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Cost Less Individual Portable Drip Irrigation System (Gravity System)

[1]Patil Ashish P, [2]Geete Mandar H.
[1]Agricultural Engineering Expert, IWMP, KVK, Sindhudurg, Maharashtra, India
[2]Programme Coordinator, KVK, Sindhudurg, Maharashtra, India

ABSTRACT - *Climatic variation is the major factor which affects on the Indian agriculture economy. Increase in irrigation potential may be increasingly more difficult and expensive day by day in Indian continent. It is a need of India to develop of an irrigation system which gives the right amount of water at the right time for the crops at minimum cost. Individual Portable Drip Irrigation System (Gravity System) satisfies the need of an advance irrigation technology from local easily available materials at very minimum cost. Individual Portable Drip Irrigation System (Gravity System) specially designed for single, individual plant, for horticultural crops like fruit crops, flower crops, vegetative crops etc. It requires only a manpower which is abundant in Indian continent.*
KEYWORDS - *Pressurized irrigation methods, Surface irrigation methods, Intravenous bottle pipes, Flow rates, Water requirements*

I. INTRODUCTION

Climatic variation is the major factor which affects on the Indian agriculture economy. Rainfall patterns are different across Indian geographical regions. It is not just the deficiency of rainfall , but also uneven distribution of rainfall across the season, duration of rainfall deficiency and its impact on different regions of the country that characterize agricultural and horticultural growth. In India, around 68% of the country is prone to drought in varying degrees. Of the entire area, 35% of the area, which receives rainfall between 750 mm and 1,125 mm, is considered drought-prone, while another 33%, which receives less than 750 mm of rainfall, is called chronically drought-prone. A further classification of India's regions into arid 19.6%, semi-arid 37%, and sub-humid areas 21% has been presented in the section dealing with geographical spread of drought. The variability of precipitation spatially and in quantity can be inferred by the fact that rainfall has been recorded as low as 100 mm in west Rajasthan and 9000 mm in North Eastern India Meghalaya. India receives 4000 cubic kilometer of precipitation in the country out of this only 50% is put to benefit due to topographical and other constraints. The fact that water is crucial to agriculture in a country that has 68% of its net cultivated area as rainfed can hardly be exaggerated. Of this total cultivated area of 142 mha., 97mha. is rainfed. The full irrigation potential of the country has been revised to 139.5 mha. out of which 58.5 mha. is watered by major and minor irrigation schemes, 15 mha. by minor irrigation schemes and 40 mha. by groundwater exploitation. India's irrigation potential increased from 22.6 mha. (1951) to 90 mha. (1995-96) but water usage efficiency is to too little i.e. only 30-40%. That is why more than 50% of the total cultivated area is still rainfed. The state of soil and water that mainly determines land and its utility in agriculture is of prime importance to maintain sustainable development.

Agricultural sector is the largest consumer of water. Increase in irrigation potential may be increasingly more difficult and expensive. Rising demand for water for rapid urbanization, large-scale industrialization and environmental demands also necessitate that the available water is efficiently utilized. The manner in which irrigation water is applied to land is called method of irrigation. Irrigation water may be applied to crops by flooding it on the field surface, by applying it beneath the ground surface, by spraying it under pressure or by applying it drops. The quantity and quality of water available, the topography of the land, the crop to be irrigated, the cost of the water application system and the availability of labour determine the method of irrigation which is most desirable. It is essential that the system is designed to apply the right amount of water at the right time and apply it uniformly to raise the level of soil moisture in the crop root zone to its field capacity. Water application method may be broadly classified into two groups: surface irrigation methods and pressurized irrigation methods. In pressurized irrigation systems water is conveyed through pipes under pressure and applied to the crops by sprinkling it over the land surface or plant canopy or applied on the soil surface as point source, usually in the form of drops. i.e. sprinkler and drip irrigation. Surface irrigation is also called gravity irrigation, comprises of the methods of water application in which water is distributed by means of open surface flow.

II. INDIVIDUAL PORTABLE DRIP IRRIGATION SYSTEM (GRAVITY SYSTEM)

India is characterized by undulating topography, fragmented holdings, rainfed farming, shallow and eroded soils, low and stagnant crop productivity and low income from ancestral farming. To enhance income of the farmers of the area, an attempt to introduce improved method of irrigation which is combination of surface irrigation method and pressurized irrigation method called Individual Portable Drip Irrigation System (Gravity System). Individual portable drip irrigation system is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone. It is done through narrow tubes that deliver water directly to the base of the plant through independent water cans. This system designed for the small farmers. Majority of the small farmers are without an independent water-source and their land-holding is less than 1 acre. Such tiny holdings are also fragmented & located in more than one place, independent water-source and electricity is also not available to these farmers. Therefore it will address all these constraints and will empower the small farmers with a scientific, durable and simple to operate irrigation system. Individual Portable Drip Irrigation System specially designed for horticultural crops like fruit crops, flower crops, vegetative crops etc. because system designed for single, individual plant and installation of this system for agronomical crops does not practicable because it requires large manpower and installation of individual system requires more space.

III. COMPONENTS OF INDIVIDUAL PORTABLE DRIP IRRIGATION SYSTEM (GRAVITY SYSTEM)

(a). Waste oil can having capacity 5 Lit/ 10 Lit depending on water requirements to a particular crop plant each day.
(b). Waste IV (Intravenous) bottle pipes (Tubes) equipped with roller clamp (flow regulator clamp), tubing spike and dripping chamber. (Intravenous is a medical word derived from Intravenous therapy which means the infusion of liquid substances directly into a vein. The word intravenous simply means "within a vein". It is commonly referred to as a drip because many systems of administration employ a drip chamber, which prevents air from entering the blood stream and allows an estimation of flow rate.)
(c). Wooden plank made up of Bamboo species.
(d). Nail
(e). Rope

Figure 1: Components of Individual Portable Drip Irrigation System (Gravity System)

The system consists of a waste oil can, a length of flexible tubing, roller clamp, dripping chamber and tubing spike. Empty waste oil can thoroughly washed with water and make a hole at the bottom of the can with the help of nail. Waste oil can fixed at a height of approximately 5 feet from the ground surface aside of the wooden plank by inserting hardware flat head nail in a wooden plank and tightening the same by rope. After making a hole at the bottom of the can insert tubing spike inside the hole. An adjustable roller clamp compresses the tubing at one point, and allowing manual control over the system. The rate at which drops form is assessed visually, and the roller clamp is adjusted manually as needed. The flow rate through this system depends on several factors, like the height of the waste oil can, resistance of fluid inside the tubing etc. After filling the water, lead of the water can must be loosed or make a hole to the lead of the can to maintain atmospheric pressure inside the water can.

IV. CALCULATIONS

1. Flow Rate:
Flow is usually considered to be laminar when a fluid flows through a tube and the rate of flow is low.

F = ΔP/R
Where *F* is the flow
ΔP is pressure the difference
R is the resistance
When water flows through a tube, friction along the walls limits the velocity. For a constant head of water in the can, the average velocity decreases with increasing tube length. For laminar flow of liquids through long cylindrical pipes, the Hagen-Poiseuille Equation gives the pressure drop as the liquid flows down the pipe as

$\Delta P = \frac{8\mu}{Q\pi r^4} \times L$………. (1)
Where, ΔP is the pressure difference
μ is the dynamic viscosity of the liquid
r is the radius of the tube
L is the length of the tube
Q is the volumetric flow
Since the tube is cylindrical, the volumetric flow rate in terms of velocity *v* is

$Q = \pi r^2 v$ ………. (2)
Combining equations (1) and (2) the relationship between velocity and length of tubing is

$$v^{-1} = \frac{8\mu}{\Delta P r^2} \times L$$

2. Water Requirements of Horticultural Crops:
Different crop species or horticultural, plantation crops have variable degree of soil moisture stress tolerance limit hence water requirement of different crops will vary under similar soil and climate conditions. The rainfed horticultural crops have different degree of drought tolerance or drought resistance. Water requirements of crops are decided either by direct or indirect methods.

2.1 Direct Method:
Water requirements of crops (WR) are decided either by direct or indirect methods. The direct method is classified as lysimetric technique or soil moisture or soil water balance method. The lysimetric technique is precise for shallow root system, close spaced, short duration vegetable crops.

WR = P + IR + ΔSW - (r + PW)
P = Precipitation, cm
IR = NIR, cm
ΔSW = Soil water contribution, mm
r = Surface runoff, mm
PW = deep percolation, mm

The soil moisture monitoring to a desired depth either by nucleic technique or neutron probe are necessary in case of widely spaced, long duration horticultural crops. Water requirement of mostly rainfed horticultural crops such as mango, sapota, pomegranate, citrus are difficult to predict due to their deep root system and ground water contribution. Water requirement is also determined by the field experimentation method.

CU = ER + IR + ASW
CU = Seasonal consumptive use, cm
ER = effective rainfall, cm
IR = net irrigation water, cm
ASW = soil water contribution, cm

There are other methods of estimating water requirement like soil water depletion method and inflow - out flow method but precision in soil moisture monitoring is very important in estimating the requirement.

2.2 Indirect Method:

Evapotranspiration rates of various crops are estimated by pan evaporation multiplied by a pan factor (Kp) and crop coefficient factor (Kc). The crop coefficient values increase with age of the crop approaching grand growth period nearly stabilizes at the grand growth reaching its maximum at flowering and then declines with senescence. Net irrigation requirement of horticultural crops by using daily pan evaporation data is estimated and used for micro-irrigation purpose.

The equations for estimations of ETc and ETca are as follows:

Eo = Ep x Kp

Where

Eo = Potential Evapotranspiration, mm/day

Ep = USWB class A pan evaporation mm/day

Kp = Pan Factor

Evapotranspiration (ETc) is again estimated using the crop coefficient constants (Kc)

ETc = Eo x Kc

V. THE CASE STUDY

Area selected for this experiment under Krishi Vigyan Kendra, Sindhudurg, (Sindhudurg Zilla Krishi Pratishthan, Kirlos Trust) At Post Kirlos, Tal. Malvan, Dist. Sindhudurg, State: Maharashtra, India. Out of the total land 1000 m^2 (50 x 20) m^2 area and Mango species (Mangifera indica); Devgad Hapus (Alphonso) species was selected for the case study because; Alphonso mango is the main driver of the local economy of the entire district. Total numbers of 15 species were planted at 10 x 10 m .spacing. Total 15 Nos. Waste oil cans purchased from local market @ 5 Rs. each can. 15 Nos. IV bottle pipes purchased from private clinic @ Rs. 2 each pipe. 15 Nos. Wooden planks of bamboo having height approximately 5 feet purchased from bamboo local seller @ Rs. 5 each. 15 Nos. 5” flat head hardware nails purchased from local market @ Rs. 5 each. (approximately 65 Rs. /Kg). 1 kg of jute rope purchased from local seller @ Rs 70/Kg. During the installation of the individual portable drip irrigation system as like in the figure 2. Water outlet pipes must be placed at the root zone of the each plant. Root zone of the each plant covered with sufficient mulching material to avoid evaporation losses. There are many factors which governed water requirement of mango as well as dripping rate of water. After considering all these factors, the young mango plants required 10 liters of water per day per plant for this field for first 2 to 3 years and dripping rate maintained at 1 Lit/ Hr.for individual plants. After first 5 hours of dripping water cans were again filled up with water for next 5 hours of dripping.

Figure 2: Cost less Individual Portable Drip Irrigation System (Gravity System)

VI. RESULT

(a). Waste oil cans @ Rs 5 each (15 x 5) = Rs. 75

(b). IV bottle pipes @ Rs.2 each (15 x 2) = Rs. 30

(c). Wooden planks of bamboo @ Rs. 5 each (15 x 5) = Rs.75

(d). 5” flat head hardware nails @ Rs 5 each (15 x 5) = Rs. 75

(e). 1 kg of jute rope @ Rs.70 / Kg. = Rs. 70

Cost of installation of the system for 1000 m^2 area = Rs.325

Cost of installation of the system for 1 Ha. Area= Rs 3250

Cost of system for each plant = Rs. 21.67

VII. CONCLUSION

Different Water application methods having its own advantages and disadvantages. Today's farmers economical situation in different parts of India are horrible due to, without an independent water and electricity source, tiny land holdings, fragmented land, high cost of installation of drip or sprinkler irrigation system and adequate knowledge of agricultural technology. Therefore Individual Portable Drip Irrigation System (Gravity System) opens the door of the farmers to boon the agriculture technology from the available resources in minimum cost. It reduces the fertilizer and nutrient loss of the soil. This system does not require any land leveling, it can be accommodate in any field condition. It reduces soil erosion as well as weed growth. This system maintain water supply to each individual plant according to water requirement. It reduces risk of diseases because of foliage remains dry. System does not require electricity; it requires only manpower which is abundant in Indian continent. System easily applicable in rainfed areas where there is prolonged gap between rains.

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