sprinkler end caps	2	100
TOTAL			**20000**

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 10| October 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

REFERENCES

1. *Padhye.A.H,(1990), "Micro and sprinkler irrigation in India," Proc. Int., Congress on the use of plastics in agriculture, New Delhi.*
2. *Patel.I.S. et al, (1993), "Studies on sprinkler vs surface method of irrigation in summer groundnut" Cv. GG-2 in CBIP. pp. 150-152.*
3. *McCauley.G. N, (1990), "Sprinkler vs. flood irrigation in traditional rice production regions of southeast Texas, "Agronomy Journal. 82 (4): 677- 683.*
4. *Westcott.M.P and Vines. K.W,(1986), "A comparison of sprinkler and flood irrigation for rice," Agronomy Journal 78 (4): 637-640.*
5. *Muazu dantala.et al,(2012), "Design, Construction and Installation of Sprinkler Irrigation System." Bayero University, Kano Nigeria.*
6. *Abrol. I.P and Sharma.R.R,(1990), "Efficient water management is crucial for achieving self-sufficiency in food," Indian farming. 40(7): 25-27.*
7. *Capra.A. and Scicolone.B, (1998), "Water quality and distribution uniformity in drip/trickle irrigation systems," Journal of Agricultural Engineering and Research. 70: 355-365.*
8. *Dhawan.B. D, (2002), "Technological change in Indian Irrigated Agriculture: A study of water saving methods," Common wealth Publishers, New Delhi.*
9. *Krishna and Ramanjaneyulu, (2012), "Impact of Land Configuration, Life Saving Irrigation and Intercropping on Yield and Economics of Major Rainfed Crops in Southern Telangana Zone of Andhra Pradesh, India," International Journal of Bio-resource and Stress Management. 3(3): 317-323.*
10. *NABARD, (1997), "An ex-post evaluation of sprinkler irrigation schemes in Barmer District of Rajasthan," Evaluation study series, Jaipur No. 7, National bank for Agriculture and Rural Development Regional office, Jaipur, April.*
11. *Perry.C, Steduto.P, Allen.R.G, Burt.C.M,(2009), "Increasing productivity in irrigated agriculture: Agronomic constraints and hydrological realities," Agricultural Water Management. Vol.96, No.11, (November2009), pp. 1517-1524, ISSN 0378-3774.*
12. *Rajput.T.B.S and Neelam Patel,(2012), "Potential of micro irrigation for enhancing the water productivity infield crops in India," An overview. Indian Journal of Agronomy 57 (3rd IAC Special Issue): 186-194.*