REVIEW PAPER ON OPERATION OF WATER SPRINKLER IRRIGATION SYSTEM

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ABSTRACT:
A lack of information on the effectiveness of irrigation systems, including water sprinklers, has been noted as a being limiting factor in the operation of water sprinklers. This paper reviews the information currently available on sprinkler effectiveness in both irrigation and agricultural operations. An approach is generally taken for estimating sprinkler effectiveness. In this paper, sprinkle system components data and its operation estimates from system-based studies have been compiled and tabulated, with the comparison of the merits.

KEY WORDS:
Sprinklers, Effectiveness, Operation, Agriculture, Irrigation.

1. INTRODUCTION:

Sprinkler systems have revolutionized the development of irrigated agriculture. Efficient water application with sprinkler irrigation involves the design operation of pumps, pipes and sprinkler devices to match soil, crop and resource conditions. Thus sprinkler systems can be operated for efficient irrigation for a wide array of conditions. Sprinkler irrigation is an advanced method of irrigation to achieve considerable saving of water through high water use efficiency compared to surface irrigation methods. The rapid expansion of water sprinkler irrigation facilities in india since past years played a stellar role in increasing food production to meet the needs of growing millions of country's population. Research in water sprinkler irrigation conducted so far in india and abroad has shown this method leads not only to appreciate saving of water but also results in achieving higher crop yields.

2. EVOLUTION OF SPRINKLER SYSTEM:

The first ever sprinkler irrigation systems introduced on a large scale were the systems with hand moved laterals and impact type, rotating sprinklers. Later on, with the growing need to save labour and water, solid set, also called permanent system, carriage drive system with hose reel arrangement, giant sprinklers or gun sprinklers mounted on carriages were developed to facilitate rapid coverage of large areas, and in particular, those needing light supplemental irrigation. Mobile machines requiring minimum labour were developed in the sixties and seventies and at the same time, automation at va1ious levels was introduced into sprinkler irrigation system. The soil moisture, pH of the soil water , and nutrient status in the root zone of the plants can be monitored and the control system can be made to be responsive to the conditions in the root . Further, several fields can be irrigated by connecting the field units to a central master unit which is controlled by a computer. The sprinkler irrigation systems

introduced at early stages were with hand moved laterals and rotating sprinklers. Later on with the growing need to save labour and water, solid set systems came into use. Further, carriage drive system with hostel arrangement, giant sprinklers or gun sprinklers mounted on carriages, were developed to facilitate rapid coverage of large areas, mobile machines requiring minimum labour, were developed in the sixties and seventies, and at the same time, automation of various levels was introduced into sprinkler system in developed countries. Automation in its simplest form is achieved by using automatic metering valves, which are set to convey a desired volume of water and then shut off automatically. At a more advanced level, the valves could be operated in a pre-determined sequence. Even more sophisticated is the use of field control units to open and shut off the valves electronically according to a pre-set parameter such as soil moisture, soil temperature, etc.

FIG .1

3. SPRINKLER IRRIGATION:

Though, the sprinkler irrigation technology was developed more than 75 years ago, elsewhere in the world, the use of sprinkler systems in India was initiated only in the mid fifties for plantation crops like tea and coffee. Due to the increasing demands for water and the need to bring more and more area under irrigation, the Government and farmers are interested in introducing sprinkler irrigation system on a large scale to other crops also.

4. RESEARCH ON SPRINKLER IRRIGATION:

The research work on the use of sprinkler irrigation is mainly confined to the area of design of layout, operational uniformity, saving in water and the water use efficiency for different crops. In India, the adoption of sprinkler systems is limited to portable type system, being operated in medium pressure range. The related research work/ studies have been taken up by various agricultural universities, ICAR research institutes, manufacturers, on experimental farms, and on farmers fields. A list of these institutions is provided . A number of research schemes have been sponsored by the Ministry of Water Resources and the Ministry of Agriculture at different institutions as adhoc research schemes. As mentioned earlier, the adoption of sprinkler systems in India started with tea and coffee plantations in mid fifties and later on extended to various other crops in mid seventies. Some of these plantation companies have their own research units. Their experiences also contributed to research knowledge base.

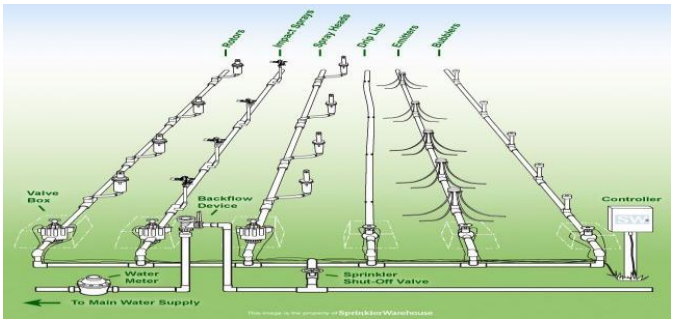

FIG .2

5. EVOLUTION OF SPRINKLER IRRIGATION SYSTEM:

General Classification Sprinkler systems are classified into the following two major types on the basis of the arrangement for spraying irrigation water. a) Rotating head or revolving system. b) Perforated pipe system. a) Rotating head System This can further be divided into three categories namely; i) Conventional system/small rotary sprinklers, ii) Boom type and self propelled sprinkler system, and iii) Mobile rain gun/large rotary sprinkler b) Perforated Pipe System . This method consists of drilled holes or nozzles along the length of the lateral pipe through which water is sprayed under pressures

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5.1. WIND EFFECT:

The wind effect on the water trajectory from a single sprinkler nozzle is very high. Normal range of wind velocity is 2Kmph to 15Kmph. Increase in the wind velocity or spacing of sprinkler nozzles results in decrease of the uniformity coefficient, Cu, which is a measurable index of the degree of uniformity obtainable for any size sprinkler operating under given conditions. A view of the field experimental set up for determination of uniformity coefficients using catch cans spread over the area. With the increase in the wind velocity, the trajectory is not only stretched parallel to wind but also squeezed perpendicular to wind direction. Under high wind velocity conditions it is beneficial to keep larger length parallel and shorter side perpendicular to wind direction in a 6 x 12m spacing of sprinklers. Further, for higher wind velocities (> 25kmph) the grid size shall be the smallest possible. Under normal wind conditions, a 6m x 6m grid is recommended. The uniformity coefficient of a 39 sprinkler system was reported to decrease from 83.35% to 65.02% with the increase in the wind velocity from 2.3 to 14 km/hr. At the same time, the depth of application at the central region was reported to increase with increase in wind velocity. It was observed that lesser the spacing of sprinklers, the better the uniformity coefficient for all cases.

5.2. PRESSURE EFFECT:

The effect of pressure on water trajectory is more pronounced than that of nozzle size. High pressure and larger nozzles gave high depth of application, as compared to lower pressure and smaller nozzle sizes throughout the length of the trajectory. A high pressure of 4.2 kg/ cm2 gave better distribution under calm or low wind conditions but the distortion was more with high wind velocities. On the other hand, a low pressure of 2.1 kg/ cm2 was reported to give better uniformity than a pressure 4. 2 kg/cm2 at high wind velocities upto 8-16 km/hr.

5.3. SAVING IN IRRIGATION WATER:

Adoption of sprinkler irrigation system has shown a positive result towards the saving in irrigation water. The saving in irrigation water is mainly due to the fact that a properly designed sprinkler system, when operated at recommended pressure gives I better water application efficiency as compared to traditional gravity irrigation methods. Further, the system enables a user to apply the desired depth of irrigation water. The research carried out using sprinkler irrigation systems, under various agro climatic conditions in India for different crops, indicates that the saving in irrigation water ranges from 10 to 55 percent. . The variation in saving of water is mainly due to variations in soil, climate and crops. For instance, saving of irrigation water in the case of wheat crop ranged between 42-56%, for groundnut crop the range is between 11-33%. For low water requiring crops like Bajra and Jowar the saving of irrigation water is as high as 55%. · The detailed results for various crops are given. The water use efficiency in most cases improved by 100-200% as compared to conventional gravity irrigation methods.

6. SELECTION OF SPRINKLER NOZZLE:

The sprinkler nozzle which gives application rate equal to or less than the infiltration rate of the soil is normally selected. The specifications of the sprinkler nozzle shall include model of sprinkler nozzle, nozzle size, diameter of throw, application rate and discharge of the nozzle.

FIG .3

6.1. SPACING OF SPRINKLER NOZZLES:

The spacing of sprinkler nozzles will depend upon nozzle size diameter of throw, and wind conditions. The values of maximum sprinkler nozzle spacing as a fraction of diameter of throw.

7. ADVANTAGES OF SPRINKLER SYSTEM

A satisfactory irrigation system needs to provide the correct amount of water needed to maintain an adequate and constant soil moisture regime in the root zone of the crop This shall be at a reasonable cost, with minimum ·use of water, land, power and labour. Sprinkler irrigation meets all these requirements. The relative advantage of 21 sprinklers over surface methods will vary from place to place and time to time. Some of the advantages of sprinkler method include: (a) Water conservation, (b) Soil conservation and effective use of land, (c) healthy growth of crops with higher yields, and (d) Labour benefits .

8. AUXILIARY USES OF SPRINKLER SYSTEMS:

Sprinkler irrigation systems can perform several auxiliary uses in addition to supplying crop water requirements. Permanently installed systems can be operated quickly to meet these additional demands. If the system must be positioned in the field and periodically moved the ability to perform auxiliary uses is diminished. The application of effluent and agricultural chemicals are two common uses. Since the

sprinkler system is designed for high uniformity and operates during the rapid growth period of crops, sprinkler systems provide excellent capabilities for these applications. However, these applications are regulated in most states to ensure protections of soil and water resources. In addition, special hydraulic designs are required to guard against the backflow of chemicals into the water source. Details of the use of sprinkler systems for chemigation are discussed .Due to the high heat of fusion for ice, sprinkler systems can be used for frost and freeze protection in some applications. Generally water must be applied frequently to the crops during periods of frost or freeze danger. This may require a higher flow rate for the field than needed for crop water requirements.

The requirement also eliminates those systems that cannot irrigate the entire field in a very short time. Very careful management is required to ensure that the objectives are accomplished for frost or freeze protection. Successful practices vary considerably depending on the water source, wind speeds, and other local conditions. Local guidelines should be followed for success. Care must also be taken to avoid damage to the irrigation system when applying water during cold periods. Ice may form on structural members of the irrigation system and the added weight may cause components to fail. In some locations wind erosion, before plants are large enough to shield the soil surface, is a major concern. Irrigation during such periods may increase the cohesion between soil particles, which increases aggregate stability and reduces erosion. Care must be taken, however, because the impact from water droplets can dislodge soil particles and contribute to increased wind erosion when the soil dries. Irrigation with small applications is usually adequate to stabilize the soil surface for a period of time. The efficiency of water use for erosion control is low. The small application does not wet the soil to a very large depth which leads to evaporation of water from the soil surface with little storage of water in the soil profile. In many ways irrigating to control wind erosion is a last-ditch effort, as it is better controlled through residue management and other production practices.

9. CONCLUSION:

This Paper has summarized available water sprinkler system components date and effectiveness estimates for sprinkler systems from usage of water resources in irrigation. With the discussion of the relative merits of each approach and the uncertainty involved. Due to majority of sprinkler failure being related to human error, component based study data should not be on comparison. Adjusting sprinkler system effectiveness due to system modification such as additional water supplies observed modern irrigation methods. Due to increase in demand for more water and to bring more areas under irrigation, everyone are interested and eager to introduce sprinklers on a large scale.

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