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Design and Fabrication of Cost Effective Sprinkler Irrigation System for Tuberose *(Polianthes Tuberosa)*

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Abstract **:** *India is known for its agricultural potential over many decades. But it's very unfortunate that it loosing it's potential due to uncertainty in availability of irrigation facility and poor management of water resources. More than 50% of irrigation potential created are unutilized. There come the micro irrigation as the solution for water saving and increase in agriculture yield. One of such system is sprinkler irrigation system. The main backlog in introducing this system is, it is very costly and unoffardable to the small and marginal farmers. To overcome this drawback a cost effective system of sprinkler is very much need of the hour. Our aim is to produce a cost effective sprinkler system which is both economical and energy efficient. The design consist of a 5m perforated pipe acting as sprinkler arm. This sprinkler arm can be collapsed into three parts to make it easy to handle and make it portable. The designing process is carried out by considering the factors, such as, soil type, infiltration capacity ,uniformity in water application, soil moisture wetting pattern, soil moisture holding capacity ,etc. ,By comparing to butterfly head sprinkler system and the new cost effective sprinkler irrigation system has less time consuming, more uniform water application, more courage area, less soil erosion and economically it is 57% cheaper than the butterfly head sprinkler irrigation system.*
Keywords *: Agriculture Irrigation potential water saving and increase in agriculture yield*

INTRODUCTION

1.1 GENERAL INTRODUCTION

Tuberose (*Polianthes tuberosa L.*)is one of the most important tropical ornamental bulbous flowering plants cultivated for the production of long-lasting flower spikes. It is popularly known as Rajanigandha or Nishigandha.It belongs to the family Amaryllidaceae and is native to Mexico.Tuberose is an important commercial cut as well as a loose flower crop due to its pleasant fragrance, longer vase-life of spikes, higher returns, and wide adaptability to varied climates and soil.They are valued much by the aesthetic world for their beauty and fragrance.The flowers are attractive and elegant with a sweet fragrance. It has long been cherished for the aromatic oils extracted from its fragrant white flowers. Tuberose blooms throughout the year and its clustered spikes are rich in fragrance; florets are star-shaped, waxy, and loosely arranged on a spike that can reach up to 30 to 45 cm in length.The flower is very popular for its strong fragrance and its essential oil is an important component of high-graded perfumes. 'Single' varieties are more fragrant than 'Double' types and contain 0.08 to 0.14 percent concrete which is used in high-grade perfumes.

Tuberose is a native of Mexico where it spread to different parts of the world during the 16th century. This is one of the earliest cultivated plants and maybe extinct in its natural habitator.png. The Aztecs were growing it nearly 600 years ago. The Spanish found the Aztecs growing it in 1519 and took it back with them to the old world. A French missionary, returning from the indies in the 1500s did so as well. Once introduce to Europe it become part of the moon garden, a collection of white or pastel flowers which release an intense fragrance after dusk.

Tuberose can be grown on wide variety of soils ranging from light sandy loam to a clay loam. The soil should be at least 45cm deep, well drained friable, rich in organic matter and nutrients with plenty of moisture in it. Tuberose should grown in well drained place. Soil having a pH in the range of 6.5 to 7.5 with good aeration and drainage are ideal for Tuberose cultivation. A place protected from strong wind is the soil is preferable.

The planting distance varies with the soil and climatic condition. Low planting density results in wastage of inputs and very high planting density leads more plant competition. Bulbs are planted at an optimum spacing 30*20 or 20*20. About 40,000 to 50,000 bulbs are required for one acre planting of tuberose.

The new innovative irrigation system fulfil the drawbacks of other irrigation methods. It's reduce the maintenance cost and reduce the labor requires this system principal based in pascal law. Pascal law is defined as 'A change in pressure at any point in an enclosed incompressible fluid and the force due to the pressure acts at right angles to the enclosing walls'.

Automation irrigation is the used for a device to operate irrigation structures so the change of flow of water from bays can occur the irrigator. Automatic can used in the to start and stop of the pumps. There was some components for On and Off pump, they are using Arduino board, soil moisture sensor, relay, connecting wires. When the soil moisture is low and then the sensor measures the soil moisture content in the root zone before a scheduled irrigation even and bypasses the cycle if the moisture is above the specific threshold. Arduino Uno wi-fi is programmed using the Arduino system our integrated development environment common to all our board and running both online and offline. That more information on how to get started with the Arduino software visit the getting started page. The Arduino uno wifi is an Arduino uno with an integrated wifi module. The board is based on the ATmega328P with an ESP8266wifi module integrated. The ESP8266wifi module is a self contained SoC with integrated TCP/IP protocol stack that can give access to your wi- fi network programing, either for transfer of Arduino sketches or wi-fi firmware.

Sprinkler irrigation is the method of applying water to a controlled manner in that is similar to rainfall. The water is distributed through a network that may consist of pumps, valves, pipes, and sprinklers. Irrigation sprinklers dan be used for residential, industrial, and agricultural usage. Sprinkler irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy. However, large sprinklers are not recommended for irrigation of delicate crops such as lettuce because the large water drops produced by the sprinklers may damage the crop. Sprinkler irrigation allows application of water under high pressure with the help of a pump. It releases water similar to rainfall through a small diameter nozzle placed in the pipes. Water is distributed through a system of pipes, sprayed into air and irrigates in most of the soil type due to wide range of discharge capacity. The sprinkler irrigation system many uses of the farmer in suitable in all type of soil except heavy clay, water saving up to 30-50%, suitable for irrigation where the plant population per unit area is very high, reduces soil compaction, suitable for undulating land, saves land as no bunds required, soluble fertilizers and chemicals use are possible, provides frost protection and helps in alteration of micro climate, reduces labor cost.

Wetting patterns in sprinkler irrigation system in the wetting pattern from a single rotatry sprinklers is not very uniform. Normally the area wetted is circular. The heaviest wetting is close to the sprinkler. For good uniformly several sprinklers must be operated close together so that their patterns overlap. For good uniformly the overlap should be at least 65% of the wetted diameter. This determines the maximum spacing between sprinklers.

Application rate is the average rate at which water is sprayed onto the crops and is measured in mm/hour. The application rate depends on the size of sprinkler nozzles, the operating pressure and the distance between sprinklers. When selecting a sprinkler system it is important it is important to make sure that the average application rate is less than the basic infiltration rate of the soil. As water sprays from a sprinkler it breaks up into small drops between 05.and 4.0mm in size. The small drops fall close to the sprinkler whereas the larger ones fall close to the edge of the wetted circle. Large drops can damage delicate crops and soils and so in such condition it is best to use the smaller sprinklers. Drop size is also controlled by pressure and nozzle size. When the pressure is low, drops tend to be much larger as the water jet does not break up easily. So to avoid cropand soi damage use small diameter nozzles operating at or above the normal recommended operating pressure.

Disadvantage of sprinkler irrigation is the expensive to install, high maintenance, water waste, unsuitable certain crops.

Sprinkler irrigation system can be costly to install, especially for larger farms or orchards. Sprinkler irrigation systems require regular maintenance and repairs to ensure they are functioning properly. If not properly set up and maintained, sprinkler irrigation systems can lead to water and runoff, which can be detrimental to the environment. Sprinkler irrigation systems may not be suitable for certain crops that require less water or different irrigation methods.

1.2 OBJECTIVES

- To develop a smart irrigation system in order to get a significant saving in the consumption of water to irrigate the horticulture crops.
- To use the soluble fertilizers and chemicals To Irrigated area is high compare to other irrigation.
- To reduce the irrigation time.
- To apply water as uniformly as possible to fill the root zone of the crop with water
- To control some destructive pests and diseases.

- To leach excess salts.
- To improve groundwater storage.

2.1 Literature review

Ang Li.et,al,(2021) says improving the application efficiency and leaching of solutes from the root zone in a sprinkler system are directly related to the uniformly co- efficient of water distribution at the field surface. The coefficient of uniformly and distribution uniformity are affected by changes in the wind speed and it's direction sprinkler characteristics and variation in operating pressure. The objective of this paper is to a present modified equation for evaluating pressurized irrigation systems based on non-dimensional infiltrated depths. The equation were obtained by four data groups including the average of the measured infiltration depths in any quarter. Coefficient of uniformity(CU),distribution uniformity(DU),application efficiency(E_a) and deep percolation(DP) were used as performance indicators to evaluate the sprinkler irrigation system. The suggested method was compared to the exiting approach to assess the evaluation indicators. Three data sets of observed information for wheel-move, permanent solid set irrigation systems were collected in Chaharmahal and Bakhtiari provinces to evaluate the proposed formulation. Furthermore the relationships between CU and DU were analysed for three scenarios of infiltration depth. Results show that the application efficiency was 12% less than previous equation because of using four values.

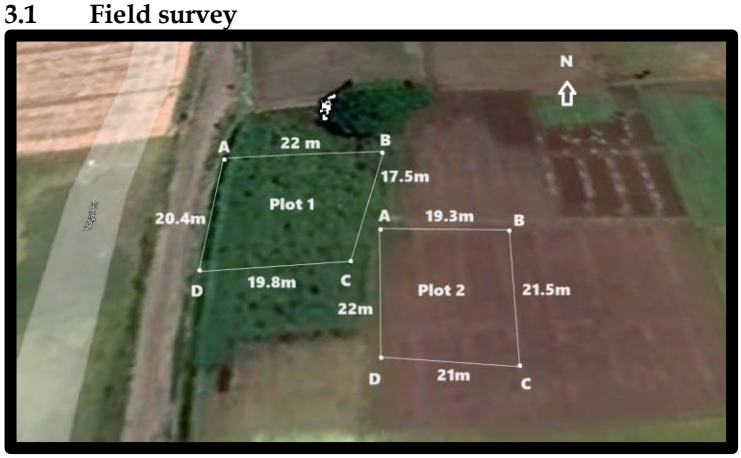
Nirali Hemant.at,al,(2022) says The need to irrigate farms or garden by a way which will replace the natural rainfall when not available led to the planning and construction of the sprinkler irrigation system was taken into study with their design, construction and installation. Planning was supported employing a rotating system to irrigate a little size plot which provides a suitable scientific basis for correct water scheduling, evaluation of the system and minimize water wastage and runoff. It had been designing for various crops. The importance of the designing and research field of the university with irrigation field demonstration practice facilities that could be used. Drip irrigation system is a basic and an artificial method of suppling water to the roots of the plant it's also called micro irrigation. In past few years there's a rapid climb during this system. The user communicate with the centralized unit via SMS or text. The centralized unit communicates with the system through SMS or text which can be received by the GSM with the assistance of the SIM card. The GSM send this particular data to ARM7 which is additionally continuously receives the information from sensors in some sort of codes, after processing the whole this data is displayed on the LCD. Thus briefly whenever then system receives the activation command from the subscriber it checks all the sector conditions and provides an in depth feedback to the user and waits for an additional activation command so start out the motor. The motor is controlled by an easy manipulation with in the internal structure of the starter

Basavaraj.et,all,(2022) says the A field experiment was conducted to study the influence of raised bed system, mulching and planting geometry on growth, yield and quality of tuberose variety Prajwal. The experiment was laid out in a randomized block design with seventeen treatments replicated twice. The treatments include four raised bed system of 100 and 70cm width with 50 and 30cm isolation with and without plastic mulch having two plant spacing of 30*30cm and 30*15cm. Crop was also raised by conventional system of cultivation as check with ridge and furrow system spaced at 30 U 30cm, applied with RDF@ 100:50:50kg N:P205: K20 ha-1 without mulch. The effects of these treatments on growth, yield and quality of tuberose were studied. The treatment having closer spacing of 30*15cm with mulch recorded significantly higher plant height. However, significantly higher plant spread, number of side shoots per plant and early flowering were recorded in the treatments having wider spacing of 30*30cm with mulch irrespective of bed system. The treatments having 100/30cm bed system with mulch of 3 rows planting at 30U15cm recorded significantly higher flower yield (46.04 t/ha), bulb yield (27.29t/ha),B:C ratio (4.38) whereas the least flower yield (11.46t/ha) and bulb yield (7.43t/ha) was recorded in farmers practice with least B:C ratio(1.04). However, superior flowers with higher flower diameter(3.18cm), 100floret weight(107.86) and shelf life (8.50days) were noticed in the treatments having 70/50cm bed

system with mulch of 2rows spaced at 30U30cm.

Peter Okechukwu Chikelu.et,al,(2023) presents a comprehensive conceptual design approach for development of a telescopic machine system, 2which is portable and will provide a safe method of harvesting palm fruits. For this machines system development, the material boom angle, force and stroke length of each hydraulic cylinder, the hydraulic pump pressure, base weight , permissible weight of the cutting system and power required were then calculated in the design analysis. Furthermore, from the calculated parameters, the model of the systems was created using Solid works engineering software, the model was developed and tested. The result shows that the cutting time of the system for one bunch of palm fruit was longer when compared to conventional systems. It was concluded that though the machine is maintenance friendly and portable, further improvements in its design are safe method of harvesting palm fruits. For this machine system development, the material for each component of the machine system was first selected, the boom length, maximum boom angle, force and stroke length of each hydraulic cylinder, the hydraulic pump pressure, base weight, permissible weight of the cutting system and power required were then calculated parameters, the model was developed and tested. The results shows that the cutting time of the systems for on bunch of palm fruit was longer when compared to conventional systems. It was concluded that though the machine is maintenance friendly and portable, further improvements in its design are necessary so as to develop a system that will give desirable economic output at a shorter time.

3.1 Field survey



(Fig no.1- Field survey map)

Field survey is done by using the Google earth pro. In this project choose the two land in near by vittankulam the land are separated by two plots plot1 is used for implement new telescopic irrigation system , plot 2 is already butterfly head sprinkler are implemented.

Point	Latitude	Longitude
A	10*2′27.96″N	78*2′37.38″E
B	10*2′27.87″N	78*2′38.09″E
C	10*2′27.28″N	78*2′37.90″E

D	10*2′27.33″N	78*2′37.31″E

Plot 1- Innovative sprinkler irrigation system implement field

Point	Latitude	Longitude
A	10*2′27.42″N	78*2′38.03″E
B	10*2′27.35″N	78*2′38.54″E
C	10*2′26.71″N	78*2′38.45″E
D	10*2′26.83″N	78*2′37.98″E

Plot 2- Butterfly head sprinkler irrigation already Implemented field

3.1.1 Field Survey (plot-1)

(Fig no3- Measuring the field)

- Measuring the area and perimeter of the chosen plot to Implement the new sprinkler system
- Then finalising the spots for placing the sprinklers.

3.1.2 Area measurement

Plot-1

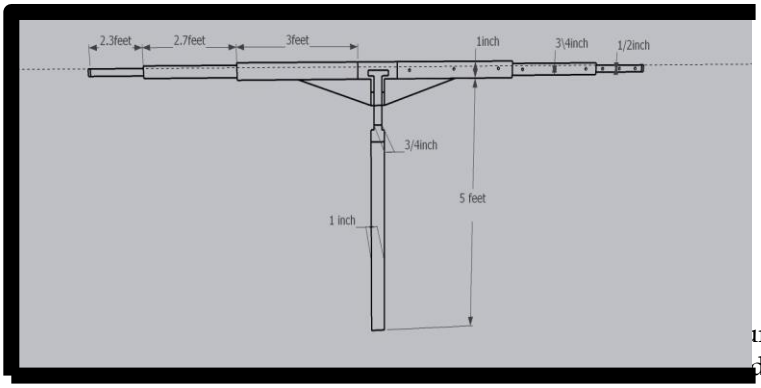
= 386.48 sq.m
= 9.6 cent

= 0.096 Acre.

Plot-2

= 452.19 sq.m
= 11.7 Cent
= 0.117 Acre

3.2 Designing the model irrigation structure



ure .
d .

- The pipes are 2.54cm (1″), 1.905cm (3/4″), 1.27cm (1/2″) in diameter.

- ❖ T-Joint (2.54cm in dia.) are used .
- ❖ The pipes are separated to three parts based on the pipe diameter
- ❖ The first part pipe (2.54cm) is connected to the T-Joint in both side
- ❖ The second part of the pipe(1.905cm in dia.) is connected to the first pipe end and the rubber washer are provided to avoid the leaking .
- ❖ The third part of the pipe (1.27cm in dia.) is connected to the second pipe end . The end cape are used to enclosed the pipe end.
- ❖ The pipes are perforated pipe hole are present inside and bottom of the pipes, the bottom side pipe hole's are very small hole .
- ❖ The "v" shaped frame are used to carry the structure for prevent the elongation. And addedly provide the strength.

3.3 Conduct the required test's

The irrigation system need a some test's for working properly. The tests was conduct in the chosen field. The test's are

I. Specific gravity determination by Pycnometer
II. Determination of uniformly co-efficient of Sprinkler irrigation system(catch can's method)
III. Determination of soil moisture wetting pattern for irrigation scheduling
IV. Determination of infiltration rate using double ring infiltrometer
V. Grain size analysis by using Mechanical shaker
VI. Determination of Root zone depth (Tuberose**)**

3.4 Farmer's review

Conduct the Farmer's review for analysis compare the conventional irrigation system and innovative irrigation system. The farmer's review are conduct in near by implemented field. The farmer names is
Sekar
Manikandan Rajkumar

3.5 Designing the Final Irrigation structure

Designing the final irrigation structure based on the Test's and farmer's review. This design make a solution to the farmer query's and its overcome the conventional irrigation method draw back.

3.6 Collection of Materials

The main material of structure making is
PVC material

I. "T"-joint 2.54cm(1')
II. PVC-pipe 2.54cm(1')
III. PVC-Pipe 1.9cm(3/4')
IV. PVC-Pipe 1.27cm(1/2')

3.7 Preparation of working model

Preparation of working model include the fitting pipe, connected the T- joint to pipe, Fitting the Telescopic based model pipe to T- joint. Dug the field and placed the base of the structure in the field. Ensure the all pipes are fitted correctly.

3.8 Submission of Working Model

The prepared structure are placed in the chosen field and connected the main irrigation line to run the motor and check the structure performance. Its include the comparison between butterfly head sprinkler and innovative sprinkler.

4.1 Result and analysis

4.1.1 Farmers review

Name : Sekar Village : Vittankulam Crop : Tuberose
Irrigation type: Spray gun Land area :1acre
Cost :70,000
Time of irrigation : 1 – 2hr Pump capacity : 5hp
Benefits

- It is very useful to kill Aloe vera aphid (Aloephagus myersi) insect.
- This type of irrigation is covered high area

Name : Rajkumar
Village :Melachinnampatti Crop :Tuberose
Irrigation type :Sprinkler butterfly head Land area :1Acre
Cost :70k per acre
Time of irrigation : 1hrs-2hrs Pump Hp : 5hp
Benefits:

- It's very use full to kill the *Aloephagus myersi* insect.
- Easy to the irrigation**.**
- Drawbacks
- It's have a more soil erosion

- It's have a issue of Ant nest in to the sprinkler head, It's block the water discharge.

Name : Manikandan Village :Vittankulam Crop :Tuberose
Irrigation type : Sprinkler butterfly head Land area : 1Acre
Cost :50k per acre
Time of irrigation : 1hrs 3inch discharge Pump Hp : 6hp
Benefits:

- It's very use full to kill the *Aloephagus myersi* insect.
- Easy to the irrigation. Drawbacks
- It's have a more soil erosion
- It's have a issue of Ant nest in to the sprinkler head, It's block the water discharge.

4.2 Test's for sprinkler irrigation system

4.2.1 Specific Gravity Determination of Pycnometer

In this test using Materials are Pycnometer, IS Sieve, weighing balance and oven.
Specific gravity is defined as the ratio of weight of soil solids at given temperature to the weight of equal volume of water at that temperature. IS specifies 27°C as the standard temperature for recording specific gravity.

- ❖ Dry the pycnometer and weight it with its cap(W1)
- ❖ Take the about 200gm of oven dried soil passing through the 2mm sieve in to the pycnometer and weigh again(W2)
- ❖ Add the significant amount de-aried water to cover the soil and screw on the cap
- ❖ Shake the pycnometer and remove the entrapped air if any
- ❖ After the air is removed, fill the pycnometer with water completely
- ❖ Thoroughly dry the pycnometer from outside and weigh it(W3)
- ❖ Clean the pycnometer by washing thoroughly
- ❖ Fill the clean pycnometer completely with water up its top width cap screw on.
- ❖ Weight the pycnometer after drying it on the outside thoroughly.(W4)
- ❖ Repeat the procedure for 3 sample and obtain the average value of specific gravity.

Formula

SPECIFC GRAVITY(G) = (W2-W1)/(W4-W1)- (W3-W2)

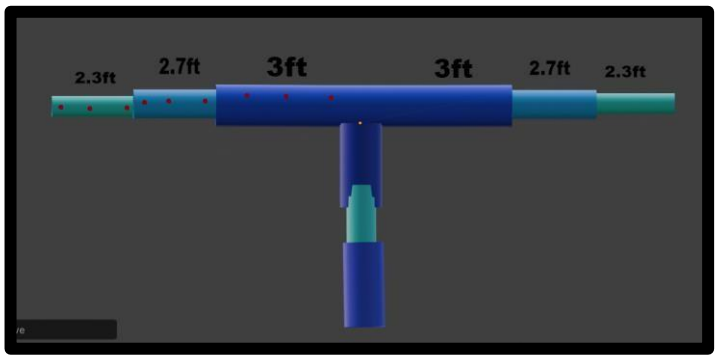
Calculation
Where

W1- Dry pycnometer weight with cap
W2- Pycnometer weight with 200g sample W3- Pycnometer weight with fill the 3:2
W4- Pycnometer weight with full of water

- The third part of the pipe (1.27cm in dia.) is connected to the second pipe end . The end cape are used to enclosed the pipe end.
- The pipes are perforated pipe hole are present inside and bottom of the pipes, the bottom side pipe hole's are very small hole .

W1=635g W2=1247g W3=1750g W4=1445g
G=(1247-635) / (1445-625)-(1750-1247)
=612 / (810-503)
=61 / 307
=1.99 ~2

4.3 Fabrication



(Fig no 14- Design Structure)

4.3.1 Collection of material

PVC pipe
Pipe (2.54cm) diameter

- Pressure rating's 450psi
- Length of the pipe 91.44cm Pipe(1.9cm) diameter
- Pressure rating's 480psi
- Length of the pipe 82.3cm Pipe (1.27cm) diameter
- Pressure rating's 600psi
- Length of the pipe 70.1cm

4.3.2 Preparation of working Model

Fitting the Pipe

- The pipes are separated to three parts based on the pipe diameter
- The first part pipe (2.54cm) is connected to the T-Joint in both side.
- The second part of the pipe(1.905cm in dia.) is connected to the first pipe end and the rubber washer are provided to avoid the leaking .

4.3.3 Fitting the "T"-Joint

- First set a 1" T-Joint on top of the structure it's connected the main 1" pipe
- Second connect the ¾" pipe to the T-Joint

- Thirdly use a 1" pipe it's fitted to a ¾"pipe and its connected to the reducer.
- The Reducer is fitted to the 4ft main pipe line

4.3.4 Preparation of working Model

- Setting the base for structure
- Using the "T"-Joint the T-Joint one end of connected to the main water pipe line second end is connected to the 1m PVC pipe
- The PVC pipe was buried to the field
- The pipe was buried for provide the extra stability to the structure
- It's provided the safety from wind
- The alternative end of T=Joint is connected to the structure.
- The structure pipe line was connected to the buried T- joint pipe
- The PVC Pipe length in 4ft. the length of the pipe is based on the plant size.
- The pipe line diameter is 1"
- Connected the T-Joint on base pipe
- This T-Joint is use to carry the Perforated pipe
- This joint is use to rotate the full structure
- The next step is connected the perforated pipe to T-joint
- The perforated pipe holes are arranged in 15cm space between one to another
- The pipes are connected in descending order
- First pipe is 2.54cm,Second pipe is 1.905cm,Third pipe is 1.27cm
- The end cape was fitted on Third pipe

4.5 Difference between sprinkler irrigation and innovative irrigation system

s.no	Perimeter	Sprinkler	Innovative sprinkler
1	Lateral length	15*5=75m	10*2=20m
2	Operating pressure	4.23 kg/c m^2	2.1kg/cm^2
3	Nozzle size	5.5563*3.175mm	5.5563*3.175mm
4	Diameter of coverage	6m	10-15m

5	Discharge of nozzle	$0.833*10^{-3/s}$	$0.588*10^{-3/s}$
6	Total no of sprinkler(10 cent)	25	4
7	Permissible head loss due to friction	6.46m	2.22m
8	Total flow through the lateral	4.165*10-3m3/s	$1.76*10^{-3m3/s}$
9	Total design head	82.61m	52.12m
10	Pump efficiency	70%	70%
11	Pump capacity	2hp	3hp
12	System cost	50k-70k per acre	15k-20k per acre
13	Irrigated time	30 min	15 min
14	Flow rate	10L/min	
15	Uniformly co-efficient	64%	77%
16	Application rate	1.3m/s	0.85m/s
17	Soil erosion	High	Medium
18	Velocity	1.5m/s	

5.1 CONCLUSION

- This innovative irrigation system is over come the normal sprinkler irrigation
- The innovative irrigation system consumed time is low compare to normal sprinkler irrigation
- In normal sprinkler irrigation one head coverage is 6m. Our innovative sprinkler coverage is 10-15m
- The innovative irrigation system protect the crop from aloe vera aphid (*Aloephagus myersi*) insect attack.
- The normal irrigation system cost for 1acre is 50-70k, innovative irrigation system cost for 10 cent is 5k-8k
- It's also used for horticultural crops

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