PERFORMANCE EVALUATION OF RAINHOSE IRRIGATION SYSTEM

BY

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KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679 573, MALAPPURAM KERALA, INDIA

2022

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PROJECT REPORT

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KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679 573, MALAPPURAM KERALA, INDIA

2022

DECLARATION

We hereby declare that this project entitled **"PERFORMANCE EVALUATION OF RAINHOSE IRRIGATION SYSTEM"** is a bonafide record of project work done by us during the course of study and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of another university or society.

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CERTIFICATE

Certified that the project entitled **"PERFORMANCE EVALUATION OF RAINHOSE IRRIGATION SYSTEM"** is a record of project work done jointly by **Ms. ANU MOHAN S (2018-02-008), Ms. HASHIFA P (2018-02-023), Mr. MUHAMMED MISBAH (2018-02-028), Ms. NAJA RAHMAN (2018-02-029)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to them.

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DEDICATED TO OUR PROFESSION

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Symbols and Abbreviations

´	Minute
´´	Seconds
º	Degree
/	Per
ºC	degree Celsius
%	Percentage
AICRP	All India Co-ordinated Reasearch Project
Am	Ante-Meridiem
BIS	Bureau of Indian Standard
CoV	Coefficient of Variation
CU	Coefficient of Uniformity
dB	Decibel
DI	Deficit Irrigation
DPR	Delivery Performance Ratio
DU	Distribution Uniformity
EC	Electrical Conductivity
EDTA	Ethylenediaminetetraacetic acid
ET	Evapotranspiration
et al.	and others
FI	Full Irrigation
Fig	Figure
GDP	Gross Domestic Product
GIS	Geographical Information System
Hp	Horse power
ICAR	Indian Council of Agricultural Research
IDE	Irrigation and Drainage Engineering

i.e.,	That is
KAU	Kerala Agricultural University
KCAET	Kelappaji College of Agricultural Engineering and Technology
Kg/cm^2	Kilogram per centimeter square
Kg/ha	Kilogram per hectare
Kg/m^3	Kilogram per meter cube
KPa	Kilo Pascal
KTIS	Kakara Tea Irrigation System
KVK	Krishi Vigyan Kendra
l/h	Litre per hour
l/m	Litre per minute
l/s	Litre per second
LNRBDA	Lower Niger River Basin Development Authority
LST	Land Surface Temperature
M	Meter
Mm	Millimeter
mm/h	Millimeter per hour
N	North
NCPAH	National Committee on Plasticulture Applications in Horticulture
PFDC	Precision Farming Development Centers
Pm	Post-meridiem
PMKSY	Pradhan Mantri Krishi Sinchai Yogana
Psi	Pound per square inch
PVC	Poly Vinyl Chloride
R^2	Regression Coefficient
S	South
SAR	Synthetic Aperture Radar
SMC	Soil Moisture Content

SMI	Soil Moisture Index
UV	Ultra violet
Vs	Versus
Wp	Water productivity

INTRODUCTION

CHAPTER I

INTRODUCTION

India requires a productive, competitive, diversified and sustainable agricultural sector to meet the needs of increasing population. Agriculture is India's largest user of water. However, increasing competition for water between industry, domestic and agriculture sectors has highlighted the need to plan and manage water. Uncertainty in rainfall distribution results in low performance of crop and thereby yield. Water availability for irrigation is reduced day by day due to various human activities and climate change.

Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation is the backbone of agriculture as water is the most important component required in the cultivation of crops. India is an agrarian country where more than 80% of its rural population depends upon agriculture and allied activities, thereby contributing about 14-15% to the GDP (Gross Domestic Product). The main sources of irrigation are wells, tube wells, rivers, ponds, lakes, dams and canals. In India, irrigation water is applied through traditional surface methods of irrigation like flooding, border strip method and check-basin method. But these methods require large amount of land levelling, which increases the cost of irrigation considerably and large volume of water is lost through seepage and runoff. The overall efficiency of the surface irrigation system range between 10-30%.

Efficient management of water is the need of the hour. Proper utilization of water, facilitates sustainable agricultural development and thus ensures food security for the progressively increasing population. The ethical and scientific use of water contributes towards the economy of the state. Judicious use of water for irrigation by ensuring farmers participation helps to avoid water crisis. There is a greater need to increase water use efficiency. Almost all the soils of Kerala have high infiltration value and low water holding capacities, and hence surface irrigation methods are inefficient and results in wastage of large quantities of water. In most of the homestead farms in Kerala, irrigation is practiced using well water and quality of water is excellent. This situation highly favourable for micro irrigation. Two important aspects to be considered in this regard are uniform water distribution in the field and accurate amount of water application by permitting accurate delivery control.

Micro irrigation is the modern method of irrigation which helps to save water and increases the water use efficiency. Micro irrigation can increase yields and decrease water and fertilizers loss and also require zero labour. It can also help to bring the degraded, uncultivable land under cultivation. Micro irrigation shows superiority over the conventional methods in terms of water use efficiency, energy saving, yield increase and net return per unit volume of water and It is a sustainable water management tool. It consists of micro sprinklers irrigation, drip irrigation, spray irrigation, bubbler irrigation and subsurface drip irrigation.

Israel, a desert nation has become a water efficient nation because they adopted micro irrigation techniques, especially drip irrigation. It can save up to $3/4^{th}$ of water that is used for irrigation. The average percentage of micro irrigation in India is 19 % (as on February 3,2021), which is much lesser than many countries. Currently only Sikkim, Andhra Pradesh, Karnataka and Maharashtra have more than half of their net cultivable area under micro irrigation. In September 2020, Agriculture minister Mr. Narndra Singh Tomar said that the government has set the target of covering 100 lakh ha land during next five years under micro irrigation.

Research studies in the field of micro irrigation systems are carried out all over the country through ICAR institutes and State Agricultural Universities, AICRP on Water Management, DRIPNET project and Adhoc schemes. In year 2015, government has bundled all ongoing irrigation schemes into Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) in which micro irrigation is an integral component. The Ministry of Agriculture through NCPAH, which has 17 precision farming development centres (PFDC) located in different agro climatic conditions has also focused attention to develop regionally differentiated technologies in micro irrigation, besides imparting training to a large number of farmers and departmental staff. Micro irrigation is a suitable method in the areas having undulating terrain and where there is scarcity of water. Greater efficiency in irrigation can be achieved through proper design of irrigation system for reducing water conveyance loss. Adoptions of water saving technologies such as micro sprinklers and drip irrigation systems are extremely effective not only in water conservation but also leading to higher yields. Comparison of various irrigation methods suggests that drip irrigation achieves highest application efficiency of 90 per cent with overall efficiency ranging between 80-90 per cent. Understanding best irrigation practices and community-based intervention models can help the present policy makers to enhance governance structures and understand key indicators that can assist in data-driven decision-making.

Rain hose is an alternate spray irrigation technology, which can act as a replacement for the sprinkler irrigation system. It is easy to install and maintain, which has a flexible hose with a pattern of drip holes. This spray irrigation system consists of rain hose, layflat pipe and the necessary connectors. Lay flat pipe is a substitute for PVC pipes. It is economical, easy to maintain, long life, UV protected, has a long life and can be exposed to sunlight. Water use efficiency for raising crops in summer season will be higher through rain hose technology than sprinkler system. With this new technology, small amount of water can be applied more frequently and helps to maintain optimum irrigation, thereby resulting in maximum yields and good quality of produce. The initial investment is much lesser than drip and sprinkler irrigation. The easily portable rain hose will also cut down the labour cost and it is user friendly. It is suitable for the plants that require less water in short time.

Rain hose system is a new way of watering crops intensely under moderate pressure. The pipe is sequentially perforated at determined intervals to create tiny holes from which crops are irrigated. The rate of water discharge is certified by the diameter and it irrigates in the opposite directions. End caps are placed at the end of the pipe to retain water in the system. Starter off-takes or mini valves connect the rain hose pipe to the main water line, while pipe connectors link two rain hose pipes. The advantages are, easy to install, easy to maintain, less costly, easy plug clearing, quick irrigating, and low water pressure, and low energy consuming. It is useful for field irrigation of crops in dry farmlands. Rain hose systems proves to be a boon in places where the land remains undulating and hence surface irrigation is not possible. It is an efficient method for irrigation loamy soils and steep and undulating topography.

The present study is aimed at evaluating the performance of spray irrigation system.

Objectives

The specific objectives of this study are,

1. To study the relationship between applied pressure and discharge of the rain hose irrigation system.
2. To study the soil moisture distribution pattern under various operating pressures.
3. To study the uniformity of water distribution and its variation using in relation to the applied pressure.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Micro irrigation is an effective irrigation system, which applies water at a very slow rate, to the root system of this crop. This makes more water available to the growing plant. The adoption of micro irrigation improve the irrigation efficiency considerably over the surface irrigation and thereby reduce the wastage of water. Micro irrigation ensures the congruence of sustainability, productivity, profitability and equity.

In this chapter, available literature relevant to the present study were reviewed and presented under the following subheads

2.1 Irrigation

The design of the irrigation system, the degree of land preparation, and the skill and care of the irrigator are the principal factors influencing irrigation efficiency (Michael, 1978)

Alsafi (2013) Conducted a study on the use of GIS software in irrigation project management and this study was conducted at the north zone of hilla-kifil irrigation project which is located in Iraq. In this study they explained applications of GIS software namely GIS mapping, database integration, planning/management and modelling and the importance of these applications of GIS software in many purposes in irrigation project management. This study showed individually the benefits of using each application in irrigation project and the necessary data required for each application.

Girma and Jemal (2015) reported that the irrigation system (pressure drip irrigation) used in Israel is the most common irrigation methods used for safe, efficient and sustainable agricultural production in arid and semi-arid regions of the world. They also revealed that drip irrigation had the highest water efficiency rate in agriculture, reaching 70 to 80% rate, versus open irrigation, which achieves

40%. Recycled waste water, nutrient mix water and desalined water can be used through this irrigation system.

Shaddad *et al.* (2019) conducted a study to predict soil moisture content using optical remote sensing data and Synthetic Aperture Radar (SAR) Sentinel-1 data and the correlation with crop pattern. The study was carried out in the east of Nile Delta of Egypt (30° 31 to 30° 33 N, 31° 55 to 31° 05 E). A number of 100 surface soil samples (0–10) were collected to represent different soil types in the study area. Soil moisture index (SMI) is assessed based on thermal remote sensing data as Land Surface Temperature (LST) besides, Sentinel-1 data. The results showed that, a high correlation between SMC and SMI, coefficient of determination (R^2) reached 0.81 between actual soil moisture and SMI. Furthermore, a significant correlation was also shown by Sentinel-1 data, with R^2 0.83 between actual soil moisture content and backscattering coefficient (dB). The thermal data gave significant results to predict soil moisture content. The accurate discrimination of crop varieties was considered as effective factor in explaining the distribution of soil moisture where moisture is associated with the crop type.

Sayed *et al.* (2022) conducted a study by comparing the trailing perforated pipe and gated pipe effect on irrigation efficiency and maize production. They studied both systems under furrow lengths of 100 m on water (Advance – recession –opportunity), total water amounts, water distribution efficiency, crop production, water use efficiency for maize crop under Egyptian condition. From the results they concluded that, the trailing perforated pipe irrigation system is better than the gated pipe for improving irrigation efficiency and maize productivity.

2.1.1 Coefficient of uniformity

Kathiriya *et al.* (2021) conducted a field experiment to evaluate hydraulic performance of rain pipe irrigation system at three different operating pressures of 0.25,0.5 and 0.75 kg/cm² under solar photovoltaic pump. They took rain pipe of length 30 m and kept 4 m spacing between two rain pipes. During the experiment, the average maximum solar radiation received at 1:00 pm was 621.26 W/m². Also the average discharge and water horse power of solar photovoltaic system at operating pressure of 0.75 kg/cm² was ranged from 4.19 to 4.92 lps during 10:00 am to 4:00 pm. They concluded that the uniformity coefficient, distribution uniformity and mean application rate increases as the operating pressure increased and the coefficient of variation increased with decreasing operating pressure.

Shashikant *et al*. (2022) conducted a field experiment to study the effect of different levels of irrigation and fertigation on growth and yield of papaya. The average value of the hydraulic performance indicators namely emitter discharge, emission uniformity, distribution efficiency and application efficiency obtained were 1.87 lph, 95.19 percent, 98.07 percent and 93.58 percent, respectively at operating pressure of 1.2 kg/cm² for 2 lph inline dripper. The results showed increase in coefficient of uniformity (CU) and the distribution uniformity (DU) with increasing heads and decrease of them with increasing slope.

2.2 Sprinkler irrigation

In this method, water is carried through a network of pipes under medium to high pressure and is forced through a nozzle of small diameter and sprayed on the ground or crop like a rain. It tends to simulate the rainfall but in a way such that the run-off and deep percolation losses are avoided (Shiva *et al,* 2015)

2.2.1 Distribution pattern

Cook (1983), conducted a study on Ngatarawa Plains in Hawke's Bay to determine the water distribution over the soil surface and within the soil during sprinkler irrigation. He used a big gun travelling sprinkler irrigator on 50 m x 50 m area with 12 plastic containers arranged in a grid pattern. He irrigated the area 3 times, providing a total irrigation time of 180 minutes. The volume of water captured in the containers were measured and soil samples from wetted area was also taken. Also measured the volume of water applied in a single pass over the soil's surface by the 'footprint'. The results reflected the poor uniformity of the depth of water infiltrated into the soil and the application rate of water from the 'big gun' sprinkler irrigator was found to be greater than the infiltration rate. Highly variable wetting pattern in the soil was occur due to surface ponding of water and runoff into micro-topographical depressions.

The technique of catch-can testing is the suitable method for the performance evaluation of spray-type irrigation systems. ASAE (1991), ASAE (1997) and BIS (1987 a,b) describes the general procedure of catch-can testing and other standard methods of testing of sprinkler systems. The performance of micro-sprinkler systems has been assessed using catch-can methods by placing catch cans in full wetted area or part (one quarter) of the wetted circle (Boman, 1989; Pandey *et al*., 1995 b; Post *et al*., 1985).

Moghazy *et al*. (2007) conducted an individual sprinkler test in no wind conditions. Selected impact sprinkler was tested in radial tests within the pressure range of 100 to 350 kPa and the trajectory angles range of 60 to 300.Trajectory height and water distribution pattern was found under each selecting pressure for each deflector set. A high degree of uniformity was achieved for 21º of trajectory angle in deflector set 2.

2.2.2 Performance evaluation

Fratino *et al*. (2006) analysed the influence of the pressurised distribution irrigation system on the performance of the on-farm sprinkler network. The pressure values at the hydrants were calculated by means of a stochastic simulation model using a random procedure to generate a large number of different operating conditions. An iterative model was developed for generating the characteristic curve of the on-farm sprinkler irrigation network. The pressure variation at downstream of the hydrant was computed by intersecting the characteristic curve of the latter with the generated on-farm characteristic curve. A detailed performance analysis was carried out on an existing irrigation system. This study highlighted that the performance of the on-farm sprinkler network is greatly affected by the variation in the hydrant pressure head.

Isiguzo and ahaneku (2010) conducted a study to evaluate the performance of a new portable sprinkler system purchased by the lower Niger river basin development authority (LNRBDA), Ilorin, Nigeria. Catch can test were carried out to determine the performance of irrigation applied with the portable sprinkler irrigation systems under field conditions. The tests were carried out using ASABE (2009) standard procedures. The coefficient of uniformity (CU) was used to compute the uniformity of sprinkler water application on the field; while the delivery performance ratio (DPR) was used to quantify the efficiency of the management inputs of the sprinkler system. Results of the field evaluation indicated that the average CU and DPR of the system were 86% and 87%, respectively, indicating satisfactory performance of the sprinkler system. Emanating from the study were a set of performance guidelines and recommendations for the design and management of sprinkler irrigation systems necessary for the achievement of optimum performance.

Hashim *et al*. (2015) evaluated a hose reel system. In addition to its technical performance para-meters, the adoptability by small farmers, ease and simplicity in operation and maintenance etc. were also studied. Application and distribution uniformity were the main parameters, which was determined by adopting standard methods of evaluation. Thus, the major variable was the operating pressures under which the system was operated and results were compiled. Application efficiency and distribution uniformity of hose-reel sprinkler system were found to be varied from 71 to 76% and 66 to 74% with the respective base pressure range of 0.38–0.46 MPa, respectively. This sprinkling system has higher efficiency than the traditional flood irrigation methods by saving water more than 30%. It is easy to operate, portable, cost effective, and suitable for all soil types and small land holdings.

Rather and Baba (2017) studied the performance evaluation of sprinkler Irrigation Systemin Ganderbal District J&K State. Field experiments were carried out at Krishi Vigyan Kendra (KVK), Shuhama (Jammu and Kashmir). They noted previous year climatic conditions like wind speed and wind directions. The micro sprinkler arrangement was made of two types–point arrangement and linear arrangement. The volume of water collected in water containers, systematically leveled on the ground surface and placed 0.75 x 0.75 m apart. The volume of water was measured using measuring cylinder. The water flow pressure for the experiment was kept 1.5 Kg/cm^2 and 2.0 Kg/cm^2. The pressure was measured by a pressure gauge. The riser height was kept 0.75 m and 1 m respectively. In point arrangement of microscopy, the uniformity coefficient ranged from 82.83 to 88.7%, whereas in the case of linear sprinklers, it ranged from 86.10 to 91.76 percent. Experiments demonstrated that the change in riser height and operating time affected the uniformity coefficient. Wind velocity was also found to be lower in the morning than in the evening, according to the data. However, there was no change in wind velocity. Because the wind velocity was determined to be quite low in the area, it had a major impact on the uniformity coefficient

Nagosh *et al*. (2018) evaluated the Kakara Tea Irrigation System (KTIS) based on its Coefficient of Uniformity CU, Delivery Performance Ratio (DPR), Irrigation Productivity (IP), labour requirements and water quality. Standard procedure was used for the evaluation. Christiansen's equation was used to compute CU. EDTA and flame photometer methods were used to analyse water quality. The result indicated that KTIS has a CU of 90.9%, DPR of 0.79 which indicated an efficiency of 79%. Sprinkler discharge rate was 1.2 l/s and application rate was 7.5 mm/hr. It is capable of irrigating 41.1ha/day with an average irrigation cycle of 9 days and irrigation productivity of 2613.7 kg/ha. Total irrigation production contributes 68.6% to the annual production. This study showed that, comparing the irrigation productivity (IP) with previous production records from 2011-2016 showed good irrigation performance trend of Mambilla Beverage Company irrigation scheme. However, the system is labour intensive since the laterals have to be moved after some period of time. The implementation or adoption of permanent laterals and risers would reduce manual labour demand. Variation in discharge can also be adjusted via use of uniform laterals, risers, and nozzles. This study further recommends an incorporation of a soil and water laboratory for the company to aid in monitoring the soil and water quality of the irrigation area.

2.3 Micro irrigation

Micro-irrigation systems are typically designed to wet only the root zone and maintain this zone at or near an optimum moisture level (James, 1988).

Chen and Zhen (1995) determined the importance of irrigation uniformity in the design of micro-irrigation system by analysis the relationship between crop yield and water consumption and also between irrigation uniformity and engineering costs.

2.3.1 Coefficient of variance

Boman (1989) evaluated several micro-irrigation emitters to determine their uniformity of distribution. The coefficient of variation of water depths in catch cans was selected as the primary performance indicator for the study. This study stated that the COV is independent of the scale of measurement, and thus allows dimensionless comparison of variability for emitters with different flow rates. The COV values less than 100 can be considered as good water distribution and values over 200 indicated patterns that a large portion of the effective area that received no water. These high COV's may also indicated that the areas with very high application depths relative to the mean.

2.3.2 Drip irrigation

Abou kheira (2009) reported that the surface drip system resulted in a good distribution of the soil profile up to 60 cm depth for treatments such as 100%, 80%, and 60% of ET_p .The moisture distribution was found to be more uniform at 48 hr after irrigation. This may be due to the high value of uniformity distribution in the surface drip irrigation system. Under subsurface drip, the water available in root zone was enough for plant growth. This is because under subsurface drip, the soil profile below effective soil depth became wetter due to minimum evaporation loss.

Abass *et al.* (2013) conducted a research to study the feasibility of saving water by studying the distribution pattern of soil moisture content in the soil under subsurface irrigation systems. Experiments were designed for two levels of irrigation 4 l/h for two hours of application time (Level 1 – 100%) and for one hour Level 2 -50%). In this, study the soil moisture content was measured at various depths by soil moisture sensors that did not cause any disturbances to crop root zone while measuring. The moisture contents were measured at different depths both parallel and perpendicular to the lateral line.

Mokh *et al.* (2014) conducted an experiment to evaluate the effect of two drip irrigation systems; surface and subsurface drip system. For that three levels of irrigation were applied viz. Full irrigation (FI_{100}) and deficit irrigation (D$I_{30,}DI_{60}$).Water with an EC_i of 7.0 dS/m was used for irrigation. Moisture was directly related to the amount of water applied at full or deficit-irrigated treatments. Moisture in the soil profile initially showed higher moisture content in all the treatments due to the irrigation amount applied before planting to replenish the soil profile to field capacity. Initial soil moisture content in root zone area was about 17.37 and 18.04% in spring season and 17.03 and 18.11% in autumn season, respectively, for SDI and SSDI. They concluded that for all irrigation treatments significant differences were observed between the soil moisture content of the subsurface irrigated plots and those irrigated with the surface drip system. SSDI had higher value of soil moisture content than SI's.

Nirala *et al*. (2017) conducted field experiments with surface drip irrigation involving three discharge rates (2 lph, 4 lph and 8 lph). The experiment was carried on two different soil sandy clay loam and clay loam after determining various physical property of soil like moisture content, bulk density, field capacity. The experiments were conducted by drip emitters of different discharge rates on separate laterals on different beds for one hour. The horizontal spreading and vertical depth of infiltration of the water into soil was measured. The experiment concluded that when discharge rate increased from 2 lph to 4 lph then maximum horizontal distance was found to be increased by 44.4% and from 2 lph to 8 lph maximum horizontal spreading was found to be increased by 11.1%. Therefore, more is the discharge rate less is the vertical movement and vice-versa. It was also observed that the lateral movement of water is more for clay loam soil than the sandy clay loam soil while the vertical distance is greatest for sandy clay loam than the clay loam. The more is the sandy nature of the soil more is the vertical movement of water and comparatively less lateral movement.

Abdulhadi and Alwan (2020) studied about the evaluation of the existing drip irrigation network of Fadak Farm. This study aimed to assess the performance of the drip irrigation systems installed for the date palm. The head discharge relationships for emitters were expressed at different operating pressure, and the best model equipped with the highest R^2 was calculated. Results from established models for the relationship of pressure discharge indicated that the pressure exponent was less than 0.5, which indicated that the type of dripper is compensated pressure. By measuring the discharge rates for emitters, the uniformity parameters, namely: absolute emission uniformity, field emission uniformity, coefficient of variation, application efficiency, design emission uniformity, statistical uniformity coefficient, emitter flow variation and pressure variation were determined. The obtained results for drip system indicate 96.5% for field emission uniformity, 96.25% for absolute emission uniformity, 95.9% for design emission uniformity, 97% for statistical uniformity coefficient, 6.85% for emitter flow variation, 0.026 for coefficient of variation, 96.5% for application efficiency, and 16.98% for pressure variation.

Jusoh *et al.* (2020) evaluated irrigation performance of drip irrigation system and estimated water productivity (WP) of rock melon cultivation in the netted rain house shelter. The results indicated that the operating pressure of the drip irrigation system tested varied from 0.8 to 3.0 psi with a discharge rate between 0.14 and 0.25 l/min. Water application uniformity between laterals varied from 66.06 to 89.72%. The WP of rock melon was around 7.93 kg/m^3, which is considerably high and in similar range as demonstrated in previous literature. The field evaluation also revealed that the manipulation of valve controller at lateral based on a few selected scenarios did not provide a significant difference in pressure and discharge at the head, middle, and tail section of the drip irrigation system.

Darimani *et al.* (2021) conducted a study to evaluate the water application uniformity for a drip irrigation system, considering the water quality and the duration of usage. The procedures were based on taking measurements of emitter discharge along selected driplines on a sub-main. The catch can be identified as L1A, L1B, L1C, L1D, same for L2A to L2D, L3A to L3D and L4A to L4D. This gave a total of sixteen (16) measurement positions as there were 4 driplines. Results indicated that the uniformity of water application was 90% indicating that the emitter was still good after a year of installation. The average discharge rate was 0.57 l/h. The uniformity coefficient (UC %) for the gravity-fed drip irrigation system was 78%, indicating good water application and was quite significant for the evaluation of the uniform distribution of water for the design.

2.3.3 Soil Moisture Measurements

Rasti *et al.* (2020) conducted a study focusing on assessment of different soil moisture measurement methods : conventional laboratory oven method versus halogen moisture analyzers. They tested different soil types, cohesive and granular, at different moisture contents using both methods. The results from both methods were analysed and found that the halogen moisture analyzer is a fast, simple, and relatively inexpensive alternative method to determine the soil moisture content. They concluded that a halogen moisture analyzer is an energy-efficient device that can measure soil moisture content and it is relatively automated process reducing user errors.

2.4 Rain hose irrigation

Rain hose systems are a new way of watering crops intensely under moderate pressure. The pipe is sequentially perforated at small intervals to create tiny holes from which crops are irrigated. It is easy to install, easy to maintain, low cost, easy plug clearing, quick irrigating and low water pressure, low energy consuming. It is useful for field irrigation of crops in dry farmland. Rain hose systems proves to be a boon in places where the land remains high and low, where surface irrigation is not possible. It is a suitable method for loamy soil and high slope and high altitude places.

KSNM is one of the eminent manufactures of rain hose irrigation system. It was used to evaluate the performance. This is a “Do it yourself kit”. No professional is required to install the kit.The kit contained all the parts required for spray irrigation for ¼ acre land. This spray irrigation kit consists of rain hose of 40 mm diameter, four straight connectors of 40 mm lock, PVC Tee 63 mm with ball valve and adaptor of 40 mm and four end cap of 40 mm.The manufacture’s specifications is given in the table.

Roll length	100 m
Height of spray	1.5 to 2 m
Diameter	40 mm
Holes	Laser punched holes
Drip hole spacing	Continuous pattern of holes approximate 5 cm spacing

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

A study was conducted to evaluate the performance of rain hose irrigation including the analysis of distribution pattern and uniformity of application. Materials used for the study and the methodology adopted for achieving the objectives are discussed in this chapter.

3.1 Location and climate of the study area

The experiment was conducted in the farm for an area of 300 m^2 located near to the farm office, Kelappaji College of Agricultural Engineering and Technology, Tavanur (plate 1). The place is situated at 10° 51' 16" N latitude and 75° 59' 18" S longitude.

Plate 1. Plot from Google Earth

Mean maximum temperature: 30°C

Mean minimum temperature: 22°C

Average relative humidity : 74%

Average annual rainfall : 2500 mm

The present study was aimed at evaluating the performance of rain hose irrigation including the analysis of distribution pattern and uniformity of application.

3.2 Installation of experimental setup

3.2.1 Land Preparation

A plot of 15 m x 20 m was selected. It was ploughed using a rotavator (plate 2). After clearing the weeds leveling was done manually (plate 3).

Plate 2. Ploughed land

Plate 3. Levelled land

3.2.2 Experimental setup

The experimental set up was installed at field, which includes the following

1. Fitting of tank and pump
2. Fitting of pressure gauge and filter
3. Laying mainline and laterals

A centrifugal pump operated by an electric motor of 1hp was used to lift the water from the storage tank and to develop the required pressure for working the rain hose. A mesh wire screen was provided for filtrating the water at the inlet of the tank (plate 4).

Plate 4. Experimental setup

3.2.2.1 Water tank

A water tank having a capacity of 500 litres was used to supply water for the experiment. The tank was placed on a levelled land near to the experiment plot.

3.2.2.2 Water pump

A single phase centrifugal mono block pump of 1 hp was used to pump water from tank to the mainline. Specifications are given below.

Discharge	: 3.50 lps
Head	:14 m
RPM	: 2900
Power	: 1 hp
Volts	: 220
Pipe size	: 40x40 mm

Plate 5. Water pump

3.2.2.3 Filter

A disc filter was installed in the mainline for fine filtration to avoid the clogging of perforations in the lateral line. A y-type disc filter of 1.5" (40 mm) having 2 kg/cm^2 nominal pressure was used for the filtration process of water coming from the tank (plate 6).

Plate 6. Filter

3.2.2.4 Pressure gauge

A pressure gauge of 0 to 7 kg/cm² was installed at the outlet port of filter to note the operating pressure.

Plate 7. Pressure gauge

3.2.2.5 KSNM Rainhose Irrigation System

KSNM is one of the eminent manufactures of rain hose irrigation system. It was used to evaluate the performance. This is a “Do it yourself kit”. No professional is required to install the kit.The kit contained all the parts required for spray irrigation for ¼ acre land. This spray irrigation kit consists of rain hose of 40 mm diameter, four straight connectors of 40 mm lock, PVC Tee 63 mm with ball valve and adaptor of 40 mm and four end cap of 40 mm.The manufacture’s specifications is given in the table.

Roll length	100 m
Height of spray	1.5 to 2 m
Diameter	40 mm
Holes	Laser punched holes
Drip hole spacing	Continuous pattern of holes approximate 5 cm spacing

3.2.2.5.1 Mainline

A PVC pipe of 63 mm was used as mainline and the length of the mainline was 10 m. From the mainline lateral was connected with the help of 63 mm PVC Tee connector.

Plate 8. Mainline

Plate 9. PVC Tee 63 mm ball valve

3.2.2.5.2 Laterals

A 40 mm rain hose pipe with perforations were used as laterals. Each lateral has a length of 15 m. A 40 mm straight connector was used to connect the laterals from mainline in between the straight connect that the Tee connector attached in the mainline, a 40 mm ball valve is provided for regulate flow through the lateral. End cap was inserted at the end of the lateral.

Plate 10. Straight connector

Plate 11. Layout in the field

Plate 12. Rainhose

Plate 13. Connecting rainhose to mainline

Plate 14. Endcap inserted to lateral

3.2.3 Parameters observed

3.2.3.1 Determination of discharge per unit length

Discharge per unit length of the rain hose is determined by using catch can test.

A grid of 1 m x 2 m was marked in the plot. 49 catch cans were placed for the discharge of one lateral and the flow is regulated using ball valve at an operating pressure of 0.5 kg/cm^2, 1 kg/$cm^2$and 1.5 kg/cm^2 by monitoring the pressure gauge. The system was operated for a period of 7 minutes and the time was noted by means of a stop watch. Then the water collected in each can was measured by using measuring jar. The discharge rate in litre per hour was calculated using the following equation.

$$\text{Discharge in lph} = \frac{Volume\ collected\ in\ litre}{Time\ interval\ in\ hour}$$

The discharge obtained from one catch can is converted in to meter length of lateral. Thus the pressure discharge relation was found out by plotting discharge rate against the pressure applied using excel. Similar procedure was repeated for a grid of 2 m x 2 m and also for two laterals to get the discharge of overlapping.

Plate 15. Catch can experiment layout

Plate 16. Catch can experiment

Plate 17. Catch can

plate 18. Amount of catch measured using measuring jar

Spatial variation of discharge was plotted using SURFER software.

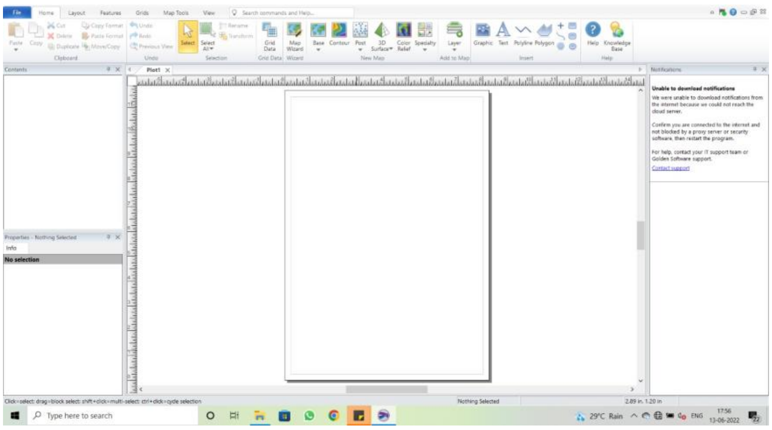

Plate 19. SURFER software

3.2.3.2 Throw distance

The distance of farthest point at which the water spray reached from the lateral was measured as throw distance using measuring tape.

Plate 20. Rain hose irrigation system

3.2.3.3 Determination of moisture content

In order to study the pattern in soil moisture content, in the surface as well as subsurface, soil moisture content at surface and different depth at different distance from lateral were determined.

Soil samples were collected using an auger. Auger is driven into the soil and samples were collected from desired depth. The samples were taken from surface and depths of 15 cm and 30 cm at a distance of 1m, 2 m, 3 m and 4 m from either side of the lateral. They were collected in airtight steel containers. Soil samples were weighed, open the cover and were dried in a hot air oven at a temperature of 105°C for a period of 24 hours until all the moisture was dried off. After removing from oven, weighed again. The difference in weight is the amount of moisture in the soil.

The percentage of moisture content on dry basis was found out by the following formula.

Moisture content (%) = ((w_2 - w_3) / (w_3 - w_1)) x 100

w_1= weight of empty container with lid

w_2= weight of container with lid and moist soil

w_3= weight of container with lid and dry soil

Using the above procedure the moisture content in percent was determined. The moisture distribution pattern was mapped using the soft ware SURFER

Plate 21. Soil sample collection using auger

Plate 22. Soil samples in steel container

Plate 23.Hot air oven

Plate 24. Weighing balance

Plate 25. Field layout of experiment

3.2.3.4 Coefficient of uniformity

The distribution uniformity of the system were studied by determined the Christiansen's uniformity coeffic/ient and it was calculated using the following equation

$$C_u = 100\left(1 - \frac{\sum X}{mn}\right)$$

Where,

C_u= is the Christiansen's uniformity coefficient (%)

m=Average value of all information (average discharge rate)

n=total number of observations

X=numerical deviation of individual observations from the average discharge rate

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

A field study was conducted to evaluate the performance at institutional farm, KCAET, Tavanur, of rain pipe irrigation system. The experiment was conducted during April 2022. The results obtained from the study are analysed and presented in this chapter.

4.1 Spatial variation of discharge:

4.1.1 Unilateral variation

Discharge of the irrigation systems were measured at different operating pressures like 0.5 Kg/cm²,1 Kg/cm² and 1.5 Kg/cm² to evaluate the variation of discharge at different operating pressure

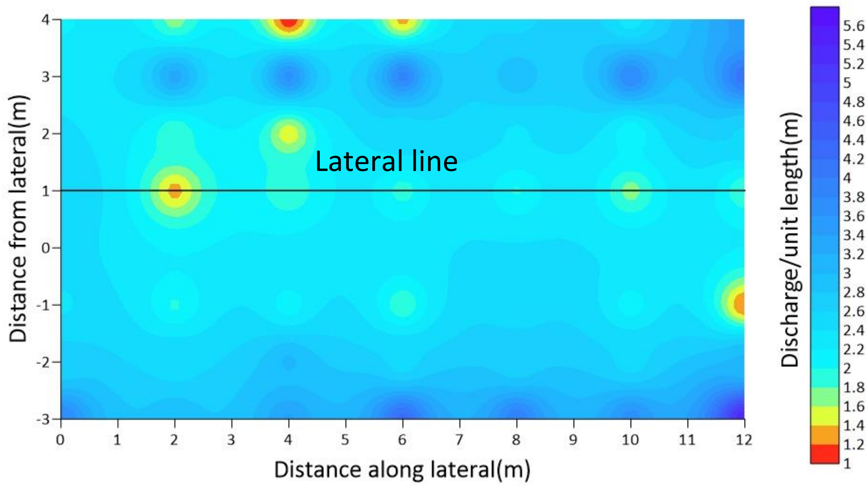

Fig 4.1: Spatial variation of discharge on ground surface at 0.5 kg/cm²

Fig 4.1 showed that the discharge at operating pressures of 0.5 kg/cm² for a period of 7 minutes. In this graph red colour indicate the least discharge and dark blue shows higher discharge.it indicates discharge is lesser nearer to the lateral line and increase as the distance increases from lateral due to the curved path of the spray pattern. Discharge varies between 1 lph to 5.6 lph.

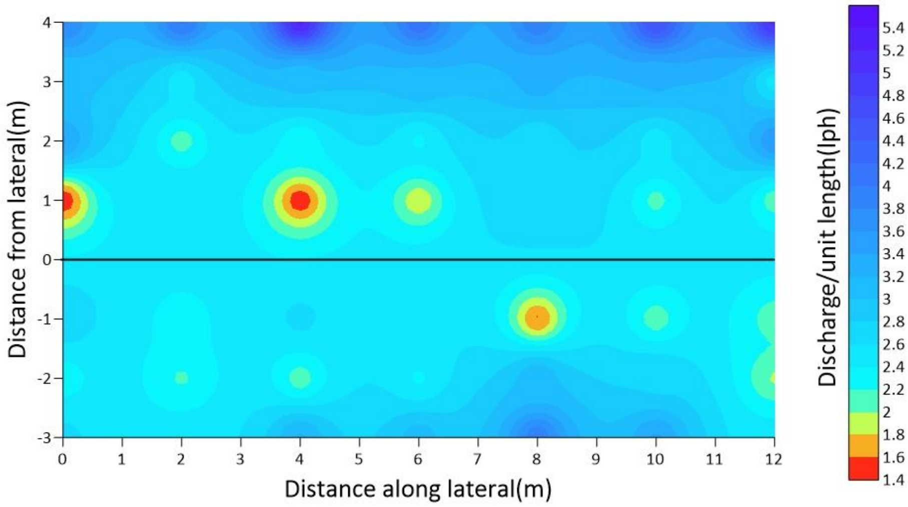

Fig 4.2: Discharge variation on ground surface at 1 Kg/cm²

From fig 4.2 it could be seen that discharge variation at 1 Kg/cm² for a period of 7 minutes. When it operated at 1 Kg/cm² it showed more uniform discharge than the discharge at 0.5 kg/cm². The discharge lies in between 1.4 lph to 5.4 lph. In this graph blue colour is more spreaded as compared to red which means discharge increased when pressure increases.

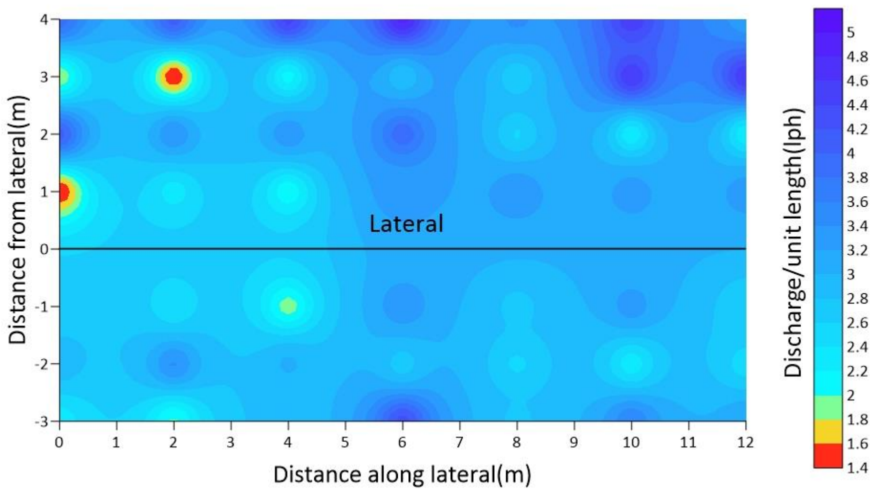

Fig 4.3: Discharge variation on ground surface at 1.5 Kg/cm²

Fig 4.3 showed higher uniformity in discharge and lesser spatial variation for an operating pressure of 1.5 kg/cm². Discharge varies in between 1.4 lph to 5 lph.

Pressure and Discharge Relationship:

Discharge variation at 0.5,1 and 1.5 Kg/cm² were measured and plotted.

Table 1: Discharge variation at different pressures

Pressure (Kg/cm²)	**Discharge (lph)**
0.5	2.64
1	2.82
1.5	3.26

Discharge variation per meter length of the lateral line at different operating presuures were given in table 1 and the graph is given in fig 4.4

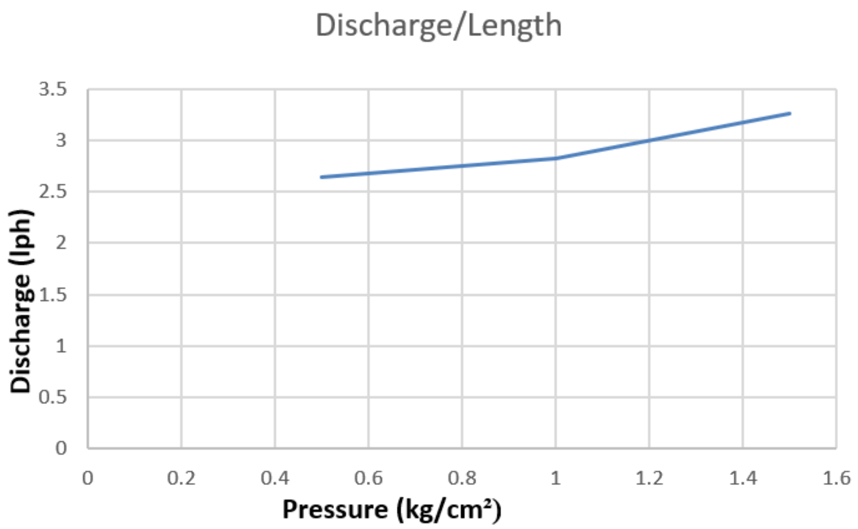

Fig 4.4: Discharge variation at different pressure

From the table 1 and fig 4.4 it is clear that the relation between pressure and discharge are in linear. As the pressure increases average discharge also increases.

Table 2: Discharge variation at 1m away from the lateral

Pressure (Kg/cm^2)	**Discharge (lph)**
0.5	2.06
1	2.08
1.5	3.48

In order to evaluate the discharge variation from the lateral, discharge for various pressures at 1 m away to lateral were analysed and the discharge value is given in table 2.

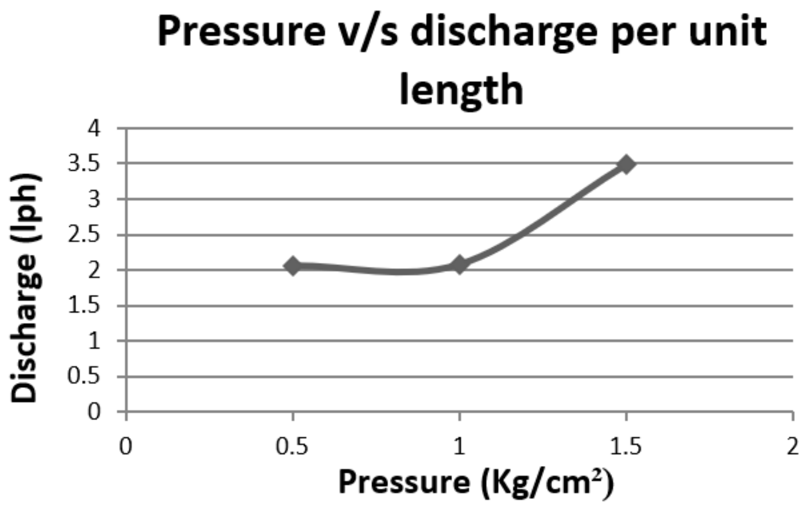

Fig 4.5: Discharge variation at 1m away from the lateral

Fig 4.5 indicates that discharge increases with increasing pressure. For 0.5, 1 and 1.5 Kg/cm^2 operating pressure the discharge obtained is 2.06, 2.08, 3.48 lph respectively.

Table 3: Discharge variation at 2m away from the lateral

Pressure (Kg/cm^2)	Discharge (lph)
0.5	2.39
1	2.55
1.5	3.00

In order to evaluate the discharge variation from the lateral, discharge for various pressures at 2 m away to lateral were analysed and the discharge value is given in table 3

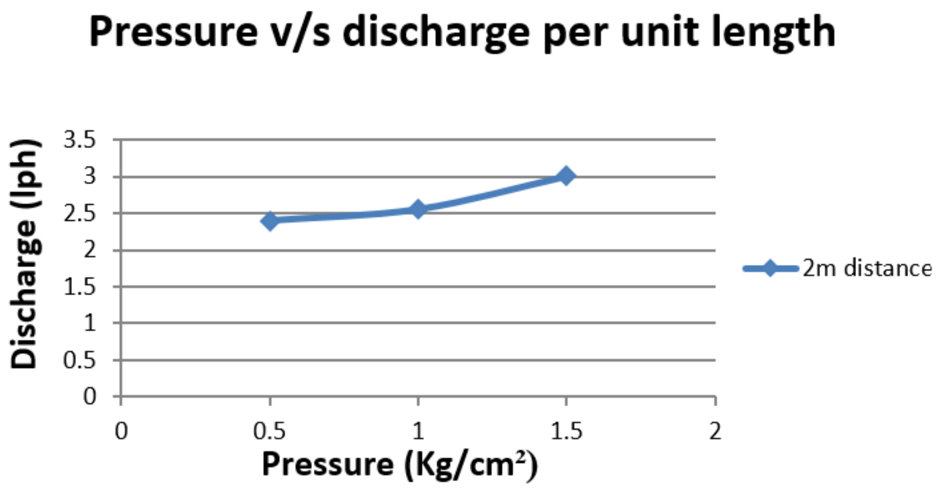

Fig 4.6: Discharge variation at 2m away from the lateral

From the fig 4.6, it could be seen that the discharge obtained at 2 m away from the lateral at different pressures is approximately proportional to its corresponding increase in discharge. At 0.5 Kg/cm^2 pressure the discharge is 2.39 lph. For 1 and 1.5 Kg/cm^2 the discharge measured is 2.55 and 3.00 respectively.

At 0.5 Kg/cm² pressure the discharge is 2.39 lph. For 1 and 1.5 Kg/cm² the discharge measured is 2.55 and 3.00 respectively.

Table 4: Discharge variation at 3m away from the lateral

Pressure (Kg/cm²)	**Discharge (lph)**
0.5	3.75
1	2.99
1.5	2.90

In order to evaluate the discharge variation from the lateral, discharge for various pressures at 3 m away to lateral were analysed and the discharge value is given in table 4.

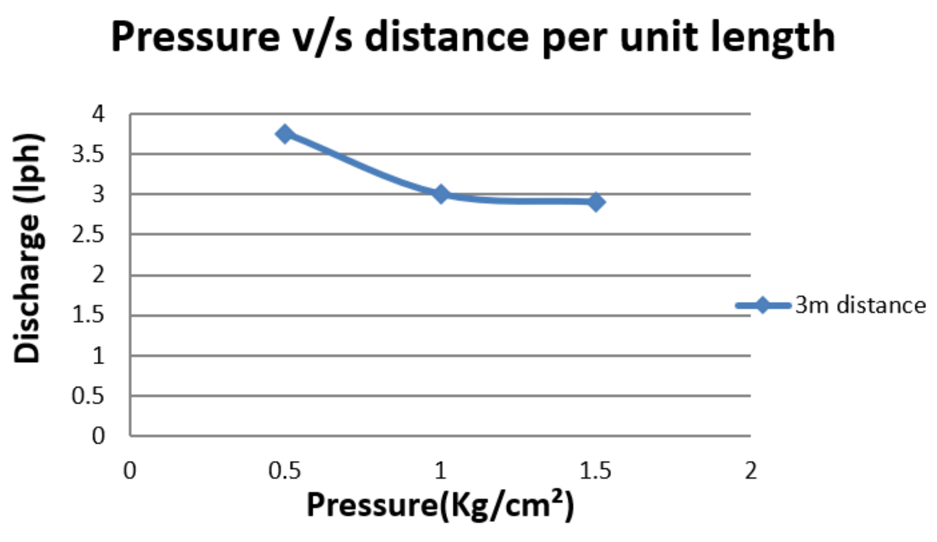

Fig 4.7: Discharge variation at 3m away from the lateral

An inverse relation between pressure and discharge is shown in this graph. when the rainhose was operated at high pressure about 1.5Kg/cm², discharge obtained towards 3m away from the lateral was in the form of fine droplets and also the wind effect contributed in to the reverse direction on pressure and discharge relationship.

Table 5: Discharge variation at 4m away from the lateral

Pressure (kg/cm^2)	Discharge (lph)
0.5	2.09
1	4.41
1.5	4.08

In order to evaluate the discharge variation from the lateral, discharge for various pressures at 4 m away to lateral were analysed and the discharge value is given in table 5.

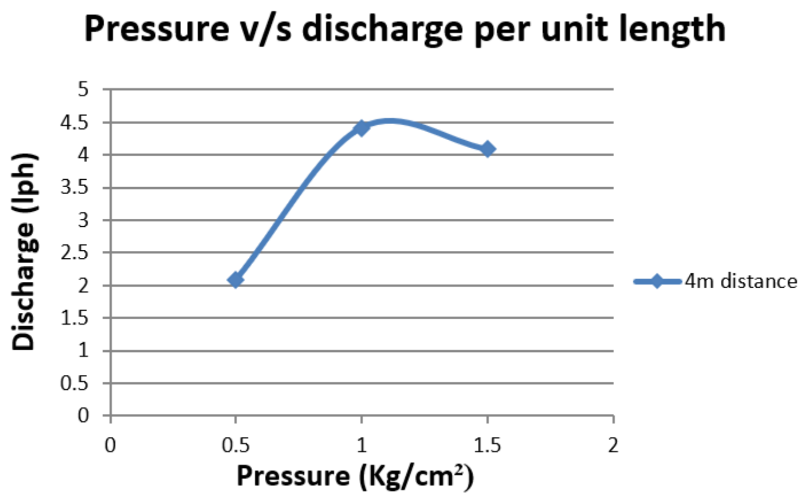

Fig 4.8: Discharge variation at 4m away from the latera

From this graph 4.8, it can be seen that the inverse relation between discharge and pressure. As distance from lateral increases the droplets becomes more finer. Here for 0.5 and 1 Kg/cm^2 pressure, the discharge increases rapidly from 2.09 to 4.41 lph and at 1.5 Kg/cm^2 pressure, it shows a gradual decrease to 4.08 lph

4.1.2 Multilateral discharge variation :

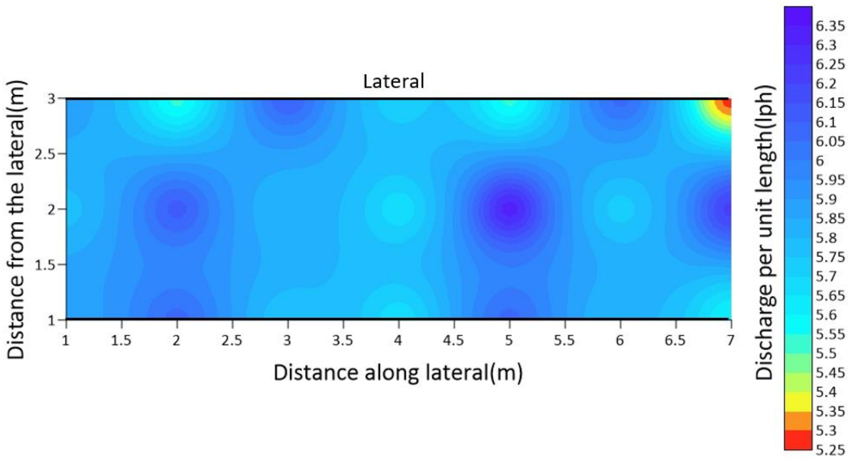

Fig 4.9: Multilateral discharge variation on ground surface at 0.5 Kg/cm²

Here two laterals are operated at the same time for 7 min. Fig 4.9 shows discharge variation at 0.5 Kg/cm².While operating two laterals at a time the spray is overlapping the spatial variation is lesser, so discharge is higher in between two laterals. The discharge is higher when compared to single lateral operation at smaller pressure. Intensity of Discharge per unit length is varies between 5.25 lph to 6.35 lph

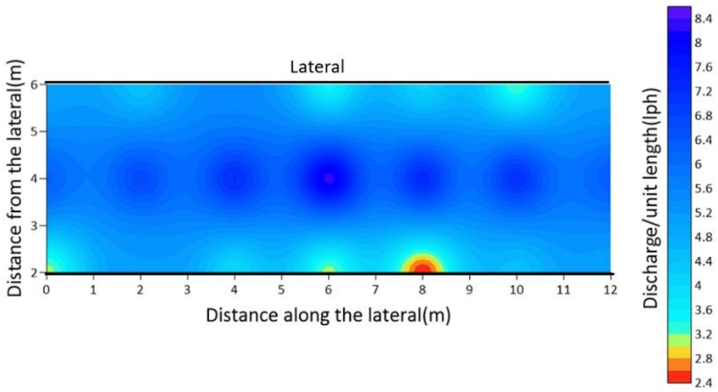

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Fig 4.10: Multilateral discharge variation on ground surface at 1 Kg/cm²

From the graph 4.10 it is clear that as the pressure increases spatial variation decreases. The discharge increases from 2.4 lph to 8.4 lph. Discharge in between two laterals is uniform. Overlapping causes the decreases in spatial variation between two sprays. Here more discharge is collected from the central portion.

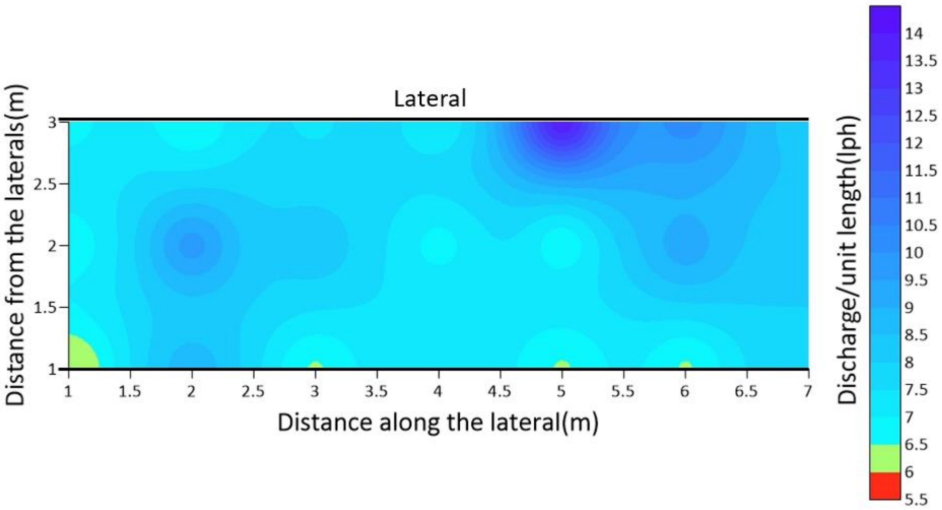

Fig 4.11: Multilateral discharge variation on ground surface at 1.5 Kg/cm²

This graph shows multilateral discharge variation at 1.5 Kg/cm² for operating period of 7 minutes. As the pressure increases it shows more uniform distribution. It is also clear that the discharge obtained from central portion. Discharge varies between 5.5 lph to 14 lph

4.1.3Throw Distance of Irrigation System:

Table 6: Throw distance of irrigation system

Pressure (kg/cm²)	**Maximum distance towards side 1 of lateral (m)**	**Maximum distance towards side 2 of lateral (m)**	**Average**
0.5	3.7	3.4	3.55
1	4.1	4.3	4.2
1.5	6.3	6	6.15

This table indicates that throw distance increases during high pressure discharge. Here for 0.5 Kg/cm² pressure the maximum distance from the lateral to the point at which the droplet falls at side 1 is 3.7 m and at side 2 is 3.4 m. When the pressure is increased to 1 Kg/cm² the distance is increased to 4.1 and 4.3 at side 1 and side 2 respectively. Increasing pressure to 1.5 Kg/cm² cause the droplets to fall at maximum distance of 6.3 and 6 at side 1 and side 2 respectively.

4.2 Soil Moisture Distribution Pattern

Soil moisture wetting pattern at different pressures were analysed and plotted.

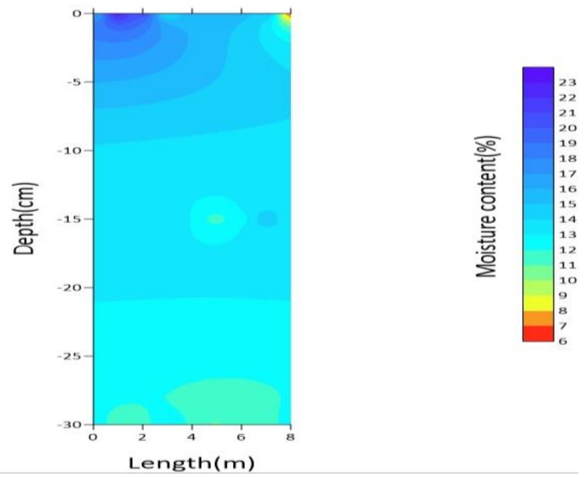

Fig 4.12: Soil moisture wetting pattern at 0.5 Kg/cm²

Fig 4.12 showing the vertical profile of the soil at 30 cm depth. Soil moisture content at top surface, 15 cm and 30 cm depth were determined at operating pressure of 0.5 Kg/cm² for a period of 5 minutes. The graph divides three different regions with different moisture content. The top region have more moisture content comparing with other two regions and the high moisture is at top surface of soil. The top region have moisture content ranging from 15-23% for a depth upto 10 cm. The mid region have moisture content ranging from 12-15% to a depth from 10-20 cm below top region. Comparatively the lower region have the least moisture content ranging 11-12% below the mid region.

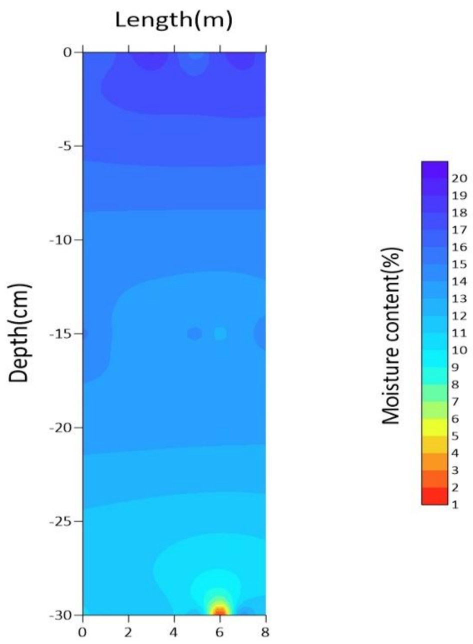

Fig 4.13:Soil moisture wetting pattern at 1 Kg/cm²

The fig 4.13 shows the vertical profile of soil moisture content at a operating pressure of 1 kg/cm² for a period of 5 minutes it is clear that higher moisture content will be at top surface and it decreases gradually with depth.Since the pressure increases the depth of water infiltrated into soil also increases. Here more water is infiltrated into a greater depth. This graph shows two regions with two moisture content range. Top region have high moisture content ranging from 20-12% for a depth near to 25 cm from top surface. While the lower region have moisture content ranges from 11-10% at a depth from 25-30 cm below ground surface.

4.3 Uniformity of Water Distribution:

In order to evaluate uniformity of water distribution in the multilateral system, uniformity coefficient were calculated at different operating pressures 0.5 Kg/cm², 1 Kg/cm² and 1.5 Kg/cm² and the values are listed in table 6.

Table 7: Variation of coefficient of uniformity at different pressures

Pressure (Kg/cm^2)	Coefficient of uniformity(%)
0.5	69.8
1	74.07
1.5	74.40

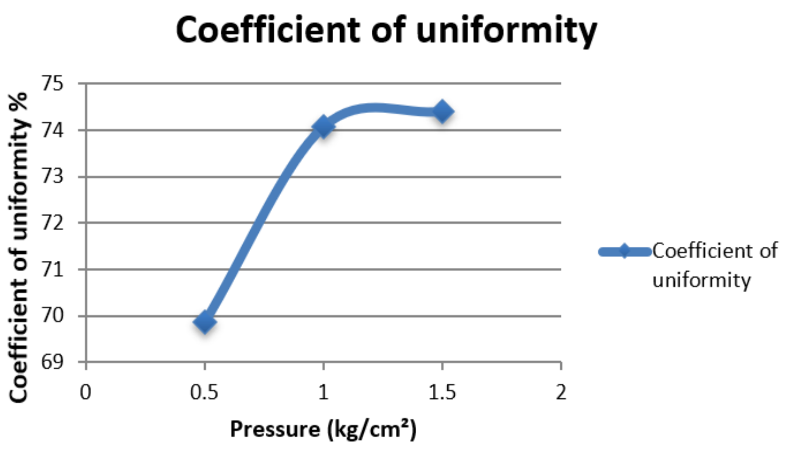

Fig 4.14 : Variation of coefficient of uniformity at different pressures

Fig 4.14 shows the graph of coefficient of uniformity which indicated that as pressure increases uniformity coefficient also increases. At 0.5 Kg/cm^2 pressure the coefficient of uniformity is 69.8%. When the pressure increased to 1 and 1.5 Kg/cm^2 the uniformity coefficient increased to 74.07 % and 74.4% respectively.

The manufacturer recommended that minimum operating pressure is 1 Kg/cm^2. But while operating the rainhose at 1.5 Kg/cm^2, more uniformity was obtained. From the graph, it is clear that uniformity coefficient is approximately 74% which is comparatively lesser than sprinkler system which is 80-90% (Rather and Baba,2017).

It is also recommended that the multilateral system has lesser spatial variation and more uniform water distribution.

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

Rain hose irrigation system is a new technique to irrigate close growing crops under moderate pressure. It overcomes the drawbacks of surface methods of irrigation. The rain hose pipe which is sequentially perforated and delivers water frequently throughout the length of the pipe. This affordable spray irrigation helps to maintain optimum irrigation.

The study was conducted to evaluate the performance of rain hose irrigation system. The objectives of this study were to study the variation of discharge under different operating pressure, to study the soil moisture distribution pattern under various operating pressures, and to study the uniformity of water distribution and its variation in relation to the operating pressure. The experiment was conducted at different operating pressures of 0.5 kg/cm², 1 kg/cm² and 1.5 kg/cm².

The experimental set up of the study included a rain hose by KSNM manufactures, water tank, 1hp pump, filter, pressure gauge, PVC pipe and connectors. The discharge per unit length were measured using catch can test at different operating pressures. Discharge per unit length of lateral were conducted and the results were plotted using the software SURFER and MS Excel. Variation in soil moisture content were determined using gravimetric method and soil samples were taken from the surface, 15cm, 30 cm and below the surface at a distance of 1 m, 2 m, 3 m and 4 m from either side of lateral. Throw distance of the irrigation system was also measured.

The results of the study reveal of that rain hose irrigation system ensures uniform and high flow rate of water with the right operating pressure and discharge rate, which is suitable for closely spaced and shallow-rooted crops like onion, groundnut, vegetable crops and leafy vegetables. The discharge per unit length of the lateral was found to be increased with increasing operating pressure and which maximum at operating pressure of 1.5 kg/cm². Throw distance also found to be increased with increasing operating pressure which resulted in an average of 6.15 m away from the lateral at operating pressure of 1.5 kg/cm². As pressure increased depth of water infiltrated into the soil was also found to be increased. Analysis of results showed that the spatial variation is lesser in multilateral system compared to single lateral system. As the pressure increased coefficient of uniformity was also found to be increased. Uniformity coefficient is approximately 74% which is less compared to sprinkler system. Overall, the rainhose irrigation system performed well at at 1.5 kg/cm^2 compared to the performance at other operating pressures.

The rain hose irrigation system is easily portable, economical, easy to maintain, UV protected and has long life. When water is sprayed like rain, it maintains the appropriate level of moisture in the soil. Thus, it helps to produce maximum and good quality produce. From this study it can be concluded that rain hose irrigation system has exhibited a fairly good performance at the right operating pressure.

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APPENDICES

APPENDICES

Discharge observation from catch can at 1kg/cm^2 pressures from single lateral operation

1kg/cm^2 1m distance cans				
Distance along lateral (m)	Distance from lateral(m)	Discharge (ml)	Discharge (lph)	Discharge/unit Length.
1	0	22	0.188571	1.450114
2	0	52	0.445714	3.427543
3	0	46	0.394286	3.032057
4	0	58	0.497143	3.823029
-1	0	42	0.36	2.7684
-2	0	35	0.3	2.307
-3	0	40	0.342857	2.636571
1	2	38	0.325714	2.504743
2	2	32	0.274286	2.109257
3	2	38	0.325714	2.504743
4	2	61	0.522857	4.020771
-1	2	35	0.3	2.307
-2	2	33	0.282857	2.175171
-3	2	37	0.317143	2.438829
1	4	22	0.188571	1.450114
2	4	34	0.291429	2.241086
3	4	46	0.394286	3.032057
4	4	80	0.685714	5.273143
-1	4	40	0.342857	2.636571
-2	4	32	0.274286	2.109257
-3	4	49	0.42	3.2298
1	6	28	0.24	1.8456
2	6	36	0.308571	2.372914
3	6	48	0.411429	3.163886
4	6	63	0.54	4.1526
-1	6	38	0.325714	2.504743
-2	6	36	0.308571	2.372914
-3	6	47	0.402857	3.097971
1	8	42	0.36	2.7684
2	8	40	0.342857	2.636571
3	8	50	0.428571	3.295714
4	8	60	0.514286	3.954857
-1	8	24	0.205714	1.581943
-2	8	48	0.411429	3.163886
-3	8	60	0.514286	3.954857
1	10	48	0.27823	2.139589
2	10	38	0.325714	2.504743
3	10	49	0.42	3.2298
4	10	70	0.6	4.614
-1	10	32	0.274286	2.109257

-2	10	42	0.36	2.7684
-3	10	52	0.445714	3.427543
1	12	32	0.274286	2.109257
2	12	54	0.462857	3.559371
3	12	38	0.325714	2.504743
4	12	77	0.66	5.0754
-1	12	32	0.2742	2.108598
-2	12	30	0.257143	1.977429
-3	12	37	0.317143	2.438829

Discharge observation from catch can at 0.5 kg/cm^2 pressures from single lateral operation

0.5 kg/cm^2 1m distance				
Distance along lateral (m)	Distance from lateral (m)	Discharge (ml)	Discharge (lph)	Discharge/unit length
1	0	35	0.3	2.307
1	0	32	0.274286	2.109257
1	0	48	0.411429	3.163886
4	0	33	0.282857	2.175171
-1	0	36	0.308571	2.372914
-2	0	40	0.342857	2.636571
-3	0	58	0.497143	3.823029
1	2	20	0.171429	1.318286
2	2	28	0.24	1.8456
3	2	50	0.428571	3.295714
4	2	26	0.222857	1.713771
-1	2	30	0.257143	1.977429
-2	2	38	0.325714	2.504743
-3	2	45	0.385714	2.966143
1	4	28	0.24	1.8456
2	4	22	0.188571	1.450114
3	4	56	0.48	3.6912
4	4	16	0.137143	1.054629
-1	4	32	0.274286	2.109257
-2	4	46	0.394286	3.032057
-3	4	52	0.445714	3.427543
1	6	55	0.25	1.9225
2	6	35	0.325	2.49925
3	6	59	0.505714	3.888943
4	6	20	0.171429	1.318286
-1	6	28	0.24	1.8456
-2	6	38	0.325714	2.504743
-3	6	65	0.557143	4.284429

1	8	30	0.257143	1.977429
2	8	36	0.308571	2.372914
3	8	45	0.385714	2.966143
4	8	39	0.334286	2.570657
-1	8	38	0.325714	2.504743
-2	8	40	0.342857	2.636571
-3	8	60	0.514286	3.954857
1	10	26	0.222857	1.713771
2	10	31	0.265714	2.043343
3	10	58	0.497143	3.823029
4	10	35	0.3	2.307
-1	10	32	0.274286	2.109257
-2	10	38	0.325714	2.504743
-3	10	56	0.48	3.6912
1	12	28	0.24	1.8456
2	12	39	0.334286	2.570657
3	12	63	0.54	4.1526
4	12	53	0.454286	3.493457
-1	12	18	0.154286	1.186457
-2	12	46	0.394286	3.032057
-3	12	82	0.702857	5.404971

Discharge observation from catch can at 1.5 kg/cm^2 pressures from single lateral operation

1.5kg/cm^2 1m distance				
Distance along lateral (m)	Distance from lateral (m)	Discharge (ml)	Discharge (lph)	Discharge/unit length
1	0	21.5	0.184286	1.417157
2	0	62	0.531429	4.086689
3	0	28	0.24	1.8456
4	0	59	0.505714	3.888943
-1	0	42	0.36	2.7684
-2	0	44	0.377143	2.900229
-3	0	35	0.3	2.307
1	2	35	0.3	2.307
2	2	82	0.44201	3.399057
3	2	21	0.18	1.3842
4	2	62	0.531429	4.086686
-1	2	37	0.317143	2.438829
-2	2	52	0.445714	3.427543
-3	2	30	0.257143	1.977429
1	4	60	0.26541	2.041003
2	4	51	0.437143	3.361629

3	4	32	0.274286	2.109257
4	4	68	0.582857	4.482171
-1	4	60	0.24655	1.89597
-2	4	46	0.394286	3.032057
-3	4	43	0.368571	2.834314
1	6	51	0.437143	3.36163
2	6	60	0.514286	3.954857
3	6	43	0.368571	2.834314
4	6	74	0.634286	4.877657
-1	6	51	0.437143	3.361629
-2	6	41	0.351429	2.702486
-3	6	65	0.557143	4.284429
1	8	51	0.437143	3.36163
2	8	39	0.334286	2.570657
3	8	40	0.342857	2.636571
4	8	52	0.445714	3.427543
-1	8	70	0.3564	2.740716
-2	8	32	0.3325	2.556925
-3	8	42	0.36	2.7684
1	10	50	0.428571	3.295714
2	10	34	0.291429	2.241086
3	10	70	0.6	4.614
4	10	69	0.591429	4.548086
-1	10	50	0.428571	3.295714
-2	10	29	0.2953	2.270857
-3	10	54	0.462857	3.559371
1	12	50	0.428571	3.295714
2	12	34	0.291429	2.241086
3	12	70	0.6	4.614
4	12	50	0.428571	3.295714
-1	12	40	0.342857	2.636571
-2	12	38	0.325714	2.504743
-3	12	48	0.411429	3.163886

Discharge observation from catch can at 1.5 kg/cm^2 pressures from multilateral operation

Pressure 1.5 kg/cm^2				
Distance along lateral(m)	Distance from lateral(m)	Discharge (ml)	Discharge (lph)	Discharge/unit length
1	1	30	0.78	5.9982
2	1	22	0.88	6.7672
3	1	22	0.9	6.921
1	2	21	1.14	8.7666

2	2	20	1.26	9.6894
3	2	19	0.86	6.6134
1	3	18	0.84	6.4596
2	3	18	1.08	8.3052
3	3	17	0.97	7.4593
1	4	15	0.93	7.1517
2	4	15	0.89	6.8441
3	4	14	0.93	7.1517
1	5	14	0.84	6.4596
2	5	13	0.87	6.6903
3	5	12	1.8	13.842
1	6	12	0.84	6.4596
2	6	12	1.2	9.228
3	6	11	1.32	10.1508
1	7	11	1.02	7.8438
2	7	10	1.05	8.0745
3	7	10	1.08	8.3052

Discharge observation from catch can at 1kg/cm^2 pressures from multilateral operation

Pressure 1 kg/cm^2				
Distance along lateral (m)	Distance from lateral(m)	Discharge (ml)	Discharge (lph)	Discharge/unit length
2	0	27	0.405	3.11445
2	2	45	0.675	5.19075
2	4	54	0.52	3.9988
2	6	27	0.405	3.11445
2	8	21	0.315	2.42235
2	10	39	0.585	4.49865
2	12	44	0.66	5.0754
4	0	54	0.81	6.2289
4	2	58	0.87	6.6903
4	4	314	0.94	7.2286
4	6	72	1.08	8.3052
4	8	334	0.95	7.3055
4	10	62	0.93	7.1517
4	12	70	0.82	6.3058
6	0	43.5	0.6525	5.017725
6	2	38.5	0.5775	4.440975
6	4	48	0.72	5.5368
6	6	30.5	0.4575	3.518175
6	8	36	0.54	4.1526
6	10	28	0.42	3.2298
6	12	44.5	0.6675	5.133075

Discharge observation from catch can at 0.5 kg/cm^2 pressures from multilateral operation

Pressure 0.5 kg/cm^2				
Distance along lateral(m)	Distance from lateral(m)	Discharge(ml)	Discharge (lph)	Discharge/unit length
1	1	49	0.42	5.876
2	1	51	0.437143	5.7856
3	1	40	0.5672	5.8743
1	2	92	0.788571	6.064114
2	2	51	0.7953	6.115857
3	2	84	0.72	5.5368
1	3	98	0.65	5.768
2	3	60	0.7547	5.803643
3	3	40	0.7923	6.092787
1	4	86	0.737143	5.668629
2	4	86	0.737143	5.668629
3	4	44	0.7438	5.719822
1	5	92	0.788571	6.064114
2	5	78	0.668571	6.324
3	5	84	0.72	5.5368
1	6	88	0.754286	5.800457
2	6	40	0.7452	5.730588
3	6	92	0.788571	6.064114
1	7	85	0.728571	5.602714
2	7	78	0.668571	6.216
3	7	80	0.685714	5.273143

Variation of moisture content at 0.5 kg/cm^2

5 min at 0.5 kg/cm^2						
Wet weight with container(g)	Dry weight with container(g)	Container weight(g)	wet weight (g)	Dry weight (g)	M.C(wetbasis) %	M.C(dry basis) %
42.23	40.52	28.25	13.98	12.27	12.23175966	13.93643032
52.73	48.31	26.79	25.94	21.52	17.03932151	20.53903346
60.22	54	26.59	33.63	27.41	18.49539102	22.69244801
49.68	45.44	19.67	30.01	25.77	14.12862379	16.4532402
55.22	51.27	26.56	28.66	24.71	13.78227495	15.985431
53.2	49.56	25.77	27.43	23.79	13.27014218	15.30054645
64.96	60.91	34.12	30.84	26.79	13.13229572	15.11758119

40.45	39.44	24.41	16.04	15.03	6.296758105	6.719893546
53.33	50.08	26.47	26.86	23.61	12.09977662	13.76535366
33.61	32.45	23.63	9.98	8.82	11.62324649	13.15192744
49.15	46.43	26.35	22.8	20.08	11.92982456	13.54581673
38.46	36.87	24.86	13.6	12.01	11.69117647	13.23896753
37.96	36.94	28.18	9.78	8.76	10.42944785	11.64383562
40.59	39.21	28.41	12.18	10.8	11.33004926	12.77777778
41.06	40.01	32.9	8.16	7.11	12.86764706	14.76793249
33.13	32.41	27	6.13	5.41	11.74551387	13.30868762
52.38	49.66	27.85	24.53	21.81	11.08846311	12.47134342
49.22	47.04	28.61	20.61	18.43	10.57738962	11.82854042
40.58	38.76	23.3	17.28	15.46	10.53240741	11.77231565
35.12	34.12	25.98	9.14	8.14	10.94091904	12.28501229
40.74	38.98	22.82	17.92	16.16	9.821428571	10.89108911
45.11	43.15	26.37	18.74	16.78	10.45891142	11.68057211
37.82	36.88	28.3	9.52	8.58	9.87394958	10.95571096
29.5	28.43	20.33	9.17	8.1	11.66848419	13.20987654

Variation of moisture content at 1 kg/cm²

5 min at 1kg/cm²						
Wet weight with container (g)	Dry weight with container(g)	Container weight (g)	wet weight (g)	Dry weight (g)	M.C(wet basis)%	M.C(dry basis)%
43.19	40.32	25.34	17.85	14.98	16.07843137	19.1588785
44.97	42.2	26.86	18.11	15.34	15.2954169	18.05736636
41.04	38.92	25.81	15.23	13.11	13.91989494	16.17086194
46.74	44.22	29.23	17.51	14.99	14.39177613	16.81120747
38.66	36.3	20.99	17.67	15.31	13.35597057	15.41476159
40.87	38.17	23.15	17.72	15.02	15.23702032	17.97603196
42.01	39.71	27.68	14.33	12.03	16.05024424	19.11886949
48.2	45.6	30.48	17.72	15.12	14.67268623	17.1957672
45.78	43.76	29.07	16.71	14.69	12.08856972	13.75085092
41.27	39.41	25.38	15.89	14.03	11.70547514	13.25730577
36.39	35.27	27.34	9.05	7.93	12.37569061	14.12358134
41.73	40.03	28.86	12.87	11.17	13.20901321	15.21933751
44.91	42.84	28.24	16.67	14.6	12.4175165	14.17808219
76.63	75.04	62.46	14.17	12.58	11.2208892	12.6391097
86	82.77	59.51	26.49	23.26	12.19328048	13.88650043
45.8	43.65	28.63	17.17	15.02	12.52184042	14.31424767
44.97	43.31	29.44	15.53	13.87	10.68898905	11.96827686
44.12	42.6	28.72	15.4	13.88	9.87012987	10.95100865

56.12	53.22	29.19	26.93	24.03	10.76865949	12.06824802
42.26	40.74	26.6	15.66	14.14	9.706257982	10.74964639
46.87	45.05	29.65	17.22	15.4	10.56910569	11.81818182
39.91	38.35	26.46	13.45	11.89	11.59851301	13.12026913
35.18	34.31	28.1	7.08	6.21	12.28813559	14.00966184
39.78	38.64	28.49	11.29	10.15	10.09743136	11.23152709

PERFORMANCE EVALUATION OF RAINHOSE IRRIGATION SYSTEM

PROJECT REPORT

Submitted in partial fulfillment of the requirement of degree

Bachelor of technology

In

Agricultural engineering

Faculty of Agricultural Engineering and Technology

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

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ABSTRACT

A study was conducted to evaluate the performance of rain hose irrigation system which is an affordable irrigation technology and modern technique of irrigation. It consists of a flexible pipe with a pattern of holes. The relationship between the operating pressure and discharge of the system, the soil moisture wetting pattern and the water distribution pattern in the soil at different operating pressures were determined in this study.

The performance of Rainhose irrigation system under different operating pressures were analysed. The relationship between various pressures and their corresponding discharges were plotted. The increasing pressure had a linear relationship with discharge. The soil moisture content at higher pressure is more compared with lower pressure and could also found that water infiltrates to higher depth with increasing pressure. The top surface contains higher moisture content and it decreases with depth. The water distribution is more uniform at higher pressures and the uniformity coefficient is approximately 74%, which is comparatively lesser than sprinkler irrigation. In case of multilateral system due to lesser spatial variation the coefficient of uniformity is higher.

The results of the study reveal of that rain hose irrigation system ensures uniform and high flow rate of water at right operating pressure and discharge rate, which is suitable for closely spaced and shallow-rooted crops like onion, groundnut, vegetable crops and leafy vegetables. The discharge per unit length of the irrigation was found to be increased as operating pressure increased. Throw distance also found to be increased with operating pressure. As pressure increased depth of water infiltrated into the soil was also found to be increased. Analysis of results showed that the spatial variation is lesser in multilateral system. As the pressure increased coefficient of uniformity was also found to be increased. The rainhose irrigation system performed well at operating pressure of 1.5 kg/cm^2.